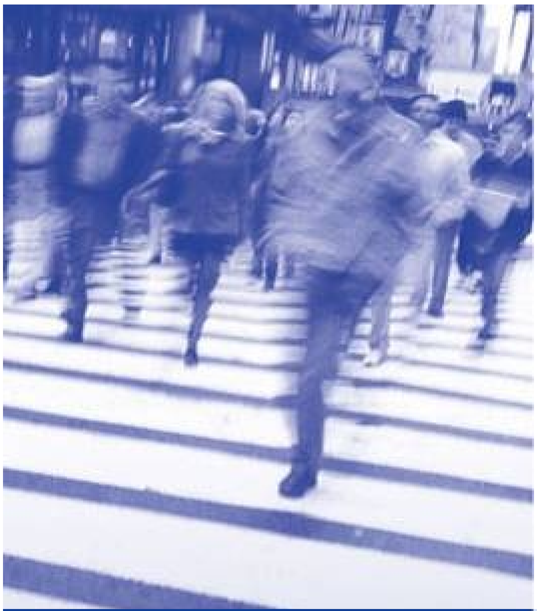

CIVITAS
Cleaner and better transport in cities

ARCHIMEDES
AALBORG • BRIGHTON & HOVE • DONOSTIA - SAN SEBASTIÁN • IAŞI • MONZA • ÚSTÍ NAD LABEM

D8.1 – Development and Experience of Bus Management and Traveller Information Systems in ARCHIMEDES

November 2012

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1. Introduction

1.1 Background CIVITAS

CIVITAS - cleaner and better transport in cities - stands for CIty-VITAlity-Sustainability. With the CIVITAS Initiative, the EC aims to generate a decisive breakthrough by supporting and evaluating the implementation of ambitious integrated sustainable urban transport strategies that should make a real difference for the welfare of the European citizen.

CIVITAS I started in early 2002 (within the 5th Framework Research Programme);
CIVITAS II started in early 2005 (within the 6th Framework Research Programme) and
CIVITAS PLUS started in late 2008 (within the 7th Framework Research Programme).

The objective of CIVITAS-Plus is to test and increase the understanding of the frameworks, processes and packaging required to successfully introduce bold, integrated and innovative strategies for clean and sustainable urban transport that address concerns related to energy-efficiency, transport policy and road safety, alternative fuels and the environment.

Within CIVITAS I (2002-2006) there were 19 cities clustered in 4 demonstration projects, within CIVITAS II (2005-2009) 17 cities in 4 demonstration projects, whilst within CIVITAS PLUS (2008-2012) 25 cities in 5 demonstration projects are taking part. These demonstration cities all over Europe are funded by the European Commission.

Objectives:

- to promote and implement sustainable, clean and (energy) efficient urban transport measures;
- to implement integrated packages of technology and policy measures in the field of energy and transport in 8 categories of measures;
- to build up critical mass and markets for innovation.

Horizontal projects support the CIVITAS demonstration projects & cities by:

- Cross-site evaluation and Europe wide dissemination in co-operation with the demonstration projects;
- The organisation of the annual meeting of CIVITAS Forum members;
- Providing the Secretariat for the Political Advisory Committee (PAC);
- Development of policy recommendations for a long-term multiplier effect of CIVITAS.

Key elements of CIVITAS

- CIVITAS is co-ordinated by cities: it is a programme 'of cities for cities';
- Cities are in the heart of local public private partnerships;
- Political commitment is a basic requirement;
- Cities are living ‘Laboratories' for learning and evaluating.

1.2 Background ARCHIMEDES

ARCHIMEDES is an integrating project, bringing together 6 European cities to address problems and opportunities for creating environmentally sustainable, safe and energy efficient transport systems in medium sized urban areas.

The objective of ARCHIMEDES is to introduce innovative, integrated and ambitious strategies for clean, energy-efficient, sustainable urban transport to achieve significant impacts in the policy fields of energy, transport, and environmental sustainability. An ambitious blend of policy tools and measures will increase energy-efficiency in transport, provide safer and more convenient travel for all, using a higher share of clean engine technology and fuels, resulting in an enhanced urban environment (including reduced noise and air pollution). Visible and measurable impacts will result from significantly sized measures in specific innovation areas. Demonstrations of innovative transport technologies, policy measures and partnership working, combined with targeted research, will verify the best frameworks, processes and packaging required to successfully transfer the strategies to other cities.

Modern transport telematics systems offer opportunities to make urban transport faster, more efficient and to support travellers. A large number of CIVITAS cities have invested in the provision of information via electronic displays at bus, tram or metro stops, keeping track of delays and giving patrons an estimate of the waiting time for the next vehicle. Real-time information tools have also been widely used in CIVITAS through the Internet, mobile phones, mobility centres and kiosks.

Information technologies are also heavily used as part of traffic strategies. Active traffic management allows monitoring of the real-time traffic situation, which varies depending on congestion, weather, accidents, road works, time of day, etc., and controls traffic flows using that information.

Communication technology can help to better co-ordinate traffic flows with the help of satellite-based applications, global positioning systems, wireless data transmission, automated traffic counting devices, and high-resolution cameras. These new technologies allow transport management for example to give priority to public transport, improve parking management and better enforce road rules. They can also provide passengers with real-time information and mobile guidance.

Essentially, transport telematics is the application of a combination of information technology, communications and control technologies to the transport sector. Transport telematics systems have the potential to contribute to all areas and modes of transport, the vehicles, the infrastructure, the organisation and management of transport and the interfaces between all of these elements.

The main objectives of the initiatives regarding transport telematics are firstly to reinforce the integration of the different transport management systems which are often functionally dedicated and/or run by different operators. The second objective is to strengthen the services that information systems may bring to passengers.

Other related objectives of such improvements are:

- To improve the management of traffic within the city centre;
- To increase use of public transport via prioritised services and active management;
- To reduce traffic congestion;
- To improve the quality of travel information.

2 Participant Cities

The ARCHIMEDES project focuses on activities in specific innovation areas of each city, known as the ARCHIMEDES corridor or zone (depending on shape and geography). These innovation areas extend to the peri-urban fringe and the administrative boundaries of regional authorities and neighbouring administrations.

The two Learning cities, to which experience and best-practice will be transferred, are Monza (Italy) and Ústí nad Labem (Czech Republic). The strategy for the project is to ensure that the tools and measures developed have the widest application throughout Europe, tested via the Learning Cities' activities and interaction with the Lead City partners.

2.1 Leading City Innovation Areas

The four Leading cities in the ARCHIMEDES project are:

- Aalborg (Denmark);
- Brighton & Hove (UK);
- Donostia-San Sebastián (Spain);
- Iasi (Romania).

Together the Lead Cities in ARCHIMEDES cover different geographic parts of Europe. They have the full support of the relevant political representatives for the project, and are well able to implement the innovative range of demonstration activities.

The Lead Cities are joined in their local projects by a small number of key partners that show a high level of commitment to the project objectives of energy-efficient urban transportation. In all cases the public transport company features as a partner in the proposed project.

2.2 Aalborg

The City of Aalborg, with extensive experience of European cooperation and having previously participated in CIVITAS I (VIVALDI) as a 'follower' city, is coordinating the consortium and ensures high quality management of the project. The City has the regional public transport authority (NT) as a local partner, and framework agreements with various stakeholder organisations.

Aalborg operates in a corridor implementing eight different categories of measures ranging from changing fuels in vehicles to promoting and marketing the use of soft measures. The city of Aalborg has successfully developed similar tools and measures through various initiatives, like the CIVITAS-VIVALDI and MIDAS projects. In ARCHIMEDES, Aalborg aims to build on this work, tackling innovative subjects and combining with what has been learned from other cities in Europe. The result is an increased understanding and experience, in order to then share with other Leading cities and Learning cities.

Aalborg has recently expanded its size by the inclusion of neighbouring municipalities outside the peri-urban fringe. The Municipality of Aalborg has a population of some 194,149, and the urban area a population of some 121,540. The ARCHIMEDES corridor runs from the city centre to the eastern urban areas of the municipality and forms an ideal trial area for demonstrating how to deal with traffic and mobility issues in inner urban areas and outskirts of the municipality. University faculties are situated at 3 sites in the corridor (including the main university site). The area covers about 53 square kilometres, which is approximately 5 % of the total area of the municipality of Aalborg. The innovation corridor includes different aspects of transport in the urban environment, including schools, public transport, commuting, goods distribution and traffic safety. The implementation of measures and tools fit into the framework of the urban transport Plan adopted by the Municipality.

Figure 1: The Archimedes Corridor in Aalborg

2.3 Brighton & Hove

Brighton & Hove is an historic city, in the south-east of England, known internationally for its abundant Regency and Victorian architecture. It is also a seaside tourist destination, with over 11km of seafront attracting eight million visitors a year.

In addition, it is a leading European Conference destination; home to two leading universities, a major regional shopping centre, and home to some of the area's major employers. All of this, especially when set against the background of continuing economic growth, major developments across the city and a growing population, has led the city council to adopt a vision for the city as a place with a co-ordinated transport system that balances the needs of all users and minimises damage to the environment.

The sustainable transport strategy that will help deliver this vision has been developed within the framework of a Local Transport Plan, following national UK guidelines. The ARCHIMEDES measures also support the vision, which enables the city to propose innovative tools and approaches to increase the energy-efficiency and reduce the environmental impact of urban transport.

2.4 Donostia - San Sebastián

The city of Donostia -San Sebastian overlooks the sea and, with a bit more than 180,000 inhabitants, keeps a human scale. Some people consider the balanced combination of small mountains, manor buildings, and sea as the setting for one of the most beautiful cities in the world. We have a tradition in favouring pedestrians, cyclists and public transport.

For about twenty years, the city has been enforcing a strong integrated policy in favour of pedestrians, bicycles and public transport. Considering walking and cycling as modes of transport, has led to the building of a non-motorised transport network for promoting this type of mobility around the city.

Likewise, the city has extended its network of bus lanes. The city holds one of the higher bus-riding rates, with around 150 trips per person per year.

The CIVITAS project is being used as the perfect opportunity to expand Donostia -San Sebastian's Sustainable Urban Transport Strategy. With the package of CIVITAS measures Donostia-San Sebastian will:

- Increase the number of public transport users;
- Decrease the number of cars entering in the city centre;
- Increase the use of the bicycle as a normal mode of transport;
- Maintain the high modal share of walking;
- Reduce the number of fatal accidents and accidents with heavy injuries;
- Reduce the use of fossil fuels in public transport.

2.5 Iasi

The City of Iasi is located in north-eastern Romania and is the second largest Romanian city, after Bucharest, with a population of 366,000 inhabitants. It is also the centre of a metropolitan area, which occupies a surface of 787.87 square kilometres, encompassing a total population of 398,000 inhabitants.

The city has five universities with approximately 50,000 students, the second largest in Romania. The universities and their campuses are located in the central and semi-central area of the city. In the same area, there are also a large number of kindergartens, schools and high schools with approximately 10,000 pupils. This creates a large number of routes along the main corridor, served by the public transport service number "8" (Complex Tudor Vladimirescu - Copou) with an approximate length of 10 km. The City of Iasi will implement its integrated measures in this area to be known as the 'CIVITAS+Corridor'.

The city's objectives in CIVITAS - ARCHIMEDES are based on the existing plans related to transport, Local Agenda 21, approved in 2002, and the Sustainable Social-Economic Development Strategy for City of Iasi. The CIVITAS Plus objectives will be integrated in the Strategy for metropolitan development which was finalized in October 2009.

2.6 Monza

Monza is a city on the river Lambro, a tributary of the Po, in the Lombardy region of Italy, some 15km north-northeast of Milan. It is the third-largest city of Lombardy and the most important economic, industrial and administrative centre of the Brianza area, supporting a textile industry and a publishing trade. It is best known for its Grand Prix.

The City of Monza, with approximately 121,000 inhabitants, is located 15 km north of Milan, which is the centre of the Lombardia area. This area is one of the engines of the Italian economy; the number of companies is 58,500, i.e. a company for every 13 inhabitants.

Monza is affected by a huge amount of traffic that crosses the city to reach Milan and the highways nodes located between Monza and Milan. It is also an important node in the Railways network, crossed by routes connecting Milan with Como and Switzerland, Lecco and Sondrio, Bergamo and Brianza. 'Regione Lombardia', which in the new devolution framework started in 1998, has full responsibility for establishing the Local Public Transportation System (trains, coaches and buses) and has created a new approach for urban rail routes using an approach similar to the German S-Line or Paris RER.

Monza has recently become the head of the new "Monza and Brianza" province, with approximately 750,000 inhabitants, so will gain the full range of administration functions by 2009. Plan-making responsibilities and an influence over peri-urban areas will require the city to develop new competencies.

In this context, the objective of the City of Monza in participating in CIVITAS as a Learning City is to set up an Urban Mobility System where the impact of private traffic can be reduced, creating a new mobility offer, where alternative modes become increasingly significant, leading to improvements to the urban environment and a reduction in energy consumption (and concurrent pollution).

2.7 Ústí nad Labem

Ústí nad Labem is situated in the north of the Czech Republic, about 20 km from the German border. Thanks to its location in the beautiful valley of the largest Czech river Labe (Elbe) and the surrounding Central Bohemian Massive, it is sometimes called 'the Gateway to Bohemia'. Ústí is an industrial, business and cultural centre of the Ústí region.

Ústí nad Labem is an important industrial centre of north-west Bohemia. The city’s population is 93,859, living in an area of 93.95km^2. The city is also home to the Jan Evangelista Purkyně University with eight faculties and large student population. The city used to be a base for a large range of heavy industry, causing damage to the natural environment. This is now a major focus for improvement and care.

The Transport Master Plan, to be adopted in its first form in 2007, will be the basic transport document for the development of a new urban plan (2011), which must be developed by the City subject to the provisions of the newly adopted Building Act. This will characterise the development of transport in the city for the next 15 years, and so the opportunity to integrate Sustainable Urban Transport Planning best practices into plan development during the project means an ideal match of timing between city policy frameworks and the ARCHIMEDES project.

The projects main objective is to propose transport organisation in the city, depending on the urban form, transport intensity, development of public transport, and the need for access. The process, running until 2011, will include improving the digital model of city transport that Ústí currently has at its disposal. The plan will have to deal with the fact (and mitigate against unwanted effects that could otherwise arise), that from 2010, the city will be fully connected to the D8 motorway, running from Prague to Dresden.

3. Background to the Deliverable

This deliverable summarises the research and demonstration activities conducted in relation to workpackage 8 of the CIVITAS ARCHIMEDES project – Transport telematics.

3.1 Introduction to the Measures

Research and demonstration activities in respect of transport telematics have been conducted in five of the ARCHIMEDES cities, namely Aalborg, Brighton, Donostia - San Sebastian, Iasi and Monza, in the form of measures 3, 68, 69, 70, 71, 72, 73, 74, 75, 76, 77, 78, 79, 80, 81 and 82. These measures are introduced in the following sections.

The results from the individual measures are reported in detail as follows:

Measure No:	Research Deliverables	Implementation Deliverables
3		T3.1
68		T68.1
69		T69.1
70	R70.1	T70.1
71		T71.1 T71.2
72		T72.1
73		T73.1
74		T74.1
75	R75.1	T75.1
76		T76.1
77		T77.1
78	R78.1	T78.1
79	R79.1	T79.1
80	R80.1	T80.1
81	R81.1	T81.1
82	R82.1	T82.1

This deliverable draws together the experiences gained from the individual measures and presents the common issues and conclusions that can be drawn at the workpackage level. Further information and outcomes of the measures can be found in D10.3 Final Evaluation Report and D12.4 Final version of measure level result templates.

Measure 3: Emissions Variable Message Signs (VMS) in Brighton & Hove

The measure monitored vehicle emissions and ambient air quality around three schools to educate pupils about their environment and how local transport activity could affect this. The intention was that the VMS relayed information about vehicle emissions and their impact on local air quality. This was combined with educational programmes at the schools to raise awareness about the link between the emissions from traffic and air pollution.

Measure 68: Pre-trip & On-trip Mobile Phone Information in Aalborg

In this measure, a mobile portal for public transport was developed, including a set of Location Based Services for mobile phones. The services included real time information from the 30 nearest bus stops selected from a user's present GPS position, and a 'Take Me Home' service that gave the user a combined walking and public transport trip from their present position to a predefined home address.

Measure 69: On-trip Bus Traveller Information in Aalborg

In this measure, on-board information screens were implemented on 100 city buses. These information screens showed information about the current trip in terms of upcoming bus stops, the overall trip destination and other services such as traffic information, news, weather forecast and advertisements. Indicators on passenger numbers were covered by an overall analysis of the modal shift in the ARCHIMEDES corridor, developed across the measures.

Measure 70: Congestion Monitoring Using Telematics in Aalborg

This measure aimed to influence car drivers' choice of routes and travel time, and thereby reduce congestion during rush-hours. Congestion measurements during the day enabled provision of information about travel time savings if journeys were re-scheduled away from the peak period. This measure included two different initiatives that focused at reducing congestion levels within Aalborg:

- Implementing navigation systems in 100 taxis to gather data on travel time and congestion levels

- Adaptive Traffic Signal Control System (SPOT) which allowed central monitoring and expanded possibilities for operating traffic signals.

Measure 71: Personalised Travel Information Website for Brighton & Hove

The main task was to make the journey planner available on mobile phones so that people could access real time bus and train information and journey planning whilst they were on the move. The mobile version of the website included a journey planner which compared mode of travel, calories burned, distance, time, costs and carbon emissions for all travel modes (walking, cycling, public transport, and car) and for each trip requested by the user. A secondary task was to install two interactive bicycle counters in the city that displayed the number of cyclists passing.

Measure 72: Public Transport Information for Visually Impaired People in Brighton & Hove

"Talking bus stops" were introduced in August 2007 and launched city-wide at 22 bus stops in Brighton & Hove and East Sussex. The main task within ARCHIMEDES was to install an additional 12 audio units at bus stops in the CIVITAS corridor, and purchase a further 200 key fobs for distribution to the blind and partially sighted community in Brighton & Hove.

Measure 73: Bus Traveller Information in Donostia - San Sebastián

Within this measure, a more efficient travel information system was implemented. The system enabled current and potential public transport to better plan trips and to optimise their travel times. This was achieved mostly by reducing waiting times at stops and favouring reliable connections with other services. The new system provided real time information such as arriving bus lines, waiting times, connections and service incidents, through the following means:

- Real time information system on-board buses announcing next stop and connections;
- Electronic information panels at bus stops providing information on arriving buses, waiting times and disruptions or re-directions of services;
- Provision of bus arrival times by SMS messages;
- Provision of bus arrival times via Bluetooth;
- Renewed web site including real time information at bus stop level and a route planner.

Measure 74: Bus Management System in Donostia - San Sebastián

The Public Transport Company (CTSS-DBUS) introduced a new fleet management system that used HSDPA-3G (Wi-Fi) communication technology to communicate between buses and a central information system. CTSS-DBUS also introduced a new expert planning and fleet management system. This enabled the company to respond adequately to user mobility needs by optimizing the number of buses and drivers required.

Measure 75: Park and Ride Guidance System in Donostia - San Sebastián

Within this measure, the Municipality of Donostia - San Sebastián implemented an integrated parking guidance system. This helped drivers in their search for parking, providing information through VMS about the location and occupancy rates of both inner-city underground parking and Park & Ride facilities. The goal was to reduce on-street parking and more particularly increase the use of Park & Ride facilities, to which drivers were preferably directed.

Measure 76: Bus Management System in Iasi

To better organise the public transport fleet, Iasi City Hall and the Public Transport Company of Iasi (RATP) implemented a common platform for an integrated monitoring system. Within this 36 trams and 64 buses were controlled through GPS modules, optimising the transport schedule. Data was gathered from surveys and the GPS to evaluate awareness and acceptance levels, and service quality and reliability.

Measure 77: Public Transport Planner in Iasi

In this measure a public transport website was created. The website offered integrated information about local and regional transport services, i.e. buses and trams with an interactive map, rail and airport schedules, and taxi and car rental possibilities. A scheduler for planning personalised journeys was also provided. By offering this online tool, Iasi was able to communicate to users' so that travel needs and demands were met.

Measure 78: Bus Management System in Monza

In Monza, all the buses of the fleet were equipped with a localisation device which sent the position of each bus to a central server. A website was developed by the public transport fleet owner. Data concerning bus locations and the status of buses with respect to their timetable were provided through the website. It was queried every ten seconds to gather the data concerning the fleet operations.

Measure 79: Improved Traveller Information in Monza

Within this measure, Passenger Information Display Systems (PIDS) were installed at the most frequented bus stops in the CIVITAS corridor. Further, an interactive totem was installed at Porta Castello interchange node to provide complete information on the public transport service to passengers (timetables, routes).

Measure 80: Park and Ride Guidance System in Monza

Within this measure, a study was undertaken by the technical partner of Commune di Monza (PA) and the public transport company (TPM) to design a real time parking guidance system. A networked VMS system was implemented on key routes within the city of Monza. 55 excavations were performed, street works were completed, and four signs were equipped with VMS. Information was provided about mobility, street works and events occurring in the city. These four panels were located on the four main roads leading to the city centre.

Measure 81: Urban Traffic Control (UTC) System in Monza

Within this task a UTC system was designed and implemented. The system contributed to maximising the flow of traffic through the identified CIVITAS corridor in the city of Monza. The following actions were accomplished:

- Collection of information and analysis of traffic light plans at relevant intersections;
- Design and coding of new co-ordinated traffic light plans taking into account the results of microsimulation activities carried out in the RTD stage;
- Test and activation of the new traffic plans.

Measure 82: Public Transport Priority System in Monza

This measure included implementing a framework allowing the traffic light phasing of intersections managed by UTC to adapt when buses would benefit from a longer green phase at intersections with respect to the overall traffic status. The research task focused on the conceptual approach. The demonstration stage focused on applying this approach in the real context.

4. Analysis

4.1 Comparison of Measures

4.1.1 Objectives

The 16 measures covered a broad range of telematics and information systems for increasing usage and effectiveness of public and private transport. The projects are categorised into 5 overarching themes: Public Transport Information, Journey Planners, Bus Management Systems, Parking Guidance Systems and Congestion- and Emission Monitoring Systems.

Public Transport Information

The measures regarding public transport aimed at providing information to users to increase levels of satisfaction. Further, the measures aimed at providing information on the waiting times to increase the acceptance of waiting. A final common objective was to increase accessibility to Public Transport by increasing the understanding of schedules and to provide dedicated information to different user groups, for example blind people.

The objectives of the on-trip bus traveller information system in Aalborg were to:

- Increase the number of users of public transport;
- Increase satisfaction among users;
- Provide users with real time passenger information (RTPI) about current trips and transfer possibilities to reduce barriers to using public transport;
- Demonstrate whether on board bus-trip information would lead to increased user satisfaction.

In Brighton & Hove the focus was on visually impaired people and the objectives were:

- To equip bus stops with devices providing audio messages to blind and partially sighted people to help make public transport more accessible;
- In turn, it was intended to encourage greater use of public transport.

In Monza, the focus was to provide the daily users of public transport with real time information and the objectives were to:

- Render public transport more effective and appealing for daily use;
- Improve traveller information in relation to the public transport fleet;
- Implement a real time information system for urban public transport.

In Donostia - San Sebastián the main objectives were to increase the reliability and availability of travel information, and to make this information accessible to visually impaired people. The targets were:

- Increased reliability of travel time;
- Higher frequency of service;
- Increased quality of service.

Journey Planners

The overall objective for the measures regarding journey planners was to improve availability of Public Transport information. Real time information and personalised travel information were other objectives.

In Aalborg, the focus was on mobile phones. A GPS application was developed and incorporated in the national journey planner. The objectives were to:

- Increase the number of public transport users;
- Increase satisfaction among users;
- Provide information to attract new users to public transport – including tourists not familiar with the public transport system;
- Provide users with Real Time Information in a convenient format on their mobile phone for all bus stops within the corridor.

In Brighton & Hove the measure aimed at achieving modal shift by providing citizens with a mobile version of personalised travel information. The objectives were to:

- Improve availability of transport information;
- Develop a personalised travel information website for visitors and residents;
- Develop a mobile version of personalised travel information;
- Raise public awareness that cycling was an everyday activity in the city rather than a 'niche' market.

In Iasi, the aim was to create a web-based tool for public transport journey planning. This instrument was intended to support the measures improving the quality and reliability of public transport services. The objectives were to improve access to public transport information and thereby increase passenger numbers.

Bus Management Systems

The objectives of the bus management systems were to reduce travel times for Public Transport and to create more efficient and optimised systems based on current infrastructure and materiel.

In Donostia - San Sebastián the objectives of the fleet management system were to:

- Introduce a new fleet management system that enabled CTSS-DBUS to respond adequately to the mobility needs of users;
- rationalise public transport to make it more competitive compared to the private car.

The measure comprised state-of-the-art expert planning and fleet management systems. The communication between the central information systems and buses was based on Wi-Fi technology (HSDPA-3G).

In Iasi, the main objective was to build a common platform for integrated monitoring and passenger information services. The system made it possible to monitor and plan public transport services. In addition, it increased the level of information offered to users of these services. Improving public transport services through the implementation of these systems aimed at reaching:

- A change user perception and consequently an increase in user numbers;
- Reduced waiting times in stations;
- A reduction in the number of incidents involving public transport vehicles.

In Monza, the main objective was to provide the city of with information that optimised bus fleet operation to make energy savings and to reduce travel times.

Parking Guidance Systems

In Donostia - San Sebastián the objective was to provide an alternative mobility option for commuters that previously had inadequate access to the public transport network at the origins of their trips. By offering parking at a lower price than in the city centre, the measure contributed to the overall city/corridor level objective of reducing the number of cars entering the city centre by 5 %.

In Monza, the objective was to design and implement a real time parking guidance system to search traffic and inform drivers about occupancy rates of relevant urban parking areas. This minimised time spent looking for parking. Some of the dynamic information panels concerning occupation rates were augmented with a free message sign that could be used for other purposes.

Congestion and Emission Monitoring Systems

In Aalborg, the objectives of the measure regarding congestion monitoring were to:

- Improve traffic management in the city centre;
- Provide new and innovative information to all road users, and influence their choice of route and travel time during the day

- Demonstrate impacts of advanced signal control systems on traffic flow and congestion during rush-hours;
- Reduce congestion in peak periods. This would provide better conditions for public transport which thereby would be a more attractive mode.

In Monza, the objective was to implement an urban Traffic Control System. This had centralised control of eight important intersections, and traffic light plans were managed to improve the flow on several critical routes. A further objective was to enable Public Transport Priority management.

In Monza, the Public Transport Priority System was closely linked to the UTC system in measure 81. The objective was to maximise priority for buses without worsening congestion problems.

In Brighton & Hove, the measure focussed on awareness of emissions at school roads. The initial objective was to install VMS signs displaying the level of passing vehicle emissions. Those shown as poor, would receive a subsidised emissions check and repair work. However, due to technical problems, the objective was subsequently revised to focus on an emissions monitoring and education package in conjunction with local schools.

4.2 Differences in Approach

Research and preparatory activities for demonstrations of transport telematics and information systems were conducted in three of the ARCHIMEDES cities, namely Aalborg, Donostia - San Sebastián and Monza.

Public Transport Information

In Aalborg, the planning and pre-data collection phase started in winter 2008. A working group was formed, consisting of the ARCHIMEDES measure leader, two people from the bus fleet operator, Nordjyllands Trafikselskab, the Public Transport Authority of North Jutland (NT), and a traffic planner from the Department for Sustainable Development of the City of Aalborg. In 2009, NT initiated a pilot project on one selected bus line to test the system and to gather user evaluations as input to the final system. The pilot project consisted of installation of software and two flat screens in each of 6 buses on the bus line, starting in June 2009. The screens included information on the current trip, news, advertisements and the next bus stop was announced through loudspeakers.

After the pilot project, experiences with the user interface and the passengers' acceptance were collected with the help of a questionnaire. This was conducted in November 2009 to which 368 people responded. The respondents showed a very positive attitude towards the information screens. Key results were:

- 88 % of the respondents liked the information screens;
- 87 % of the respondents found it positive that news and advertisements were shown as a supplement to traffic information;
- 91 % supported the method of providing traffic information on screens in buses;
- 90 % thought that the information screens were a service improvement;
- Only 15 % preferred announcements of the next bus stop via loudspeakers instead of the screens. (40 % preferred the information both via screen and loudspeakers, whereas 50 % preferred only to have the screen information.)

For the evaluation, a questionnaire was conducted in November 2010. The questionnaire undertaken was similar to the one conducted in 2009. A comparison was made to the first questionnaire to evaluate if the changes made in the final system had further improved satisfaction with the user interface and the passengers' acceptance.

Figure 2: The on-trip information screens are implemented in 100 buses in Aalborg.

In Brighton & Hove, the improvements of public transport information were directed at visually impaired people. The approach was to firstly identify the locations of the 12 units using the results from a user satisfaction survey carried out in January 2008. Then a working group was formed. This comprised members from the city's blind and partially sighted community, a member from an organisation representing local blind and partially sighted people and a member of staff from the City Council's Sensory Services team. The group was asked to comment and agree on the final locations for the 12 new units. Afterwards, the orientation messages were composed and recorded by the unit supplier in July 2009 and the first unit was installed September 2009. An information leaflet about the system was produced in December 2009 and the remaining 11 units were installed between January and March 2010.

In Monza, the improved traveller information was enabled by the activation of measure 78 (Bus Management System in Monza). This allowed bus tracking and monitoring. The approach covered both research and demonstration stages. Within the research task, the work focused on the study of the public transport service in Monza with the following activities:

- Analysis of the current regulatory framework;
- Analysis of the urban public transport network in Monza to identify the most suitable locations to install PIDS. Attention was primarily focused on the most frequented lines, which cover the CIVITAS corridor for public transport;
- Identification of the software and the technological framework to implement the measure, consisting of:
  - The electronic display to be installed at the bus stops;
  - An interactive totem to be installed at Porta Castello interchange to provide complete information on the public transport service to passengers (e.g. timetables, routes).

After these preliminary activities the work focused on 5 stages:

- Stage 1: Identification of bus stops;
- Stage 2: Inspections of locations of the bus stops;
- Stage 3: Installation of first two electronic bus stops ;
- Stage 4: Installation of the interactive totem;
- Stage 5: Completion of installation of electronic bus stops.

Figure 3: The improved traveller information in Monza consisted of electronic bus stop (pictured left) and the interactive totem (pictured right).

In Donostia - San Sebastián CTSS-DBUS prepared, purchased, installed, implemented, tested, demonstrated and monitored a new travel information system. Real time information was provided in the vehicles, via SMS messages and on a website that contained real time information for the bus stops along the CIVITAS corridor. In September 2009 CTSS-DBUS purchased a system for counting passengers and a system for the provision of real time information.

The approach was four-fold and CTSS-DBUS developed and implemented:

- A new website to provide real time information at bus stop level and a new route planner for the trips inside Donostia – San Sebastián using public transport, www.dbus.es;
- A real time information system on-board buses (next stop announcements), and provision of bus arrival times by SMS, by web and by electronic information devices at bus stops. The bus on-board and web information was adapted to visually impaired people.
- A new system for counting of passengers on bus lines of the high quality public transport corridors. The approach to the system was based on the development of:
    - New software for passenger counting;
    - Improvements to contactless card readers (new antenna, modulator box and logic plate) to count all kind of travellers using all kinds of smart contactless cards;
    - A new portable inspection assistant to check smart card validations and counts;
    - Extensive field work counting travellers' alighting at bus stops by time slots and type of day (weekdays, Saturdays, Sundays and holidays).

A large amount of traveller reports related to passenger counting (e.g. by line, stop, route, hour, trip.). This provided all the data necessary to take the best decisions and actions in the future concerning the bus service offer.

Journey Planners

In Aalborg, and in the rest of Denmark, an online multi-modal journey planner already existed. However, in order to improve the end-user functionality the approach was to add a GPS based function, named 'Take Me Home'. User could apply this to find the most convenient public transport journey from their current location to their home.

Firstly, a working group was formed consisting of the ARCHIMEDES' measure leader, two members from NT and a planner from the Department for Sustainable Development of the City of Aalborg. Within the working group, ideas were discussed, the solution designed and the project managed.

The planning started in the winter 2008 and strategic decisions were taken during 2009. Different possibilities for the framework were discussed. It was decided to subcontract with an IT company for the mobile portal. A decision was taken to co-operate with the National Journey Planner Cooperation (Rejseplanen A/S) owned by the Public Transport Authorities in Denmark since this would offer the best end-user product. This meant it was possible to build upon the National Journey Planner service and implement RTPI for the bus users in the Journey Planner. Different features of the measure were discussed and it was decided to focus on the following three features:

- The development of the mobile platform 'NTmobil.dk';
- The location based services providing RTPI via mobile phone on the nearest bus stops, based on GPS;
- The 'Take Me Home' feature for mobile phone based on GPS data and the National Journey Planner.

The mobile platform, NTmobil.dk, included a slight makeover of the mobile phone RTPI system, originally from the CIVITAS MIMOSA project. It was launched early in 2010. The 'Take Me Home' and the new GPS based RTPI were launched as a java application in October 2010. Migration of the functionality to HTML5 (an Internet technology which aim to reduce the need for plug-in based technologies like Adobe Flash, Sun Java etc.) is expected to be launched in a later generation.

In Brighton & Hove, the approach to the journey planner was to make it personal. The travel information website (JourneyOn) enabled users to obtain personalised information about their journeys, including optimum route, time required, calories burnt (by mode) and topography. Elements of this service were programmed to become accessible via smart phones. As a supplementary initiative to the personal journey planner two bicycle counters were established.

The implementation of the journey planner began with a technical review of other similar websites which already had established mobile versions. A plan for implementation was drawn up based upon the review. Then two suppliers were employed to design and deliver the measure. Once completed, the mobile site was tested and officially launched.

The approach was divided into an evaluation of options and actual recommendations to the system:

- Brighton & Hove City Council commissioned Atkins Limited to provide an evaluation of options for enhancements to the travel and transport information website, journeyon.co.uk. The report was completed in September 2010.
- The benefits and risks of each option were considered, along with their suitability for implementation using CIVITAS funding.

After consideration of those options, three recommendations were identified:

- Establish a social media presence using Facebook and/or Twitter;
- Create a device-adapted version of the JourneyOn site to deliver a simplified version of the pages. These would be more suited to the limitations of mobile web-devices and focusing on providing functions most beneficial to users on the go, specifically, real-time bus information and journey planning;
- Use the GPS functionality available to offer directions from the user's current location to their selected bus stop.

It was estimated that all of these changes could be implemented within a timescale of three to six months.

The JourneyOn mobile site was launched on 12 December 2011. The mobile version was launched via the JourneyOn website itself, BHCC's website and via social networking such as Facebook, Twitter and Yammer (council in-house social media site). When the site launched, the measure leader worked with the council's press and marketing teams and alongside transport colleagues to promote the initiative to as many users as possible. Various channels were used:

- the Council's corporate intranet which reaches 8,000 staff;
- the Council newsletter 'the Channel';
- 'City News', a free council magazine distributed to 125,000 households quarterly
- Other media outlets, including working with health partners to promote the mobile site in doctors surgeries and hospitals.

The site was monitored during the spring 2011.

Figure 4: The personal journey planner in Brighton & Hove, JourneyOn (pictured left) and the 'Take Me Home' application to the existing journey planner in Aalborg (pictured right).

In Iasi, the municipality and the public transport operator developed a journey planner website with the assistance of employees of their communication and informatics departments. A range of approaches was analysed and as a result the final form of the website was established. The site focused on providing information related to all forms of public transit in Iasi: local public transport, regional bus transport, air transport, railway transport, taxis and car rental. It had a broad scope, since it was useful to both citizens and visitors to the city and people in transit. They might wish to plan their itinerary in advance or just to become familiar with the available public transport services.

Local public transport was prioritised; users were provided with lists of tram and bus lines, a map of the tram and bus network, and a tool for automatically searching the routes between two points. This tool offered an itinerary described both:

- In written form, i.e. the stops which made up the route and the number(s) of the relevant transport line(s)
- graphically, i.e. a global, easy-to-read view of the stops and relevant transport lines, and a map of the corresponding area of the city on which the route was marked with different colours for each line.

Bus Management Systems

In Donostia - San Sebastián, CTSS-DBUS defined and implemented an expert planning and fleet system that met the company's requirements. This expert planning system related to the buses and drivers needed to provide the bus service offer defined by the Town Hall. The aim was to make more efficient use of the available resources of the public transport company of Donostia-San Sebastian. This provided better working conditions for drivers and made it possible to dedicate more funds to increase the standard of CTSS-DBUS services.

The approach focused on the internal management of the public transport service operation. Previously, this fleet planning work was undertaken by an expert employee, identifying the number of drivers and buses needed. The results of this planning were excellent but the weak points were that:

- it took a long time to complete
- there was a big risk, because everything depended on one expert employee, with much difficulty in training new employees in this job, due to its complexity and specialisation.

After analysing the market, CTSS-DBUS purchased and implemented an expert planning and fleet management system that did not depend on one employee. It was a system that could be used by several employees, so that CTSS-DBUS had more flexibility and it would be easier to train other employees in the future. The expert planning and bus management system is now completely integrated with the GPS system.

In Iasi, the bus management system made it possible to monitor and plan public transport services. In addition, it increased the level of information offered to users of these services. The approach to the bus management system comprised three tasks:

- GPS monitoring system: each vehicle was equipped with necessary elements such as a GPS satellite positioning module and a GSM module;
- Maintenance depot: each depot was equipped with management, recording and storage systems;
- Modules for management of incidents and specific equipment: these managed all existing and new events occurring during the operation of the traffic management system.

After a public procurement the SafeFleet system was implemented. It comprised:

- SafeFleet X700 equipment: GPS hardware equipment with a General Packet Radio Service (GPRS) modem installed on each vehicle. The system read information like location, speed, and distance. The SafeFleet portal software application allowed viewing of data in real time and generation of different reports and statistics;
- Fuel flow meter: Hall sensor flow meter to control fuel flow;
- SafeFleet portal software application: A stand alone software application which offered an interface for tracking public transport vehicles in real time and then generating detailed reports. The software application could be accessed through an updated web browser from either desktop units, or portable units with an internet connection, e.g. notebooks, tablets or Smartphones.

With the SafeFleet system specific bus data could be gathered into a centralised form containing, for example: type of vehicle, registration number, weight, average fuel consumption, total number of registered kilometres.

In Monza, the approach was to integrate several systems. Due to organisational and ownership changes in the public transport sector in Monza, some buses were equipped with a bus management system which did not comply with ARCHIMEDES standards. It was necessary to co-ordinate and upgrade the bus management system to encompass the whole bus fleet.

Each vehicle of the public transport fleet was equipped with an On-Board Unit (OBU) which consisted of an industrial PC with specific devices and sensors:

- A GPS device to determine the vehicle position, coded with Lat-Long co-ordinate system (WGS 84);
- A GPRS communication system to send the information to a control centre.

Data concerning vehicle positions were produced at a given frequency (sampling interval) and sent to the control centre at another given frequency (transmission interval). The sampling interval was 5 seconds and the transmission interval was 3 minutes. For use in Measure 82 (public transport priority) the transmission interval will depend on the position of the bus on its route. When a bus approaches the CIVITAS corridor with centralised intersections, the transmission interval will be 30 seconds; elsewhere, the transmission interval will be 60 seconds. Both the sampling and transmission intervals can be adjusted.

Since the sampling interval is shorter than the transmission interval, more than one record could be sent when the transmission is established. Once the control centre received records sent by buses they were stored in a database table, for subsequent uses. In the ARCHIMEDES context, the immediate use provided information to Measure 79 (InfoBus) and to Measure 82 (Priority to intersections on the corridor identified). In addition, data was available for every type of statistical analysis of e.g. travel times on different stretches in different time periods.

Parking Guidance Systems

In Donostia - San Sebastián, the municipality worked on a strategy to help car drivers in their search for parking, installing several static signposts to guide them to underground parking facilities. The next step was to direct drivers already in the city or the point of entering it, through use of VMS.

Two types of panel were installed depending on the type of information to be conveyed:

- VMS, installed at entrance points to the city and at key strategic points on main routes. These showed city parking status information, either individually or grouped by zones, including warnings and recommendations
- Parking availability information signposting, installed along main routes. These displayed information about the available places in each parking facility and an arrow indicating its location.

Figure 5: The parking guidance system in Donostia - San Sebastián consists of signposts (pictured left) and variable message signs (pictured right).

In Monza, the approach to the parking guidance system was divided into a research and an implementation phase.

During the research task, the work focused on the identification of parking areas to be considered by the system. Meetings were arranged with the companies owning the most significant parking areas in the city, aimed at gaining approval to implement the measure. An agreement between parking owners and the Commune of Monza about the location of the signs and reciprocal obligations was reached. A second stage of research examined data collected in the draft General Urban Traffic Plan, which was to be adopted by the city government. Once the parking areas to be included in the system were identified, the road network and traffic flows were analysed.

Starting from data collected in the draft of the General Urban Traffic Plan, nine principal routes approaching the historical centre were identified. It was decided to equally distribute the number of dynamic signs between the different parking areas to obtain an equal distribution of traffic flows in the city. In each sign there could be a different number of modules, indicating different parking areas; the entire system comprised 83 modules. Further, a clause binding parking companies will be applied to all new parking areas which will be built in Monza.

TPM developed the tender document to define technical and legal requirements of the system. In June 2011 the tender was awarded to Solari of Udine. As soon as Solari signed the contract, inspections started on locations of panels to define technical aspects of the street works that had to be undertaken to enable panels installation.

Congestion and Emission Monitoring Systems

In Aalborg, the approach to address the consequences of rising congestion was divided into three parallel approaches:

- Efforts were made to develop a congestion monitoring system. The system needed to show variations in congestion daily and within a year, and the long-term trends from year to year.
- The travel behaviour of road users had to be influenced to move traffic away from peak hours and most congested roads. This was achieved by using the congestion monitoring system to collect the information necessary to build a picture of typical speeds by location and time of day and then to provide this information to road users. This information was given both before and during travel.
- The traffic flow on the roads was optimised based on present traffic load on the road network. This was achieved by letting an adaptive signal control system manage prioritisation in the most important intersections.

The three approaches outlined above were put into practice by the following two initiatives:

1. *Collecting data on accessibility from road users and using these for:*

- Planning purposes – arguing for resources and allocating them to the roads most in need of resources;
- Influencing road users' choice of travel time and travel route, by making expected travel times available for them via GIS congestion map and in-car navigation units.

Data collection was a vital part of the monitoring system and at the time of implementation the technical possibilities had changed. The manufacturer, TomTom developed a unit, which tracked speed and location with high accuracy. When connected to a PC, the information was uploaded to TomTom. This meant that TomTom possessed more than 3,000,000,000,000 speed measurements. For the Aalborg area, any congestion analyses could be carried out on even the smallest road segment with much better precision, than if the city collected data itself.

Consequently, it was decided to seek an agreement with TomTom giving the City of Aalborg access to the congestion data. After some negotiations, it was agreed that the city could buy these data, on the terms that data were not accessible for the company's competitors. It was also decided to buy 100 navigation units from TomTom, which were installed in 100 local taxis driving in the Aalborg area to further accelerate the data accumulation. Every three months new speed profiles were downloaded to a car's navigation units, thereby helping the driver to avoid congested times or routes. These speed profiles were refined each quarter based on driving times collected from the previous quarter.

2. *Implementing an intelligent intersection controlling system to demonstrate impact of adaptive signal controlling on the main ring route.*
   A new adaptive signal control system (SPOT) was implemented on a part of the main ring route in Aalborg. The system controlled the red and green lights according to traffic flow in adjacent intersections. The main ring route was chosen as the demonstration area because the reconstruction of the harbour front caused a shift of traffic from this area to the main ring route.

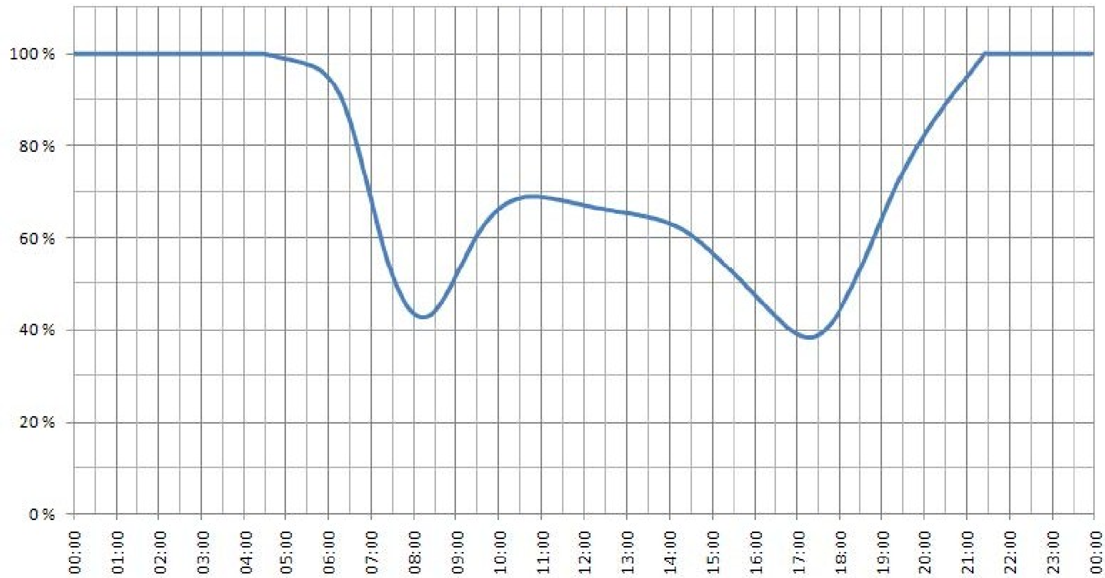

Figure 6: Congestion measurements showing the relative speed of the vehicles in Aalborg.

In Monza, the approach to increase the traffic flow and mitigate congestion improved the traffic light systems with special regard to implementing priorities for public transport as described in measure 82. A UTC system was developed to manage intersections driven by traffic lights in a co-ordinated way. One of the main advantages gained was to enable varying green times, duration of cycle times, and green waves[1] depending on factors such as traffic conditions, day of the week and hour of the day.

New traffic light strategies were designed to optimise the throughput of the corridor, using existing sensors. The approach was divided into two tasks:

1. The collection of information concerning the traffic light systems managing intersections and related information concerning the staged planning of traffic light systems, split of green light use among the different stages and eventual on-demand pedestrian movements.

[1] Green waves consist of a series of co-ordinated traffic lights that allow a vehicle travelling at legal speed to encounter a green light at each consecutive traffic signal encountered

2. Identification and enumeration of all the movements to be served at the intersections, both for vehicles and pedestrians managed by traffic lights. Each movement was managed by one or more lights whose lamps were connected to signal groups of the Traffic Light Controller (TLC). Each signal group was submitted to safety checks by specific electrical circuits of the TLC.

Subsequent activities consisted of:
- Design and coding of new co-ordinated traffic light plans taking account of the results of microsimulation activities carried out in the RTD stage;
- Test and activation of the new traffic plans.

In Monza, a study was undertaken by PA, in agreement with the Commune di Monza and NET which is the owner of the Public Transport fleet. The aim was to propose a conceptual framework to manage public transport priority at relevant intersections. In summary, the approach consisted of:
- 'Decision Module 1' which received priority requests issued by buses approaching the intersections of the corridor and decided whether they were eligible to be served or not;
- 'Decision Module 2' which filtered all the incoming priority requests for each intersection, deciding which of them (one or more, if compatible) would be served by the UTC system;
- An 'Interface Module' which translated the selected priority requests to specific commands that the UTC could process and activate.

Four intersections of the CIVITAS corridor for public transport were equipped with the devices necessary for them to be managed by the UTC system.

Whereas the research task focused on the conceptual approach, the demonstration stage applied this in the real context. It has to be highlighted that the buses share the road space with private cars. The demonstration stages were:
- Description of the ARCHIMEDES Corridors;
- Review of the conceptual approach defined in the RTD stage;
- Detailed analysis of the actual behaviour of the buses in the public transport corridor, defining an appropriate sample to be surveyed and analysed;
- Creation of a relational database, in which all the localisation and monitoring data provided through measure 78 were saved, to allow detailed statistical analysis;
- Detailed statistical analysis of collected data, to find out the right timing to adapt the cycles of traffic lights plan to prioritise buses;
- On-site experiments, to assess the results achieved.

The demonstration stage for this measure has been implemented through the following tasks:

Stage 1: Design and Coding of Traffic Light Plans. In this stage a set of activities have been carried out, such as:

- Collection, documentation, analysis of performances of the current traffic lights plan: type of plan (fixed/variable cycle), cycle time, percentage of green time for the movements of the intersection, relationships stages-movements;
- Analysis of traffic flows in several conditions: working days, holydays, special days; morning peak hours, evening peak hours, late mornings, afternoons, evenings;
- Definition of the groups with correlated intersections to be modelled in the UTC system in the managed conditions (working days, holydays, special days; morning peak hours, evening peak hours, late mornings, afternoons, evenings);
- Design of coordination diagrams with relevant green waves for the groups identified;
- Plan coding and laboratory test to allow the installation in the real environment.

Stage 2: UTC Startup and Performances Analysis. In this stage the UTC system is made operational and it is loaded with a first set of plan for the relevant intersections. Particular care was put on the results on traffic flows, especially in the most critical situations, to avoid unexpected jams.

Stage 3: Analysis and improvement of the performance of the System. This stage was devoted to provide data and information to the Evaluation Stage. The plans made operational could be reviewed in order to match in the best way the results expected.

Stage 4: Evaluation stage. During this stage measurements has been collected to carry out impact evaluation.

In Brighton & Hove, the approach was to engage school children and their teachers in measuring emissions in the local surroundings. Three schools were chosen on the basis of their location within the CIVITAS corridor, their close links to the city council's school travel team and their commitment to participate and contribute to the measure's objectives.

The key milestones to be completed within this deliverable were as follows:

- Three schools were identified and agreed to participate – Balfour Junior, Elm Grove Primary, St Bartholomew's Primary;
- Imperial College, and its in-house 'partner' company Duvas Technologies, were identified and agreed as the providers of the educational programme and the technology respectively;
- The first trials and development of the technology took place at one school from February 2010. These were linked to preparation for Walk to School Week in May 2010. (This is a national campaign to encourage UK school pupils to walk to and from school.)

Between November 2009 and March 2010, Duvas Technologies developed the technology that enabled traffic emissions and ambient air quality to be monitored simultaneously. This used two forms of equipment sited on both sides of a road adjoining the school (the 'Open Path (OP2)' system, pictured below), and on school buildings (through monitoring equipment known as '006'). A weather station, which would remain at the schools after equipment decommissioning, was also installed. A real-time plasma screen to display the VMS data was installed in the schools' ICT suites. Finally, two portable units were provided so that children could take the equipment out of school and monitor air quality on home-school journeys.

The overall educational objective was to allow pupils to develop an understanding of air quality, pollutants, and their causes and effects. Year 5 and Year 6 students from Balfour Junior attended Imperial College in September 2010 for a site visit and meeting with education staff. Additional to this, ambient air quality within the local vicinity of school grounds was monitored with accompanying educational programmes to educate young students about science, their environment and how local transport activity might affect it.

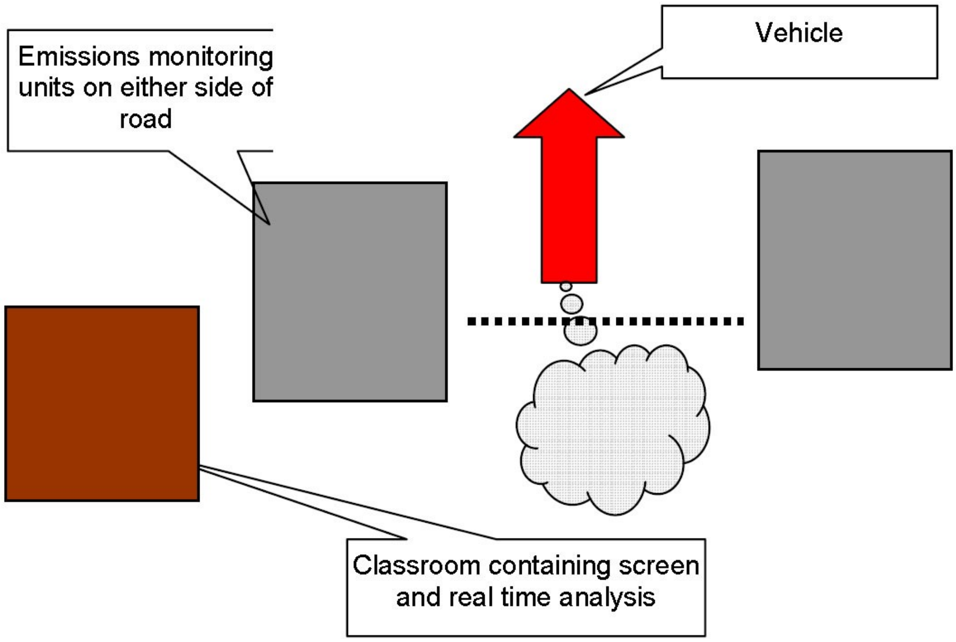

Figure 7: Schematic overview on the emission measurement in Brighton & Hove.

4.3 Problems Encountered & Solutions Attempted

4.3.1 Technical Issues

The technical issues encountered largely related to software issues. The quality of software systems was a prerequisite for the success of real time travel information. Issues of connectivity were also encountered, especially where multiple operators utilised the same system. Furthermore, rapid technological development meant that some solutions became outdated even as they were implemented. The issues were addressed through revised project specifications.

Public Transport Information

The technical issues in the measures regarding public transport information were mostly related to software issues or technical suppliers. The quality of RTPI and other software systems determined the success or failure of the whole initiative. A clear IT strategy was a precondition for success. Some delays occurred due to technical issues. In some cases road space was insufficient for the development of high quality bus stops, including shelters and information panels, without jeopardising accessibility conditions at street level.

In Brighton & Hove, for example, a software problem in existing units was identified prior to installation of the units. The supplier agreed to provide a software fix for this, but this meant installation of new units was delayed for approximately 3 months. Once the 12 units had been installed it soon became clear that not all units were functioning correctly. Both the supplier and the installation contractor spent a large amount of time investigating the cause of this. It was eventually identified as being a problem with the data cable which allowed the real time link between the real time display and the unit (called React) itself. This delayed the deliverable date by a further 3 months. However, all 12 units are now fully operational with audible orientation and real time information.

Journey Planners

The rapid speed of technological development presented challenges for some projects. In particular, the new generation of smart phones and open source development of software caused project managers to rethink how to create journey planners. Another issue was insufficient HDSPA-3G (Wi-Fi) which caused problems with the accuracy of real time information for example. A further issue related to the connectivity when units from several operators were to communicate on the same system.

In Aalborg, for example, the big challenge was the speed of technological development in mobile phone applications. When including the GPS dependent mobile phones functions in the ARCHIMEDES proposal, this was very innovative and ambitious. With the launch of the iPhones and Android based phones, and the open programming interfaces associated with these systems, some GPS based journey planner functions were created by third party developers. The inability of any current browser to access the GPS function on mobile phones, meaning users had to download and install a program to access the GPS based RTPI and the 'Take Me Home' functions, was a barrier to their uptake. There was still unwillingness among users to do so. Fortunately, this unwillingness was less prevalent amongst young people which comprised the target group for this measure.

In Donostia - San Sebastián the HDSPA-3G (Wi-Fi) communication systems used for on-board and real time information were not commonly used by bus companies. CTSS-DBUS was one of the first companies in Spain to use this communication system. Therefore, there was no past experience to rely on in the preparation phase of the measure. HDSPA-3G communication systems were very expensive. It was also noted that due to insufficient HSDPA-3G coverage in certain points of the public transport network, incorrect real time information was provided. Hence, an important task was carried out with the communication supplier EUSKALTEL, which improved their coverage in Donostia - San Sebastián to cater for the ARCHIMEDES project.

Bus Management Systems

The technological issues regarding bus management systems mainly related to the accessibility of the network on which the bus management systems communicate. Problems with the coverage of the data systems resulted in deficiencies for systems relying on the data.

Parking Guidance Systems

The main issue related to several operators having to comply with one common system of collecting and sharing data. A clause binding parking companies to provide data on occupancy rates was established.

In Donostia - San Sebastián, the electronic real time guidance systems were very expensive. There was also an issue with installation of the signs where space was limited. This affected the width of pavements or other pedestrian routes, or reduced the visibility of existing signposts. This required careful planning of the location of signposts. Finally, a deficiency within the automatic counting system when "abnormal" situations happened (closing entrances or exits for specific events) required development of alternative counting systems.

Congestion- and Emission Monitoring Systems

The congestion- and emission monitoring systems were prone to technological challenges in relation to data and technological development of the systems.

In Aalborg, for example, one of the main challenges was the rapidly changing technology which made the detailed description of congestion measures obsolete even before they were initiated. Therefore, it was necessary to develop new ways to reach the objectives in the DoW. By being willing to find new alternative solutions, and use new technological possibilities, this proved possible. Analysis of raw data showed different levels of congestion than analysis of aggregated data. It was not possible to identify the reason for this. Even though aggregated data was collected over 3 years, and the raw data was from the latest year, this should not influence the result. This implies that there could be some kind of systematic bias in the data.

In Brighton & Hove, the most significant problem was that technology was not suitably advanced to enable emissions from specific cars to be accurately measured. This was especially the case in areas where general residual levels of pollution were likely to be quite high. The problem was addressed through the revised measure specification. This included a research and development process, and used innovative technology.

Associated with this, it was apparent that the measure would cost significantly more than anticipated if the technology was developed according to the plan. This was not felt to represent good value for money. The measure as originally designed was intended to provide instant feedback on the emissions from their vehicles to drivers. This project was thought to not be deliverable and was changed to a more educational one linked to schools in the CIVITAS corridor. This proved to be very popular with the children and the teachers at the schools involved.

Parking Guidance Systems
In Monza, some minor changes were made to the original locations of the parking guidance signposts. This was to locate panels in more visible positions, or achieve power supply, or avoid damage to flower beds, green areas and trees.

4.3.2 Process Issues

The process issues mostly related to public transport information and the journey planners. In particular, the financial situations in the participating cities hampered the implementation of initiatives for improving public transport.

In Aalborg, for example, the final system for information to public transport travellers became rather complex with a lot of parties involved. A clear strategy and willingness to simplify the system and keep traffic information in focus were regarded as necessary to handle the complexities.

In Brighton & Hovenegative press surrounding the implementation of the cycle counter displays made the promotion of the measure problematic. It wa generally felt in the local media that the measure was a waste of money at a time of financial crisis. This negative feeling was heightened by the continued repair work that was required for the counters.

In Monza, and in Italy in general, public transportation companies are in bad shape. Most companies show negative budget sheets. Ticket sales account for 18-20% of budget in the worst cases and the 31-35 % in the best ones.

Fuel prices continued to increase since they were considered one of the strongest levers for Government to raise incomes. However, the latest rises in price of fuel were not supported by the state or local authorities through increased contractual payments to the operators. On the contrary, fund transfers from central government were reduced. To maintain a good standard of the service, it was necessary to increase fares, whilst rationalising routes and reviewing programmes to focus on more popular routes and timetables.

Such a situation made it difficult for public transport companies to invest in improvements to the service offered to users. Without sufficient financing for extra buses, improved infrastructure etc. the best way to encourage people to continue or start using public transport is to offer passengers better quality and more personalised services. Hence, this approach is regarded as the best way of improving public transport in the harsh financial environment.

As an example on the economic issues the electronic bus stops can be mentioned. 10 electronic bus stops cost € 217,800 VAT included (€ 6,720 for each electronic bus stop), whilst the interactive touch screen totem cost € 24,600 VAT included plus € 9205.48 VAT included to develop palimpsest.

In Monza, the measure for improved traveller information was delayed due to merging of the two public transport companies, TRM and NET. A particular delay related to the decision about using the Automatic Vehicle Location/Automatic Vehicle Monitoring system (AVL/AVM) system implemented by TPM or extending the system already used by ATM fleet to the new acquired fleet. Because of the huge investment required, NET took some time to decide about the installation of the devices. Finally, there were problems in achieving energy connection for all electronic bus stops due to the long and slow bureaucracy of the supplier.

In Brighton & Hove, it was necessary to adjust the timing and scope of the measure regarding emission measurements. This was due to restrictions on match funding within BHCC's budgets. There was also a procedural issue related to a BHCC internal review of ICT policy regarding web-based material, which coincided with the start of the measure. This meant that the process for obtaining approval for an ICT based measure became much longer that had been envisaged.

4.4 Main Outcomes & Results

4.4.1 Impacts

Public Transport Information

In Aalborg, the main outcome was the on-trip information screens, which were implemented in the 100 buses servicing Aalborg. The user surveys showed that almost all passengers considered the screens and information as a service improvement and were satisfied with the way the information was presented. Almost two thirds of the passengers were content with advertisements being shown in between the information. The advertisers welcomed the opportunity and the results for them advertisers were predominantly positive. For the advertisement agency the passengers' impressions of the adverts were also positive. However, economically, the bus screens did not generate the expected turnover. As a result of all measures regarding public transport (a mix of information, smart tickets, ITS etc.) a 1 % yearly increase in Public Transport modal share in the CICITAS corridor was achieved.

In Brighton & Hove the following outcomes and impacts were achieved:

- The number of bus stops with audible announcements around the city increased from 22 to 34, with 12 new units having been installed;
- It was found in a previous user satisfaction survey that prior to the first wave of installation of 22 React units at bus stops, 30 % of users used the bus 2-3 times a week, rising to 47 % following the installation of the new units;
- Production of the information leaflet helped BHCC to promote the system and its benefits to the local blind and partially sighted community. However, in addition, BHCC has also begun to promote the system to bus users with learning difficulties, some of whom have experienced problems when trying to read the real time displays. More recently, a key fob has been issued to a wheelchair user who also finds it difficult to read the real time displays in certain lights despite them not being registered as blind or partially sighted.

In Monza, tho results can be extracted from the implementation of the improved traveller system:

- An increase in use of public transport was detected (+ 4.1%) after measure implementation. The upscaling of these installations to all bus stops in the city could achieve further modal shift in favour of public transport;
- In spite of the fact that devices may be physically seen, there were some people who were not aware of the implementation of electronic bus stops. This was probably due to the measure being implemented at just some of the city's bus stops. (There are more than 500 bus stops in total.)

In Donostia - San Sebastián, a more efficient information system enabled current and potential public transport users to better plan their trips and optimise their travel times, mostly by reducing waiting times at stops and favouring a reliable connection with other routes and services. The traveller information system was very successful, with more than 3,500 daily requests for real time information via SMS or the website. The provided information was highly reliable, with 98.1% of all the information requests assessed by the users as correct. When assessing these figures, it should be born in mind that 60,000 users had access to real time information at the bus stops through electronic boards. As a result of mixed measures like information, ITS, management etc., there was an increase of users on 8.6 %, in public transport

Journey Planners

In Aalborg, the main results regarding the improved journey planner for mobile phones are:

- By June 2012 the 'Take me home' java application had been downloaded 3,353 times;
- In a short period of 30 days during June 2012, statistics showed that there were between 250 and 600 unique users daily. The average visit was approximately 4 minutes, and there were about 4,000 unique visitors;
- The number of users that knew about and used NT Live increased from 9 % in 2009 to 26 % in 2012. The number of users that knew about but did not use the service increased from 34 % to 47 % in the same period.

In Brighton & Hove, a survey was carried out among public transport users. Results revealed that information issues were perceived as very important, with an average score of 8.47 out of 10. User demand for quality information services was therefore very high. Complementing this figure, a user's satisfaction survey revealed a very high acceptance level (7.55 out of 10) regarding information provision in CTSS-DBUS' service. This figure is almost identical to the one achieved in the reference year (2006).

In Iasi, the public transport planner was implemented successfully from an operational perspective. The measure was evaluated through surveys among the inhabitants of Iasi.

- 61 % of the interviewees were aware of the website and its usefulness, and of the CIVITAS project in 2011, and 65 % in 2012;
- Many of the respondents who had heard of the portal had used it to get information or to plan a journey, with an increase from 67 % in 2011 to 70 % in 2012;
- The level of the respondents' satisfaction concerning the ease of trip planning and quality of the website information increased to 41 % in 2012 from 33 % in 2011;
- The number of website visits was counted from 2010. Regarding the monthly average number of visits, there was an increase by 71 % in 2012 from 2011, when 506 visits were recorded on average per month.

Bus Management Systems

In Donostia - San Sebastián, the new management system comprised a significant change in the way that services were scheduled and drivers' hours assigned. It took advantage of the innovative developments in communication technologies. With the new expert planning and fleet management system, drivers' planning timetables were improved, with less time lost. An Optimisation Index (where the most optimised situation is 100 %) of 94.87 % was achieved regarding driver hours in relation to the offered service (1.21 % more than the situation before CIVITAS). As a result, operating costs were reduced by 2.5 %. As a consequence, the new management system helped CTSS-DBUS save 0.6 million Euros in 2010 and 0.7 million Euros in 2011.

The main changes perceived by operational staff (drivers and operations management) were the new service schedule and drivers' timetable. These changes were widely accepted right after the implementation of the new management system in 2010. It achieved an acceptance index of 6.5 out of 10in the yearly survey of employees. The acceptance level increased once that the new management system was consolidated and its benefits tested by operational staff. In 2011 the acceptance level reached an index of 7.0 out of 10.

In Iasi, all the GPS satellite positioning modules were installed in 100 public transport vehicles. The SafeFleet Portal software application that monitored all 36 trams and 64 buses was well received by the Maintenance Facility Centre operators. It offered valuable information, in real time, about the monitored vehicles. Public transport vehicle drivers were professionally satisfied because they could fulfil their schedule more easily. The Incident Management System helped to solve incidents in a faster and more modern way.

In Monza, the evaluation results were:

- The quality of data concerning localisation and monitoring of buses were suitable to be used for the other ARCHIMEDES measures regarding improved traveller information and UTC system in Monza;
- The performances to access data through the web service made available for this purpose were suitable as well;
- The framework established was therefore robust and ready to be extended to other public transport fleet;
- The decision to continuously store all data concerning evaluation in a relational database allowed evaluation to be conducted on a periodic basis in order to quickly detect shortcomings.

Parking Guidance Systems

In Donostia - San Sebastián, parking management measures, such as the P&R guidance system, combined with other sustainable transport measures, resulted in significant impacts on the transport system.

For example, as a consequence of the measures the number of cars entering to the CIVITAS corridor was reduced by more than 7,500 cars per day compared to the before situation.

As for the public perception of the measure effectiveness, evaluation surveys revealed that the majority of respondents (78 %) assessed the measure as positive after its implementation. Also a majority of respondents believed that the measure helped to improve the parking situation in Donostia - San Sebastián.

In Monza, evaluation activities were aimed at:

- Collecting data about investments needed by Commune of Monza to implement the measure;
- Checking the level of knowledge of the measure with users of public transport, to promote intermodality;
- Measuring the parking occupancy rate in the city.

The implementation of the system required an important investment by the Commune of Monza, which nevertheless improved the situation of traffic in the city, reducing parasitic car traffic looking for free parking places. Before measure implementation, the Commune of Monza was unaware of parking occupancy rates except for data provided by parking owners, which are far from reliable. The data from parking systems are much more reliable and can be used to better understand distribution of cars in the different urban parking areas. The implementation of the system was well known and accepted by citizens. They would welcome further improvements, like web services or smartphone applications to check parking availability.

Congestion- and Emission Monitoring Systems

In Aalborg, congestion data and data about travel times were continually collected by all users of TomTom navigation units. 100 units were implemented in taxis to improve the amount and quality of data available in the Aalborg area. On the basis of these data, new travel times and congestion information were calculated, and communicated back to the units. The aim was to influence choice of travel route and travel time. It is difficult to measure an impact due to the small sample size.

Furthermore, Aalborg introduced an advanced signal control system on a part of the main ring road, Østre Allé. All traffic signals in an area were optimised every third second based on the incoming and outgoing traffic in each lane of all intersections. Based on the data a forecast about how traffic would move through the area the next 2 minutes was generated. The traffic signals were set in a way so the traffic flow is as high as possible.

In Monza, the key results from UTC system were:

- The proposed approach proved successful. There was a significant improvement of the performances of the corridor. Cycle time reduction of co-ordinated traffic light plan from 160 seconds to 150seconds at peak hours and from 160 seconds to 125 seconds in off-peak hours has produced the effect of a better regulation of vehicle platoons, measured through a reduced variance without worsening the overall performances and reducing waiting times for pedestrians and cyclists.
- Cost benefit analysis proved that the benefits obtained were greater than the incurred costs, having estimated the value of time saved. After seven years the incurred costs will be covered and when considering a 10 year period, the final three years generate a positive return on the investments accomplished.
- The overall process set up for carrying out this measure involved the Municipality and the industrial partner of the project. This led to a substantial improvement of skills and attitudes of the traffic experts of the Municipality.

In Brighton & Hove, the following outcomes were achieved:

- Development of innovative technology followed by trials at one school, additional development and further deployment at this site;
- The measure and associated publicity is anticipated to have led to a greater awareness of air quality in the city, and has helped to support wider initiatives (Walk to School) in educating people on sustainable travel choices.

4.4.2 Changes to Processes

In Iasi, the original objective in regarding the bus management system was to build a common platform for monitoring and planning of public transport information services. To do this, a procurement process for the implementation of bus management system was organised. 4 tender procedures for an integrated ticketing system were launched. However, they were all cancelled because the legislation changed twice, which led to a modification of procedures' documentation. The Dispute Settlement Public Procurement National Council considered that required "similar experiences" for the suppliers within tender documentation was too high.

As a consequence, the initial measure was cancelled. An alternative proposal was approved by the European Commission, comprising 3 tasks:

- GPS Monitoring System;
- ATV (Automatic Ticket Vending machines);
- Maintenance Facility Centre.

In Brighton & Hove, the original emission measuring initiative focused on displaying an indicator of a vehicle's emissions quality to drivers. However, this proved problematic to deliver. Detailed feasibility work showed that the measure as originally planned was not deliverable for several reasons. The most significant problem was that technology was not suitably advanced to enable the emissions created by specific cars to be accurately measured, especially in areas where general residual levels of pollution were likely to be quite high. Associated with this, it was apparent that the measure would cost significantly more than anticipated if the technology was developed further, which was not felt to represent good value for money.

To overcome these issues, an amended measure specification was devised and successfully implemented, thus enabling the original objectives to be met. However, some problems were encountered, particularly as a consequence of the very innovative nature of the project (and the technology it used).

In Aalborg, the traffic control system was initially based on data collection from 10 cars. However, during the planning phase this approach was refined to data collection from and information to all cars with TomTom units, supplemented with the installation of 100 extra units in taxis. This different approach was not due to delays. It was a changed approach due to the fast-running development in this area, which made the original solution obsolete. The selected solution was of much higher quality and reliability than the planned one.

4.5 Future Plans

Most initiatives regarding ITS were positively received. Hence, the cities are maintaining the ITS-initiatives as it is a feasible way to optimise the transport system within the given physical framework.

Public Transport Information

In Aalborg, the screens containing the on-trip bus traveller system were expanded from the 50 buses driving in the CIVITAS corridor to all 100 buses driving in Aalborg. Further, the system is being expanded to include other regional buses in Northern Jutland. The system will also be expanded with further information from local service providers such as Visit Aalborg and the Sports Arena, and with new types of (dynamic) information such as real-time information on train and flight connections with Aalborg. The demonstration system is expected to continue after the end of ARCHIMEDES.

In Brighton & Hove it is intended to continue with the expansion of the public transport information system aimed at visually impaired people. Continuation of the system is dependent on further funding which can be difficult to obtain. It is also the intention to use the existing and new units as part of a Pedestrian Wayfinding project already underway in the city. The aim of the Wayfinding project is to provide all visitors to Brighton & Hove with directional and tourist information. This includes the provision of a clear and consistent mapping and signage system. By integrating the React units with the Wayfinding signage, it will also be possible for blind and partially sighted visitors to have access to the same information. The Wayfinding project was launched in September 2009.

In Donostia - San Sebastián, CTSS-DBUS will continue implementing real-time information panels at bus stops. It is expected that in 2012 the number of bus stops with this panel will reach 100 stops (approximately 20 % of all bus stops in the city). Also, the information system via SMS is expected to be expanded to the whole network. Increased functionalities will be added to the mobile version of the website.

In Monza, installation of remaining bus stops will lead to a full realisation of the improved traveller information system. The implemented technological framework was designed to host other functionalities that could be implemented in the future, such as:

- Software applications to provide information through SMS;
- Software applications to provide information through a website;
- Installation on buses of screens to provide passengers with trip information.

The installation of the bus stops was financed outside the ARCHIMEDES project although planning and evaluation was supported. ARCHIMEDES was applied for harvesting information and experiences regarding the initiatives.

Another important possible extension is the management of data related to other public transport fleets in the city of Monza run by other public transport operators. For these purposes, the Realtime Updater server needs to be fed by data originated by fleets through specific software interfaces (e.g. web services). Other public transport companies have already been approached to ask them to develop such interfaces in order to have public transport information available at the bus stops.

As far as the totem is concerned, the opportunities for installing further similar devices at other strategic locations in the City Centre, at the Hospital or at the Park are being evaluated. The decision will depend on citizens satisfaction levels. These are surveyed through the Municipality website section devoted to citizens' participation, www.monzapartecipa.it.

In the future all bus stops in the city will have to be equipped with electronic bus stops, to provide information to all citizens, not just those using buses on CIVITAS Corridor. This is why the list of electronic bus stops to be installed by NET is made up of 30 locations. Probably, it will not be possible to equip all the bus stops in the city by the time the current public transport contract expires in November 2014. However, the path is traced and the next tender for the public transport service will make installation of electronic devices obligatory.

Journey Planners

In Aalborg, there are no activities planned regarding the mobile phone service. However this area is rapidly developing and today's mobile unit is an important source of information for most people. NT Live is an HTML-based service with all the upsides and downsides this gives. With smartphones being more common, developing a smartphone public transport app. is one of the most obvious future activities, because it gives some possibilities that HTML-based services cannot provide. Such an app. has been developed on a national level. Finally, the GPS service has been integrated with the national travel planner where the application will be further developed.

In Brighton & Hove, the continued development of the JourneyOn website will be entirely dependant upon available funding. Maintenance of the website will continue for the foreseeable future, however, the provision is unlikely to be enhanced at the moment. The key future activity will be continued monitoring and evaluation of the site's usage.

The cycle counters will still need to be tested and repaired in a sustained period of successful operation before any further evaluation can take place. Due to the negative experience of this intervention, it is unlikely any expansion or similar initiatives will be pursued in the near future.

In Iasi, the web portal will continue to offer access to relevant information (including information about ARCHIMEDES). Combined with an open forum for the exchange of opinion, it will generate dynamic changes in developing the public transport. Also the team in charge of monitoring will launch different challenges to the users regarding their expectations (e.g. to complete questionnaires including questions regarding new improvements and to participate in debates).

Bus Management Systems

In Donostia - San Sebastián, there are no changes planned regarding to the measure regarding the bus management system. It is already implemented across the whole public transport system and will continue to operate.

In Iasi, the bus management systems will be connected to the traffic management system project. This is co-financed by European Commission under Regional Operational Programme, and will be implemented in the entire city.

Parking Guidance Systems

In Donostia - San Sebastián, there are no future plans to enlarge the parking guidance system in the short term. However, the information provided by it is continuously under revision to improve its usefulness. In particular, future enhancements will consider the possibility to guide drivers towards available parking areas. The possibility to inform drivers about availability of on-street parking in the city centre is also being assessed, mostly as an effect to deter people from on-street parking. Due to future construction of new city entrances, it may be necessary to reposition the VMS of the city. This would require a new analysis of routes towards parking facilities.

In Monza, the parking guidance system has been tested and installed. No future developments are scheduled. Monitoring of the occupancy rates of parking areas will be necessary to test the effectiveness of the system in better distributing traffic flows to avoid parasitic traffic of drivers looking for free parking. This will be reported in the evaluation of the measure.

The process of adding a new parking area and of managing data about occupancy rates to the system requires the interface function to be available. Hence the Municipality has already established a clause binding parking companies, which have built two new parking areas, to provide data on occupancy rates. This means they could be integrated with the system which will be implemented in ARCHIMEDES. This clause will be applied to all new parking areas which will be built in Monza.

It can be assumed that, with an already installed system to which all existing parking areas are connected, it will be in the interest of owners of new parking areas to be connected to the system in order to exploit the opportunity of a correct distribution of potential users.

Congestion- and Emission Monitoring Systems

In Aalborg, the TomTom data showed reliable and very precise results. It is, however, historical data and the future will be real-time dynamic traffic data. It does not mean that the TomTom data will be of no use. They will be a necessary basis for future real-time traffic data from other sources. This is because the TomTom data is useful in monitoring if real-time traffic data are reliable. Hence, this basis is required to ensure that any extreme (and unreliable) data will not be used, which would result in erroneous traffic information.

Aalborg Municipality is testing number plate recognition and Bluetooth devices as data sources for real time traffic information. Although promising test results, they are still under development and are only covering the central arterial roads. Hence the more detailed data from TomTom are still required currently to see the full pattern of traffic flows on the arterial roads.

The adaptive traffic signal control system showed positive effects on the congestion level. This is especially so in the most congested, afternoon peak period. It points towards a system which will be more beneficial for road users and the City of Aalborg to manage congestion in future. Hence it is being considered to up-scale the system to include other parts of the most congested arterial roads in Aalborg.

In Monza, the future plans for the UTC system will consist of:

- Possible review and adjustments to the plans proposed in this deliverable as they will be evaluated in the specific task;
- As the centralised plans become stable, other particular situations will be faced (e.g. events at the racetrack that generate specific demand profiles on viale Battisti);
- New requirements that will emerge from measure 82 (Public Transport Priority in Monza): possibly new approaches will be implemented to extend green light for movements affected by the transit of buses.

In Monza, the application of a priority management approach for public transport, together with precise information on real bus arrival times in measure 79 is a good opportunity to attract more people to use public transport. The effective collection of data relating to the movement of buses across the city, (accomplished through measure 78,) as well as the implementation of an UTC system is a necessary precondition to carry out this measure.

There are no plans for the expansion of this measure in Brighton & Hove currently. The contract between Imperial College and Brighton & Hove City Council was for a fixed period of time and there is no funding to renew it at present. However as part of the measure Imperial College developed new emissions monitoring technology. This technology will be used by the college for future research. The university's school engagement unit will also continue to operate and will offer similar programmes to other schools in the country.

5. Conclusions and Recommendations

Workpackage 8 focuses on transport telematics solutions to increase use of sustainable of transport, mitigate congestion and create effective traffic solutions for the public and private fleets. A wide range of technologies exist on the market and many are undergoing rapid development. The success of new developments and improvements in software for application in daily urban traffic depends on user acceptance and appreciation. Most initiatives within the workpackage were characterised by involving several public and private companies and one main challenge was to create technological solutions which reflect the needs of a broad range of stakeholders.

This section summarises results, conclusions and recommendations regarding the various technologies within this workpackage. More detailed information regarding the different measures can be found in D10.3 Final Evaluation Report and D12.4 Final version of measure level result templates.

5.1 Conclusions

The experiences regarding **public transport information** are that:

- Almost all passengers consider information screens in the buses in Aalborg as a service improvement and are satisfied with the way the information is presented;
- Advertisers welcomed the opportunity and the results for them were predominantly positive. For the advertisement agency the passengers' impressions of the adverts were positive, ut the expected turnover was not achieved.
- The success or failure of the system for real time public transport information depends on the reliability of the underlying RTPI system and the quality of the information in the system. A clear IT strategy for these matters is a precondition for success.
- In particular, information on transfers in real time requires exact data and quick handling, and communication between the buses and the central system. It is a complex technical task that does imply a risk of delay to measure implementation.
- Installation of bus stops with audible announcements around the city significantly increased the use of public transportation for visually impaired people;
- In Monza, for example, an electronic bus stop costs approximately € 7,000 and an interactive touch screen totem costs approximately € 25,000;
- Implementing electronic improvements for real-time information for public transport travellers increased the use of public transport by approximately 4 % in the implementation zone in Monza. However, this increase was based on implementing 10 electronic bus stops and 1 interactive totem. A larger increase might be expected when implementing such initiatives throughout the whole city.

The experiences regarding **journey planners** are that:

- Journey planners were very well received by public transport users, being regarded as very useful. However, not all information and features are suitable for mobile devices, which should be considered in the development phase.
- Journey planners were prone to technological challenges as rapid technological development, e.g. the massive increase in the use of smart phones, can outdate the initiative;
- Innovative initiatives developed at the regional level can be up-scaled to the national level although it depends on availability of resources and technological development at national level;
- If a journey planner is personalised this tends to increase appreciation of the value of the journey planner;
- The awareness of the journey planner is important as it is a virtual initiative. Hence, promoting it is important and exposure on various platforms increases awareness significantly (like magazines, newspapers TV, social networking sites, advertisements in urban spaces.)

The experiences regarding **bus management systems** are that:

- Optimising bus time tables and driver schedules can increase the effectiveness of the bus system. In Donostia - San Sebastián, for example, optimising the bus system's effectiveness by 1.2 % reduced the operation costs by 2.5 %;

- Optimising bus schedules and drivers timetables were widely accepted among the operation staff as a planning tool for overview.

The experiences regarding **parking guidance systems** that:

- Parking management measures can result in significant impacts on the transport system - in Donostia - San Sebastián, for example, the parking guidance system resulted in a reduction in the number of cars entering the CIVITAS corridor by more than 7,500 per day;
- More than 75% of the population consider the parking management measure as positive and a majority believed that the parking situation improved;
- Variable message signs (VMS) and signposting are useful if installed at strategic points on main routes;
- Such initiatives can decrease the searching traffic and can help monitor the parking supply and create a tool for future decision making on parking facilities.

The experiences regarding **congestion- and emission monitoring systems** are that:

- A congestion monitoring system can enable provision of detailed traffic information regarding individual sections of arterial roads. Also the information can be adapted regarding different time periods of the day and the time of the year. When developed, monitoring systems can contribute to prognoses of traffic loads that can be communicated to travellers before setting of for the car journey.
- As a result of the adaptive traffic signal control system transport time decreased by an average of 25 seconds (8.5 %) per trip in peak periods. This was mainly due to a significant effect in the most congested period of the day, the afternoon peak. No positive effects were found regarding the off-peak results.
- Observed speeds of motorised vehicles tended to be lower, i.e. fewer and shorter decelerations in front of the intersections,
- Due to a smoother driving pattern estimated fuel consumption decreased by 2.45 %,
- A barrier delaying the implementation of the adaptive traffic signal control system was changes in land use (from industrial to offices and shops) in the adjacent areas to the road in question. The brown field development led to changes in traffic amounts and vehicle types.
- Regarding analysis of the air quality it can be concluded that there was a regular pattern of peak levels of NO_2, with a 24 hour frequency corresponding to peaks in local travel patterns. There was a 4.5 hour offset between the peak traffic and NO_2 levels, linked to the time taken for NO emitted by vehicles to oxidise in the ambient air to form NO_2.
- Variations in the regular pattern of NO_2 levels were observed. These were linked to fluctuations in weather patterns that brought in additional pollution from neighbouring major roads when the wind was in a particular direction. This led to the peak levels from local roads at the school to be partially obscured by an increased background.

5.2 Recommendations

For future public transport information projects, the following points should be considered:

- Search the market to find the technology that best fits the needs of the desired information provision scheme (e.g. targeting information via apps, general information via VMS etc.)
- It is advisable to develop software which both monitors bus location and helps activate public transport priority at traffic lights along key corridors;
- Consider integrated collection, processing and distribution of data. Focus on data communication protocols for ensuring data is applicable for multiple use in different systems;
- To offer comprehensive information to public transport users, all public transport companies in a locality should choose the same information system or develop an interface. This is so that

every bus travelling in the territory can send real time information to electronic devices. Although this may be seen as a means of excessive control by managers of public transport provision contracts, it will enhance knowledge of public transport performance and could encourage people to shift to public transport.

- If an information system is implemented throughout a city, it is crucial to include in tender documents an obligation for public transport providers to complete installation of devices to support RTI. For this reason, it is advisable that the contract has a duration allowing depreciation of such an important investment.
- Make careful selection of the bus stops in which real time information will be provided at the start of the scheme;
- Disruptions in the public transport system demand a quick response from operators to avoid negative public reactions. To guarantee efficiency in the management of this kind of situation, additional funds are required. Using the management systems information is available to reason such additional funding;
- Success is dependent on good communication with relevant stakeholders. One way of achieving this is by creating working and user groups. Promotion is also required to ensure that there is awareness of the system;
- For projects that aim at improving information for blind and partially sighted people, the presence of a local society representing them in the immediate area would contribute greatly to the likely success of the project; If no such society exists, other steps should be taken to identify and engage with user representatives from the start of the project
- For projects that involve use of Radio Frequency Identification (RFID) fobs in connection with audio units at bus stops, a number of trials should be undertaken. This is to ensure that the message is triggered within a reasonable distance of the bus stop and that the audio is clear.

For future projects regarding journey planners, the following points should be considered:

- The period of time over which the project is developed and implemented should be very short. Otherwise, there is a risk that the project technology is outdated before it is implemented. Another possibility is to release RTPI data via a public Application Programming (API) or a XML output. This will make it possible for creative developers to design applications and services that will benefit the public. The downside is that there is no control of the way data is used and presented. This which can lead to errors and uncertainty as to how changes in the way data is structured will affect applications.
- Allow plenty of time for developing and testing of chosen new technology, for both journey planning websites and cycle counters. Be sure that potential users understand the initiatives are being trialled and may have issues. It is also important to be certain that the technology is fully operational to provide a good service. Provide clear information regarding the stages in measure implementation and the long-term objectives, to overcome negative reactions from users not having this service available across the entire network at once;
- The use of innovative technology requires that an on-going communication framework with technology suppliers be established from the start of the project.
- Mobile versions of journey planners should deliver a simplified version of the original site, more suited to limitations of mobile web-devices. They should focus on providing functions most beneficial to users on the go, specifically, real-time bus information, guidance on bus lines etc.;
- In a Real-time Bus Info iPhone application use GPS functionality to offer directions from the user's current location to their selected bus stop;
- When setting up a mobile version of a travel information website, establish a social media presence using Facebook and / or Twitter.

For future projects regarding bus management systems, the following points should be considered:

- Search the market to find the technology that best fits the migration from the current to the foreseen scenario;
- The use of innovative technology requires that an ongoing communication framework with technology suppliers be established from the start of the project clarifying basic project input and output data, operational interface, training needs etc.;
- It is important to provide contributing staff with training and incentives in the early stages of the preparation and implementation phases, to motivate them and gain their confidence.

For future projects regarding parking guidance systems, the following points should be considered:

- Ensure the establishment of good systems for data collection and make sure that knowledge about parking is gathered. Then formulate a strategy for the structure of the guidance systems to support overall traffic planning policies before implementing the specific parking guidance systems.
- Select an appropriate route or routes to guide vehicles towards different parking facilities in a city. This depends on the time needed and the distance travelled to access parking. Thus it is important to show the distance and occupation level on signposts so that the user can choose the parking place based on these factors. It is a delicate process, because depending on the routes by which vehicles are directed it may increase congestion, generating a negative effect of the P&R guidance system.
- Define at the outset all the components that will form part of the communication network to identify maintenance requirements;
- Define in advance availability of power supplies for any new equipment, since procedures to activate new supplies can be lengthy and complicated;
- Involve the owners of parking sites. This kind of project provides an opportunity to bring together parking owners (usually in competition with each other) to work towards improved urban traffic flows.
- If new parking sites are to be developed, it is advisable to insert in the building authorization a clause requiring owners to interface with the parking guidance system.

For future projects regarding emission monitoring systems, the following points should be considered:

- Sufficient time and resources must be allocated to ensure that a) the physical equipment of traffic monitoring systems are fully operational before positive effects can be achieved b) traffic signals can be refined to reflect changes in the amount and type of traffic
- Localisation and monitoring data must be affordable and easily available, delayed availability might lead to ineffectiveness;
- The technological suite must be well established and ready-to-use;
- Evaluation can be integrated with system refinements in an iterative procedure
- Ensure that the technology used is capable of producing the results required for evaluation;
- Retain control of the data gathering during the project and of all “before” and “after” surveys.