APPENDIX A

UPDATE ON PRoGRESS CITIES
A1  Bristol

A1.1  Introduction

Bristol is the largest urban area in south-west England 160 kilometres west of London, near the border with Wales and is the principal urban settlement, covering an area of a little under 110km². In 2001 the city of Bristol had a population of 380,600. The predominantly rural catchment area of 1 million population generates much of the traffic found in Bristol.

New industries such as aviation engineering have gained prominence in Bristol with the development and production of aircraft, most notably Concorde at the Rolls Royce and British Aerospace plants to the north of the city in Filton. 10% of workers in Bristol city are employed in the financial sector and recent years have seen the development of media and information technology companies. There has been a great increase in the number of domestic and overseas tourists visiting Bristol and many jobs in Bristol are reliant on the tourist industry, around 8% in 1999.

A potential shortage of office space has been predicted and demand is expected to rise. Several parts of the city are undergoing extensive recent renovation for commercial, and in particular office, developments. The Centre has undergone a significant change in recent years with the quality of life increasing as more public space has been introduced, traffic has been redesigned out, and residential and leisure development has been undertaken.

A1.2  The Existing Situation

Road Network

The road system in the city is essentially a radial route network with main roads crossing through the centre of the city. An inner circuit road forms the boundary of the proposed charging cordon. In the city centre there are 15,500 pay parking spaces (both on and off-street) managed by Bristol City Council. Private-non-residential (PNR) parking, accounts for in excess of 50% of city centre parking spaces. The city centre has been designated as a special parking area, which is managed by the City Council.

Public Transport

There are 180 scheduled coach services every day to major cities and airports. Public transport provision in the city is the responsibility of private companies although First in Bristol, part of FirstGroup, operate 90% of buses. The city is located on the intercity rail network, with a mainline station at Bristol Temple Meads providing links to all parts of the country. The station provides a focus for commuters into central Bristol. In addition, Bristol also has a local rail network of 11 stations, circling the north side of the city. A second mainline station, Bristol Parkway, is found just outside the city boundary of Bristol in the neighbouring authority of South Gloucestershire.

Bristol International Airport is located 10 miles south of the city. The airport handles more than 2 million passengers a year, and the capacity has been recently upgraded to handle 3.5 million.

At the moment, a regular ferry service exists principally aimed at the tourist market, but there is potential for a commuter ferry service. There are over 50 kilometres of segregated cycle routes in Bristol, a further 4 kilometres of on-road cycle lanes, and 160 kilometres of public rights of way.
However, cycling only accounted for 4.6% of journeys to work, with walking accounting for a much larger 15.6%, in 2001.

420,000 vehicles drive into the city every day. Car ownership of 0.37 per head in Bristol is the highest for any UK city of comparable size, car journeys account for nearly 63.5% of all trips.

Bristol suffers from congested traffic conditions, especially at peak times. The recent increase in congestion is reflected by the reduction in journey speeds. Average speeds attained by vehicles in central Bristol fell from 25.6 kilometres per hour to 17.6 kilometres per hour in the ten years to 1999. This means that many of the roads accessing the city centre are characterised by slow-moving or queuing traffic in the peak hours every morning. The average delay suffered by drivers in central Bristol accounts for 50% of their total journey time. It has been estimated that this traffic congestion costs businesses approximately 30 million Euros a year.

At the same time air quality levels consistently fall below recommended standards, and 85% of the people who responded to Bristol City Council’s Local Transport Plan consultation were worried about air pollution arising from traffic.

This makes it clear that congestion is a key problem in the city and continued growth in private car use is unsustainable.

*Mobility Data and Indicators*

Surveys are made of the overall journey times for buses and other road-based modes on chosen routes/roads around the city. Annual censuses are made of rail passenger numbers at all the local stations in Bristol and a recent survey has been undertaken at Temple Meads. Pedestrian and cycle flows are usually collected during roadside surveys of all the vehicles using the section of road under examination. To monitor travel behaviour, the City Council has a programme of household travel surveys. In addition, roadside interview (RSI) surveys have been undertaken to understand travel movements in the city, and to build transport models. Almost 30,000 roadside interviews were conducted at 29 sites although these were not focussed on road user charging.

A detailed attitudinal survey asking people about their views on various aspects of traffic and transport policy was undertaken in 1999 as part of a major consultation process for the Local Transport Plan. Meetings were also held with residents, local businesses, transport users, and interest groups.

**A1.3 Current National Policy Situation Regarding Urban Road Pricing**

The 2000 Transport Act, gives Local Authorities, outside Greater London, new powers to introduce Road User Charging (RUC) or Workplace Parking Levy (WPPL) schemes where they believe these will be effective in tackling congestion and pollution in their areas. [For London such powers already exist through the Greater London Authority (GLA) Act 1999]. The Bill also provides for the revenue raised from these schemes to be ring-fenced and to be used specifically for local transport improvements for at least 10 years.

Together with 24 interested local authorities, the Government set up a Charging Development Partnership (CDP). Through this high level forum the Government and the local authorities aim to
share ideas, experiences, and develop pioneering schemes to tackle congestion and pollution and to improve local transport services and infrastructure for the benefit of all users.

A1.4 The Policy Context in Bristol

Bristol City Council’s integrated transport strategy is built on three policy strands: transport supply (improved public transport, implementing Light Rapid Transport), travel demand management (parking, Home Zones, and road user charging) and land use development and regeneration.

The modal split for public transport (bus and rail) accounts for 28% of all trips into the city centre of Bristol. Total vehicle kilometres for buses in Bristol are 18 million per year, with 650 million bus passenger kilometres.

The quality of the inter-urban rail connections as compared to the lesser services within Bristol is highlighted by the proportion of rail for journeys to work. In 1991, only 0.9% of Bristol residents travelled to work by train, whereas 3.4% of non-Bristol residents working in the city made their trip by this means. Bristol Temple Meads, on the inter-urban rail network, handles 12,000 passengers every day (2000).

Some of the principal policies to be introduced to reach the goals as described are outlined below:

- Facilities and conditions for pedestrians and cyclists will be improved with segregated paths and safety measures.
- Through a Quality Bus Partnership, and the introduction of Showcase routes, Bristol City Council is acting to improve the city’s bus services.
- The City Council, in partnership with neighbouring authorities, has developed a rail strategy aimed at improving the frequency of local services and the facilities provided at stations. The targets set are to increase rail use by 5% each year and achieve a 1.5% modal share for journeys to work by 2006.
- Bristol’s proposed Integrated Transport Information Centre (ITIC) will contain real-time travel information delivered to the public through kiosks, by telephone, via the internet, and on video screens in the city.
- The development of a Light Rapid Transit (LRT) scheme is seen as the major step change in transport required to achieve modal shift. Some of the revenue from the road user charging scheme will be used to fund this scheme.

In Bristol, the idea of a “Sustainable City” in matters of planning is being developed through planning of new developments close to public transport linkages and following Government policies of city centre regeneration. The Council also works with local companies to draw up Green Travel Plans for their employees.

With the Bristol City Council’s Local Transport Plan 2001/2 to 2005/6, the City Council intends to introduce road user charging in a “transparent” way so that high quality alternatives to the car are clearly visible to citizens and businesses prior to any charging scheme being implemented. Based on consultation, Bristol has acknowledged that improvements to public transport will be made before road user charging is introduced, the introduction of road user charging will lead to further transport investment in the city, resulting in schemes proposed in the LTP being introduced ahead of schedule.
A1.5 The Plan

The full road user charging scheme proposed for Bristol could not be made operational within the
time-frame of the PRoGRESS project. However, significant research work was undertaken in
Bristol on key issues such as the impacts and acceptance of such a scheme. This mainly comprised
developing an area wide transport model (BATS), for private and public modes, to investigate
future scheme options and appraise their impacts. In addition, attitudinal surveys were undertaken
with local populations.

In parallel with this, the UK Government adopted a new policy for a national distance-based
charging scheme for heavy goods vehicles, which is likely to use satellite positioning technology as
well as microwave detection. Bristol City Council (BCC) saw the new Government policy as an
opportunity for studying the synergy between a national charging system and the local charging
scheme. To this end, Bristol worked with the UK Government Department for Transport (DfT) to
establish a joint technology demonstration.

The demonstration concentrated on the use of Vehicle Positioning System (VPS) based pricing
systems in heavy goods vehicles and other commercial vehicles. In addition to the VPS element,
the demonstration examined the use of digital cameras and Automatic Number Plate Recognition
(ANPR) software as a potential enforcement technology. The trial area followed the cordon used as
the basis for developing a full scheme.

Owners of fifty commercial vehicles participated in the trial, ranging in size from cars through to
heavy goods vehicles. Each vehicle was fitted with on-board equipment (OBE) that consists of an
on-board unit (mounted to either the dashboard, the glove compartment or underneath the
passenger seat), a power lead to the ignition of the vehicle, and a magnetic footprint antenna
mounted on the roof.

The on-board unit (OBU) contained a smartcard that can hold a total of 50 charging transactions in
the event of communication with the central control system failing. When a vehicle passes a charge
point, the OBE communicates with the MPS system and allocates a charge. The functioning of the
VPS equipment is illustrated below.

For the trial there were 3 different charging methods deployed:

1. Distance-based corridor charges on the M4 and M5 motorways and two main access roads into
the city. These work using segments on the roads, the further a vehicle travels on the road the
more segments they pass, and the higher the charge allocated.

2. City centre cordon charges that form the basis of the road user charging scheme detailed in the
Local Transport Plan. For this method, 100 points were used to define a zone. There is an
outer zone and 200 metres inside was an inner zone. Charges were only allocated once a
vehicle had passed through both zones.

3. Individual virtual gantry charges on each of the main routes in and out of the cordon. The
virtual gantries are 50m by 50m rectangles, and were activated by a vehicle passing in either
direction.

Trials ran for four months in Autumn 2003 and data was collected on vehicle movements when
they entered trial areas, and via control vehicle testing. This enabled analysis of VPS performance
and fleet pattern analysis. In addition, assessment of ANPR for enforcement purposes was carried out, which would be required to complement DSRC or VPS used in any full size scheme.

Following the Local Transport Plan settlement letter in December 2000, funding has been provided for the further development of complementary measures such as improved bus services, Park and Ride, and public transport information. Consultation is also continuing with local stakeholders and the public, but also with national organisations. Funding has been won from the EC CIVITAS-Programme.

**Complementary Measures**

As well as improving public transport, Bristol City Council has implemented certain policies to reduce car use including downgrading of major roads, pedestrianisation, increasing road space for buses. Parking policies have also been used as a means of restraining car use through making public transport a more cost-effective method of commuting than driving, reallocating parking space to more sustainable sites such as Park & Ride and resident’s permit schemes.

At the same time the Council works in partnership with the bus companies to ensure that a good service is provided, including the provision of subsidies for the bus operators to maintain services that are socially necessary. For this, Bristol already has: three Park & Ride sites with a combined total of 3,200 car parking spaces, real time information at some bus stops, signal priorities on selected routes, 15.2 kilometres of bus lanes, alternative fuelled buses, more of which are being sought as part of the Bus Quality Partnership, Night Buses running on 8 routes and 500 taxi and private hire vehicles.

Accompanying measures for the near future are stated below:

**Park & Ride Facilities** – Portway Park and Ride opened in April 2002. There is also an application for a new Park & Ride in the South East of the city. The revenue from the road user charging scheme would allow high quality public transport alternatives to be in place prior to the charging scheme becoming operational with Park & Ride a key initiative in this respect.

**Showcase Bus Routes and Bus Priority Measures** - A Quality Bus Partnership was formed between Bristol City Council and First Bristol Buses in 1998. Showcase Routes benefit from high quality shelters, raised kerbs for low-floor buses, and bus priority measures, real-time information and more stringently enforced parking controls. Bus Showcase route measures are continuing to be rolled out.

**Parking** - Bristol City Council’s parking policy is to progressively reduce the number of long-stay parking spaces in the city centre and relocate them to alternative sites such as Park & Ride and introduce Controlled Parking Zones (CPZs) in residential areas. There are many car parks surrounding the charging cordon, all of which have potential to be used as Park & Walk sites.

**Charging Trials in Bristol** - Road Pricing equipment has been successfully trialled on major commuter routes in Bristol in the ELGAR (1998) and INTERCEPT (2000) European Commission supported projects. The trial was structured so that volunteers who shifted to Park and Ride or other modes during the project saved money compared to drivers who did not.

The PRoGRESS demonstrator will work within the DfT DIRECTS programme. It will consider mobile positioning systems for both the national lorry charging scheme and the local RUC scheme.
50 vehicles will be equipped and scenarios will be defined by time and location. Bristol will work with the Driver Vehicle Licensing Agency (DVLA) on enforcement. This will examine ANPR technology and the use of mobile units.

A.2 Copenhagen

A2.1 Introduction

The main objective of the Copenhagen PRoGRESS trial is to gain knowledge of the possible effect on travel behaviour if road pricing is introduced in Copenhagen. The demonstration project in Copenhagen is planned to test three different pricing schemes with varying principles of charging and with different levels of charges.

Copenhagen, the capital of Denmark is situated in eastern Denmark on the island of Zealand and at the Swedish border. As the capital, the city houses the Royal Family, the Danish Parliament, a number of government institutions and financial institutions together with international organisations and company headquarters. In recent years the level of economic activity has increased in the Copenhagen region. The economic development and a new housing policy have made it popular to settle and work in central Copenhagen. An increase in offices, hotels and service sector functions is putting the traffic system under pressure. The new Öresund bridge between Copenhagen and Malmö, in southern Sweden will increase traffic pressure in Copenhagen.

The Copenhagen Region has 1.8 million inhabitants, 35% of the total population. The region consists of 5 strong and relatively independent counties and some 50 municipalities with a high degree of autonomy. The municipality of Copenhagen – the City of Copenhagen – forms the central part of the region and has 500,000 inhabitants. A new regional planning and development council (with representatives from the 5 counties) was formed in 2000 and will be responsible for regional planning including transport planning.

A2.2 The Existing Situation

The last 10 years has been a period of heavy investment in roads and public transport including the new bridge to Malmö in Sweden, expansion of Copenhagen Airport, construction of a fully automatic Metro and upgrading of existing railway infrastructure. Copenhagen has a long tradition of bicycle use and a lower building density than comparable cities which contribute to a green and pleasant environment with relatively few traffic problems. The low density on the other hand has spread the urban activities over a large area increasing the risk of car dependency in the future. Car mileage on major roads increased by 20% between 1995 and 1999 but has not changed significantly on the total road network in Copenhagen for the last 30 years.

A well developed public transport network of metropolitan trains, buses and express buses serves Copenhagen and the Copenhagen Region.

Road Network

The road network in Copenhagen has good radial road links and motorways from the outskirts and into the city centre but there is a lack of ring roads and little potential to develop them. Therefore there is a need for better management of the current flows and at the same time a need to focus on methods to diminish the travel demand. Better management can be obtained by increased traffic
control and travel demand management combined with improvement in public transport to combat increasing levels of congestion, longer “rush hour” periods and lower average speeds. To diminish travel demand, road pricing could be one of the instruments.

Denmark has a lower car ownership rate than many other European countries due to very heavy taxation on cars. In the Municipality of Copenhagen the car ownership rate is very low even by Danish standards (220 cars/1000 inhabitants compared to a national average of 350). Car ownership and car use are however on the increase. Bicycles account for roughly 1/3 of all trips in the Municipality of Copenhagen, the modal split for 1999 is shown in A3 below.

<table>
<thead>
<tr>
<th>Year</th>
<th>Walk</th>
<th>Bicycle</th>
<th>Car</th>
<th>Public Transport</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>1999</td>
<td>6%</td>
<td>34%</td>
<td>33%</td>
<td>27%</td>
<td>0%</td>
</tr>
</tbody>
</table>

A2.3 Current National Policy Situation Regarding Urban Road Pricing

Road pricing is a relatively new phenomenon in Denmark. Until now costs for maintenance and construction of roads are funded via budgets provided by the overall taxation scheme. During the last three years however a road tax has been introduced in the areas of Storebæltsbroen and Oeresundsbroen as well as for the bridges connecting Sealand with Funen and Sealand with Malmö in Sweden. The road taxes on these stretches cannot be regarded as a behaviour regulating tax, but strictly as user's fee as a financial supplement in order to achieve sufficient funds for the construction. Apart from the tolls for vehicles crossing the bridges over The Great Belt and Oresund there is no legal framework for urban road pricing.

At the end of 2000 the Danish Parliament decided to spend 21 million Danish Kroner (2,8 mill. Euro) during a 3 year period, in research and to examine possible obstacles for an introduction of road pricing in the larger cities or nation wide. At the same time a road pricing commission under the management of the Ministry of Transport has been installed by means of a signed agreement between the government parties. It is the purpose of the commission to prepare a framework constituting the basis of future decision regarding the implementation of a road pricing scheme in Denmark.

The duties of the commission are directed towards a road pricing system for cars, but include at the same time considerations about the possibility of the introduction of the system for other vehicles. It is stated that the introduction of a road pricing scheme will be conditioned by a maintaining the “status quo” of the costs of having a car and certain special conditions for rural districts.

The deadline for the commission to submit a basis of decision is in the autumn 2003. It is expected that a proposal for the possible introduction of road pricing will be debated in the Parliament in 2004.

A2.4 The Policy Context in Copenhagen

A Traffic and Environment Plan was approved by the Council in 1997. The main objective of the Traffic Plan was:

“To ensure a well-functioning transport system to serve the city with substantially less effect on the environment than at present. This means that the total level of road traffic in the Municipality of
Copenhagen must not increase, whilst the possibility of increased transport activity must be satisfied by increased public transport and increased bicycle use”.

For a long period Copenhagen has had a fairly good traffic situation with only minor problems. But transport policy is now under pressure from increased car ownership and increased use of cars. An extension of the existing road network is not possible. Therefore several transport plans addressing different solutions have been developed. The ideas being developed in these plans are:

- To limit the growth in car traffic by a number of traffic calming projects in local areas and extending the area with parking restrictions and parking charges.
- To improve the use of bicycles the plans include separate bicycle paths at all major roads (90% of the major roads have bicycle lanes) and the introduction of a complete network of green bicycle routes. The overall capacity of the city’s road network has already been reduced due to construction of bicycle paths, bus priority schemes, pedestrianisation schemes and other environmental initiatives.
- To improve the use of public transport by means of the construction of a new Metro and the construction of a new circle line around the inner metropolitan area.

The above described transport improvements are not, however, expected to produce a considerable reduction in levels of car traffic. Although there will be an increase in levels of public transport use, few of these extra passengers are expected to be former car users. With the ongoing trial project under PRoGRESS it is expected to unveil whether road pricing is a viable instrument to control the level of car traffic. The improvements in public transport facilities and in bicycle facilities can be seen as “up-front” investments prior to an eventual road pricing scheme.

A2.5 The Plan

The main objective of this demonstration project was to understand how road user charging could influence the mobility pattern in the Greater Copenhagen area towards a more sustainable pattern. The question is whether road user charging is an efficient means to change the travel behaviour of the motorists. In other words, is car travel reduced when road pricing is introduced?

To answer this question, 500 volunteer drivers’ cars were equipped with a vehicle position system (using GPS technology) with the ability to read virtual cordon rings and zones. A display kept the motorist up to date with the charge in the current zone and with the total cost of the trip.

To be able to test different concepts in the same demonstration project, due to its flexibility vehicle-positioning technology was used. The benefit of using vehicle-positioning technology was its ability to simulate different pricing strategies of interest for Copenhagen.

The demonstration tested the impact on travel patterns of two main types of pricing strategies:

- The multiple zone (or cordon) charging approach.

Dividing the Greater Copenhagen Area into 11 zones (see Figure 2.7). Crossing a zone border costs a small amount of money, but when crossing many borders driving costs become high. The multiple zone system is believed to have less of an effect on central Copenhagen, and is well suited to limit the number of kilometres driven.

- The distance charging approach.
Dividing the area into different zones with different levels of charging, but automatically deducting the charge as the car is being driven. The distance charging system gives greater flexibility and allows a detailed management of the mobility pattern. The 11 zones used in the multiple zone system are reduced to 4 zones as the charge increases as the motorist drives closer to the centre.

Using the two basic scenarios above, three different charging schemes and level of charging were tested in the demonstration:

1. Cordon charging – Level of charging: 1.61 Euro/cordon crossing in city centre gradually reduced to 0.26 Euro/cordon crossing in the outskirts; off peak half level;
2. High kilometre/distance charging – Level of charging: 0.67 Euro/km in city centre in gradually reduced to 0.13 Euro/km in the outskirts in peak hours; off peak half level;
3. Low kilometre/distance charging – 0.33 Euro/km in central zone gradually reduced to 0.07 Euro/km in the outskirts; peak hours; charging only in peak hours.

With various combinations of user response to these 3 different pricing schemes it was possible to analyse driver sensitivity to the level of charging, the time of charging and the geography of charging.

The trial used real money, with the basic principle that the volunteers were paid the amount of money that correlated to their reduction in travel. This payment is made in two different ways to test if the timing of the payment has any influence on the outcome of the trial. The difference between the two timings of payments can be described as follows:

- The test-drivers lose money from their potential reward, which they may have otherwise received in the future;
- The test-drivers are called upon to pay an amount of money they already had at their disposal, equal to the value of their travel by car.

**Complementary Measures**

As the Copenhagen trial is not a full scale demonstration but only a limited demonstration project with a few hundred volunteers, no complementary measures are included in the project. But some major initiatives could easily be seen as "up-front-investments" prior to introduction of a road pricing scheme in Copenhagen.

The Metro system - The new Metro will give Copenhagen a brand new public transport system consisting of small, “driver-less”, fully automatic trains. The first stage of the Metro 11 kilometre line (5 km of which will be underground) will open in 2002. The new Metro will be substantially faster than with the existing local railway system bus system. High frequency of trains mean waiting times will be only 1-2 minutes at busy times. Some 250,000 passengers per day are expected to use the system when fully developed. The existing metropolitan railway system –a much larger network – is currently used by approximately 300,000 passengers per day. The Metro will offer a modern alternative to the private car drivers.

A new Circle Line - The new circle line will link the six metropolitan railway radials and improve public transport links to radial lines substantially. The line will be served by modern light rolling stock with frequent service and shorter journey times than the current metropolitan railway service.
The new circle line is planned to open stage by stage from 2004 to 2007. The investments in the Metro system and the Circle line will give a tremendous lift to the total public transport system in the Copenhagen Region. The so-called OTM-model has been set up for the Greater Copenhagen Area to assess the two charging alternatives. A road pricing committee under the Ministry of Transport which reported on road pricing in Copenhagen in March 2000 has undertaken model simulations of the two different strategies “Kilometre pricing” and “Cordon pricing”. These calculations are so far the best estimates of the possible effect of introducing road pricing in Copenhagen.

A2.6 Modelling and Simulation of Pricing Schemes

The so-called OTM-model has been set up for the Greater Copenhagen Area. It is a sequential disaggregated traffic model in three steps: traffic demand, trip generation and assignment. This model is going to be used in PRoGRESS. Model calculations have been carried out for a reference level and for the two charging alternatives.

The road pricing committee under the Ministry of Transport as mentioned earlier has made some model simulations of the two different strategies “Kilometre pricing” and “Cordon pricing”. These calculations are so far the best estimates of the possible effect of introducing road pricing in Copenhagen, see Table A5. It can be concluded that the reduction in the number of passenger trips is equal in the two alternatives whereas the reduction in mileage is larger for virtual toll system.

Table A5: The Results of the Simulation of the Two Different Strategies “Kilometre Pricing” and “Cordon Pricing”

<table>
<thead>
<tr>
<th></th>
<th>Relative reduction in no. of passenger trips in the region year 2010</th>
<th>The relative reduction of person kilometres (in millions) in the Greater Copenhagen area year 2010</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Km pricing</td>
<td>Cordon pricing</td>
</tr>
<tr>
<td>Car</td>
<td>-3,4%</td>
<td>-3,4%</td>
</tr>
<tr>
<td>Walk</td>
<td>1,2%</td>
<td>1,3%</td>
</tr>
<tr>
<td>Bicycle</td>
<td>3,6%</td>
<td>3,5%</td>
</tr>
<tr>
<td>Public transport</td>
<td>4,7%</td>
<td>4,7%</td>
</tr>
<tr>
<td>Total</td>
<td>0,0%</td>
<td>0,0%</td>
</tr>
</tbody>
</table>

A3 Edinburgh

A3.1 Introduction

Edinburgh is the capital city of Scotland, with a population of 448,850 in 1996 which expands to around one million including the surrounding “travel to work” area. The city’s economy is based on a modern service industry. Banking, finance and tourism are all extremely important, with manufacturing making up just 10% of employment. There is a large knowledge economy with three universities and a number of higher and further education institutions. The economy of the city is expanding faster than the UK average at present and the population is predicted to grow by
approximately 15,000 by 2006. Edinburgh is also the seat of the Scottish Parliament and, accordingly the base for the headquarters of many financial and non-governmental organisations. The Old and New Towns of Edinburgh have been declared a World Heritage Site by UNESCO, indicating their international importance in architectural and historical terms. Future developments in the city must therefore be expected to preserve and enhance the historic city centre.

A3.2 The Existing Situation in Edinburgh

New road infrastructure, especially the city bypass, has increased the potential for longer distance, and especially orbital, travel by car. Car ownership has grown rapidly; the number of cars per 1,000 population in Edinburgh increased by 77% from 211 in 1981 to 373 in 1997. The growth of out of centre shopping and employment has influenced modal shift from public transport to car and upgraded roads have facilitated long-distance commuting by car.

Within Edinburgh, public transport provides more than 100 million passenger journeys per year. There are over 200 local bus services using 800 buses and 2000 bus stops. Bus service provision is deregulated. There are 7 railway stations within the city boundary. Public transport and walking still account for significant proportions of travel in Edinburgh, much higher than in many other UK cities of similar size. Whilst most travel to and within Edinburgh is road based, the rail network is important for travel to the city centre, and for medium/long distance travel. There is a shortage of capacity on the rail network and overcrowding on certain services.

The volume of peak-hour traffic coming into the city centre has actually stabilised in recent years but there has been a considerable increase in traffic outside the centre, and during off-peak hours. Car use still continues to rise. Without further action, increasing congestion will undermine Edinburgh’s economy and the quality of life for residents and visitors. Pollution levels will rise further as growing numbers of vehicles outweigh improvements from cleaner fuels and vehicles. Parking problems in residential areas will get even worse. Edinburgh’s reputation and hence future prosperity, built on high quality of life and a good environment, could be seriously jeopardised so further action is required.

Road user charging presents a real opportunity for the City to meet its transport objectives by directly influencing travel behaviour and helping to meet the investment requirements.

A3.3 Current National Policy Situation Regarding Urban Road Pricing

Together with 24 interested local authorities, the Government set up a Charging Development Partnership (CDP). Through this high level forum the Government and the local authorities aim to share ideas, experiences, and develop pioneering schemes to tackle congestion and pollution and to improve local transport services and infrastructure for the benefit of all users. Edinburgh also participates in this partnership, but only with observer status.

A3.4 The Policy Context in Edinburgh

The specific aims of Edinburgh’s Local Transport Strategy are:

- To improve safety for all road and transport users.
- To reduce the environmental impacts of travel.
- To support the local economy.
- To promote better health and fitness.
- To enhance equity and social inclusion.
To maximise the role of streets as the focal point of local communities, where people can meet, shop, and, in appropriate circumstances, children can play.

The Council’s transport strategy over the last five years has started to have an impact, because Greenways (high quality bus routes) have begun to reverse the long-term decline in bus use., the city centre is an easier and safer place to walk. There are new cycle facilities, and cycle use is increasing and bus services and information for bus users have been improved.

However to keep congestion under control and maintain the quality of further investments, it is necessary to influence travel behaviour by making car drivers pay every time they make a trip into the city centre. The Local Transport Strategy has an overall objective of reducing car dependency and improving alternatives to car travel.

A3.5 The Plan

Since the city’s road user charging scheme is to be introduced after the lifetime of PRoGRESS, Edinburgh conducted a more limited demonstration within the project. The purposes of the demonstration were:

- To demonstrate the viability of the proposed approach to the technology for a full scheme, in particular focusing on potential problems in the Edinburgh environment and with the likely scheme requirements;
- To investigate aspects of enforcement in the proposed full system;
- To investigate behavioural aspects of the proposed full scheme related specifically to the way in which licences might be purchased.

The demonstration had to be meaningful and useful for the preparation of the full scheme implementation, which implied:

- The viability of the proposed approach for a full scheme should be shown, in particular focusing on potential physical issue of the Edinburgh street environment;
- Behavioural aspects should be investigated with regard to licence purchase using the main anticipated licence purchase methods of telephone, Internet, and retail.

The technology used for the demonstration was therefore determined by the likely technology for the full scheme. Two sites, forming part of the proposed inner cordon for the full scheme, were equipped with cameras and Automatic Number Plate Reading (ANPR) equipment: Dean Bridge and in Home Street.

Eight retail outlets were recruited to participate in the trial and simulated retailing of congestion charge licences. Four retailers were located on the approaches to the two camera sites, the other four in different parts of the city centre. In addition, volunteers could purchase licenses through a project web-site.

Around 200 volunteers were recruited at the end of August 2002, all of whom had indicated that they travelled by car regularly into the city centre, and that their routes normally took them through one of the two demonstration sites. The volunteers simulated the purchase of licences whenever travelling to the city centre by car during the day.
In addition to the demonstration activities, extensive survey and public opinion work was carried out in Edinburgh, in a lead up to a full road user charging scheme, the results of which are set out later in this report.

*Complementary Measures*

A mix of actions is needed to reduce the amount of car use in the city:

- Major investment in the transport system, particularly in alternatives to the car.
- Management of the transport system to encourage choice of the most appropriate form of transport for any particular journey.
- Appropriate planning policies to ensure the city develops and grows in a form that reduces the need to travel longer distances.

The end result should be attractive alternatives to car use for far more journeys than at present, less congestion for traffic that does need to use the road network, fewer accidents and a more pleasant, less polluted, city environment for everyone. Major investment backed up by road pricing is fundamental to achieving this.

The proposed investment package has a number of core elements:

- A new *light rapid transit network* (LRT) providing a step change in the quality and capacity of public transport on the main movement corridors in the city.
- Major level of service and quality improvements to the city’s *bus network*, including more frequent evening and weekend services, reduced fares initiatives, easier interchange, and more extensive priority for buses on the road network.
- Enhancing the *rail network* in the city’s catchment area by opening new lines and stations, increasing frequency and capacity on existing lines, and providing better linkages to and facilities at stations.
- Investing in *public transport customer care* covering information provision, more convenient ticketing, and passenger security.
- Providing a ring of *Park and Ride* sites around the edge of Edinburgh linked with high quality bus and LRT services to major destinations in the city.
- A major increase in spending on *road maintenance* to overcome the deteriorating standard of the road network and improve the safety and comfort of all road users.
- Providing a network of *pedestrian routes* throughout the city to improve the convenience, safety and attractiveness of walking.
- Improving *cycle* facilities including a comprehensive network of cycling routes and better cycle parking.
- Making the *city centre* a much more attractive centre for work, shopping and leisure activities through a comprehensive range of traffic and environmental measures.

The details of many of these proposals have not yet been extensively developed. It is important to note that the exact structure of the investment package will be dependent on the configuration of the charging scheme, to ensure that the investments are generally targeted at providing choice and alternatives to those potentially paying the charges.
A3.6 Modelling and Simulation of Pricing Schemes

Existing Base Models

For the initial assessment of the principal options for road user charging in Edinburgh the CSTM3 (Central Scotland Transport Model) has been used. CSTM3 is a TRIPS-based model, which was developed for the Scottish Office by MVA during 1998 as a general-purpose tool for policy analysis and investment appraisal.

It represents the transport network, both road and public transport, across Central Scotland and extending south to the Border, and as far north as the line east-west from Dundee across to Crianlarich, then south to the Clyde west of Glasgow. The Glasgow to Edinburgh corridor is represented in considerable detail, while the less congested and more rural routes to north and south are modelled in less detail without, for the most part, simulated junction delay mechanisms.

MVA was then commissioned to improve the ability of the model to represent travellers’ response to charging by categorising car users into four different ‘willingness to pay’ bands, with two categories for goods traffic. This modification is now complete and is referred to as the CSTM3 Tolling Model.

Simulations comprised a total of 18 tests with different cordons (and with and without screenlines), different charging levels (from £0.50 to £4.00) and charging schemes (all day and differentiation between peak and off-peak).

The results of these tests were evaluated under nine headings:

- Economic Performance.
- Financial Performance.
- Modal Shift Analysis.
- Traffic Flow Changes and Re-Routing.
- Trip Re-Distribution Analysis.
- Environmental Analysis.
- Safety Analysis.
- Equity Analysis.
- Congestion Analysis.

All of these tests have been based on the assumption of a cordon directly around or near the city centre. Further model runs have then been carried out to provide some evidence about the potential effects of either an alternative or an additional cordon at the City Bypass. The table below summarises the impacts of the two options.

<table>
<thead>
<tr>
<th></th>
<th>Test 6 (City Centre)</th>
<th>Test 24 (Inside Bypass)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Economic performance</td>
<td>Net benefit £17m&lt;br&gt;There is less social economic benefit from the city centre cordon because the benefit of less congestion will be shared among relatively fewer users remaining on the network.</td>
<td>Net benefit £25m.&lt;br&gt;There is a greater social economic benefit from the outer cordon because of the benefit of less congestion will be shared by a greater number of users remaining</td>
</tr>
</tbody>
</table>
Revenue generation from a £1 cordon charge (both directions all day) | £110m | £110m
---|---|---
Modal Shift - PT trips Car trips (am peak) | +1800 (5% Edinburgh) -700 | +1000 (2% Edinburgh) -700
The increase in public transport trips is less for this option as the cordon will only affect trips to Edinburgh from outside the bypass, not those travelling within the city.
Traffic Flow changes and Re-routing | Reduction in city centre flows but little or no change in flows on radial routes in outer city and bypass | Some reduction on radial routes near bypass but little change in inner city flows

Methods for Pricing Schemes Modelling

A Scoping Study defined a set of requirements that a model for urban road user charging should ideally meet. In the study, the requirements were defined from the point of view of those who want to know about the possible impacts of different charging schemes: the Council, politicians, residents, business community, commuters etc. These requirements then have implications for the specification not only on input and output of a model, but also on its interior design.

Simulation of Pricing Schemes

The model to be used for the assessment of pricing schemes is LUTI (Land-Use and Transportation Interaction) model. LUTI will not only be used for the modelling of the effects of road user charging, but is designed to assist much more widely in the local transport planning for Edinburgh. LUTI is currently under development and expected to be fully available early in 2002.

LUTI consists of the three components TRAM, DELTA and TAL, which work in combination with other existing models:

- TRAM, is the Traffic Restraint Analysis Model, which is designed to examine how policies for traffic restraint might affect travel in an urban area.
- DELTA is designed to study, in combination with appropriate transport models, the future effects of both land-use and transport policies on both the land-use and transport markets.
- TAL is the TRAM Area Licensing model. TAL allows the quantification of specific aspects of area licensing.

A4 Genoa

A4.1 Introduction

The city of Genoa is located in the Italian region of Liguria on the northern shore of the Thyrrenian Sea situated between the mountains and the sea. Greater Genoa has a population of 650,000 and is subdivided into five major distinct urban areas (Centro, Levante, Ponente, Valpolcevera and
Due to a high population density, a lack of infrastructure, low capacity streets and highly urbanised areas, each of the 5 above districts has severe mobility and spatial occupancy problems. The Port of Genoa is one of the most important in the Mediterranean presenting additional passenger and freight mobility needs.

There is severe congestion in streets approaching the city centre and at several critical nodes. A lack of orbital routes means that trips between the East and West of the city centre involve crossing the city centre causing, environmental pollution and wasting energy. The administration of Genoa is presently addressing traffic congestion and pollution in the central area by applying various restrictive measures to the private traffic. The PRoGRESS project aims to contribute towards this.

A4.2 The Existing Situation

Genoa does not have a ring road although two new roads have been recently built in order to ease congestion along the two valleys. Car ownership ratio is about 1.8 inhabitants/vehicle. The road network is based on main roads running parallel to the coast and crossing the town longitudinally. The urban streets also act as parking areas, since only a few newer buildings have private car parking, a crucial negative aspect affecting efficiency of mobility. The road network is linked with the national highway toll system at 7 entry points.

Buses are the most used public transportation system with a 50% share of total motorised transport. Approximately 32 million km are travelled by a total of 153 million passengers each year. People are encouraged to use public transport through the creation of "Park and Ride", reserved public transport lanes (25 km in total) and the integration of buses and trains. There are 19 rail stations within the city situated along a single line parallel to the coast from West to East with a station every 6-8 km. Interconnections between the railway system and other transport modes have not yet been effectively implemented. There is a 3 kilometre underground metro.

Between 6:00 a.m. and 9:00 p.m., 280,000 journeys are made for work or study, 400,000 including all trip purposes. The morning peak hour is from 07:15 a.m. to 08:15 a.m. when 182,000 journeys are made, 45% of the total in the morning period from 06:00 to 09:00 a.m. The number of commuting trips in the morning peak is presented in Table A8, as well as modal split in morning peak hour computed on users’ initial choice.

### Table A8: Number of Commuting Trips Per Day and Modal Split in Morning Peak Hour (07:15-08:15)

<table>
<thead>
<tr>
<th></th>
<th>Bus</th>
<th>Car</th>
<th>On foot</th>
<th>Motorbike</th>
<th>Train</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Commuting trips per day</strong></td>
<td>97.388</td>
<td>75.791</td>
<td>63.036</td>
<td>20.025</td>
<td>12.198</td>
<td>268.438</td>
</tr>
<tr>
<td><strong>Modal split in morning peak</strong></td>
<td>42%</td>
<td>40%</td>
<td>-</td>
<td>11%</td>
<td>5% (or 7% including subway)</td>
<td>100%</td>
</tr>
</tbody>
</table>

Forty-two percent of trips in the central zone are actually through trips crossing the city centre. The average time to reach central destinations in the morning peak hour is between 35 to 45 minutes by private car (respectively, starting from Nervi and from upper Valbisagno), corresponding to a mean commercial velocity of 22 km/h. The mean commercial velocity of buses is between 12-14 km/h.
A4.3 Current National Policy Situation Regarding Urban Road Pricing

At present, the act explicitly addressing access limitation/pricing is section 7 of the Vehicle Circulation Code which gives municipalities the power to regulate private vehicles circulation “for checked and motivated preservation and preventive measures”, defined only in very general terms.

Other legislation which can be used for introduction of road pricing is focused on the protection of historic cities and so does not support road pricing across a range of different situations.

It is noted that in Italy national legislation already exists to support road pricing initiatives. However, the legislation is sufficient to provide the legal foundations for instituting a road pricing program in Genoa (first case in Italy together with Rome). The two pieces of national legislation which can be used are:

- “Codice della Strada” (road code) which authorises road pricing when used to protect private vehicle entrance historical centres;
- “Decreto Bassanini” that authorises the remote issuance of tickets for non-compliance with restricted areas (that corresponds to the possibility to use ITS technologies for enforcing these areas or for protecting them by pricing entrance).

A4.4 The Policy Context in Genoa

The Municipalities are directly responsible for urban road pricing policies through the Urban Traffic Plan and the Urban Parking Plan (PUP) and in compliance with the National Transport Plan (PGT).

Trips between opposite districts of the city crossing the city centre frequently cause traffic jams in particular sections of the centre road network. For this reason the central area of Genoa is one of the main priorities for urban traffic planning.

The Mobility, Transport and Parking Directorate (M.T.P.D.) of the Municipality of Genoa, is responsible for the Urban Traffic Plan (PUT). The main focus of mobility management is on encouraging modal shift away from cars to more sustainable modes, for instance through the promotion of collective taxi, car-sharing, sea-way (boats connecting the historical centre to the airport) and an on demand shuttle service for the city centre.

In Genoa mobility pricing measures are difficult to implement due to the site morphology. It would however be an additional advanced measure that can be very efficiently integrated to the ones already implemented or planned. However, due to the relevant impact that this policy induces on citizens and commercial operators in the "protected" zone, it is very important to test, in a first stage, the various aspects related to RP application in Genoa. The PRoGRESS initiative aims towards this goal.

A4.5 The Plan

Genoa is working towards a full road user charging scheme for controlling access to the city centre. A multi-modal model (MTCP30), developed in the PRESS project in the EC 4th Framework, was used to investigate and define a feasible RUC scheme and preferred options identified.

In the PRoGRESS project the city demonstrated the preferred scheme option. ANPR technology was chosen as the method for operating the scheme, and camera sites set up around the city centre.
area. The trial focussed on the vehicles and behaviour of volunteer participants, which enabled not only technology trials but also behavioural evaluation. The latter was used to validate model outputs.

The demonstration in PRoGRESS was designed to check the efficiency of the technology and the behaviour of citizens. The demonstration was based on:

- A cordon pricing scheme in a small area of the city centre (1 km\(^2\));
- Automatic Number Plate Recognition systems (cameras at entry points to zone);
- Application of different pricing policies (two fee levels, exemptions, time of day, etc.);
- A six-months period of testing;
- A set of volunteer users with 161 retained as representative sample.

In Table 2.2, the basic scheme parameters are presented. It compares the characteristics of the demonstration scheme (adopted for the PRoGRESS demonstration) and the possible full-size scheme design.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Unit</th>
<th>Demo Scheme</th>
<th>Possible full-size Scheme</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type of pricing scheme</td>
<td>-</td>
<td>Cordon</td>
<td>Cordon, Time based</td>
</tr>
<tr>
<td>Extent of Scheme</td>
<td>-</td>
<td>City centre</td>
<td>City centre</td>
</tr>
<tr>
<td>Area involved (DA) km(^2)</td>
<td>1</td>
<td>1</td>
<td>Up to 4,5</td>
</tr>
<tr>
<td>Type of tolling technology</td>
<td>-</td>
<td>ANPR</td>
<td>ANPR + DSRC</td>
</tr>
<tr>
<td>Number of gates (entrances in DA)</td>
<td>8</td>
<td>11 - 14</td>
<td></td>
</tr>
<tr>
<td>Complementary measure(s)</td>
<td>-</td>
<td>Free PT</td>
<td>Free PT Shuttle line P&amp;R</td>
</tr>
<tr>
<td>RP exemptions</td>
<td>%</td>
<td>40% (VU screening)</td>
<td>40%</td>
</tr>
<tr>
<td>Mean fee level</td>
<td>€</td>
<td>1.00 or 2.00 x passage</td>
<td>0.50 or 1.00 x passage</td>
</tr>
<tr>
<td>Volume of RP involved users (in peak hour)</td>
<td>Users/h</td>
<td>150</td>
<td>5,000</td>
</tr>
<tr>
<td>Application of RP</td>
<td>Days</td>
<td>150</td>
<td>continuous (300/365)</td>
</tr>
</tbody>
</table>

The demonstration area (DA) covers about 1 km\(^2\) and includes central streets and the entire ancient historical centre. Eight main vehicle entry points controlled access into the zone, and each was equipped with ANPR cameras. Both single lane and twin lane roads were included.

Results from the trials were used to both test the technology and to validate model outputs relevant to the full-scheme being investigated in Genoa.
Complementary Measures Design

Public Transport

The municipality of Genoa has planned a big interchange point in Piazzale Kennedy in order to develop a Park and Ride scheme that can be used to support accessibility to the demonstration area. An electric shuttle service is planned to connect the old harbour area with the pricing area. Also in that area, many parking slots are available to implement Park and Ride scheme.

Following the actual PT network and the revision plan, some other routes could be revised in order to maintain a good accessibility to the pricing area.

Fare Integration Schemes

Following the definition of the financial framework, the fare scheme will be developed taking into account the different types of integration (Park and Ride, PT, etc.). In the case of the demonstration with volunteers, the users for the demonstration period will be provided with special facilities in order to support their use of PT along specific routes accessing DA or Park and Ride (free ride tickets or special discount, integrated fares with Park and Ride). All necessary information about the road pricing scheme and the complementary PT measures will be provided also on the PT on road real-time displays and public access terminals.

The Investment Package

Based on earlier studies, the following might be defined as basic characteristics for an optimum feasible scheme for a future hypothetical real-scale road pricing application in Genoa with a mean fee of 1 EURO (less than 1 hour parking): total yearly revenues about 4.5 million Euro.

The total costs for the final system (gates + central HW and SW) installation: 1 million Euro, for management (data update and fee collection) about 0.6 million euro per year and for system maintenance about 0.1 million Euro per year.

A4.6 Modelling and Simulation of Pricing Scheme

The inter-multimodal simulation tool used to simulate the traffic flow of users travelling by cars and bikes, buses, trains, and walking was MTCP (Macroscopic Transport Chain Planner) system (D’Appolonia, 1999). This tool allowed to compute cumulated equivalent flows in the links and to manage the distribution of the users in the network through the 4 defined modes. Inter-multimodal system means that each user can travel on the network not only by a single transport mode, but also he can reach his destination by two or more transport modes. So, this network is a 4-layers multimodal one, i.e. 4 modes have been considered: car, bus, railway, walk.

The 4 layers are interconnected at interchange points by modal interchange links. Since the model is developed to simulate effects of various pricing measures application at the city centre, central area is more detailed.

Simulation Results

The results of the simulations (with reference to the morning peak hour: 7:30am-8:30am) for the two scenarios SP1 and SP2 are reported, compared with the simulated values of the actual situation.
S0. The application of the RP (without exemptions) causes a reduction of the private traffic volume (difference between S0 scenario and SP1: -36.2%; S0-SP2: -52.3%). The application of pricing measure induces a reduction of private cars entering the city centre; this is due to two factors:

- Decrease in number of users crossing RP Area by private cars routes; these users, in SP1 and SP2 scenarios, prefer to cross the RP Area by public transport (directly leaving by bus from their origins, as the public transport has been especially improved for the RP Area), or to change their crossing routes by car, using external routes in order to avoid the city centre. Anyway, the number of the users that prefer the first solution is higher than the number of users that choose for the second solution.

- Decrease in number of users that reach RP Area destinations by private car. These users, in SP1 and SP2 scenarios, prefer to use the new Park & Ride facilities or directly to leave by bus from their origins; the Park & Ride solution is very attractive for the type of users that need to dispose of their car later for other trip destinations.
A5 Gothenburg

A5.1 Introduction

The Gothenburg city has been substantially extended in the last few decades. According to Swedish Statistics in 1999, the population density was 1050 inhabitants/km$^2$ (467,029 inhabitants in a 445 km$^2$ area) within the Gothenburg city.

An environmental zone 3x5 km$^2$ aims at improving the local ambient air quality and reducing traffic noise by prohibiting polluting diesel trucks and buses over 3.5 tonnes to in this area. There are approximately 100,000 inhabitants and the same number of workplaces inside the zone. The number of visitors to this area is quite high. Gothenburg’s road traffic contributed to various air pollutants in 2000. Traffic noise is also a nuisance to Gothenburg residents.

A5.2 The Existing Situation in Gothenburg

There was high economic growth in late eighties in Sweden. Consequently, traffic volumes increased acutely, especially in large cities, and congestion became one of the main metropolitan problems. Today, the traffic problems are getting worse. In Gothenburg, peak period traffic is predicted to rise by 27 percent by 2010.

One million daily car movements in the Gothenburg region produce approximately 14 million vehicle-kilometres daily. Each car makes approximately 2.5 movements per day, which gives an average distance per car of approximately 35 km per day within the region. More than 7 million vehicle kilometres were produced every weekday inside the Gothenburg city. In the city centre, the average driving distance was approximately 3 km daily, 9 km in the remaining part of the urban area.

Road Network

There are four connections over Göta River (Göta Älv) – the Tingstad Tunnel, Älvsborg Suspension Bridge, Göta Älv Bridge and Angered Bridge. The existing semi-circular ring roads located to the South and West of the city centre play a major role for the parts of the region South of Göta River. The number of available parking spaces in the central part of the city in 1992 was 96,500, (public and private parking facilities). Approximately 12,000 were situated in the city centre.

Public transport inside the Gothenburg city consists of buses and trams. In 1997, there were 205 trams and 200 buses in the vehicle fleet. The route network consists of approximately 120 km of tramway and 480 km of bus routes. Approximately 90 million public transport trips are made each year. Within Gothenburg city, there is a cycling network of 380 km separated lanes. Cycling and walking are not used to any greater extent as a direct alternative to the other transport modes in peak hours.

The modal split for The Gothenburg region for home to work trips is as follows; Car drivers 56%, car passengers 6%, public transport 20%, cycling 8%, walking 9%, others 1%.

A5.3 Current National Policy Situation Regarding Urban Road Pricing

Seen from a historical point of view there is a strong awareness of the possibilities of road pricing and political interest in the issue. This interest is ongoing. The Minister of Industry recently (May
2000 and June 2001) declared that all legal obstacles shall be overcome to allow for the introduction of Road Pricing. Also the newly appointed General Director of the Swedish National Road Administration has declared (August 2001) that congestion pricing (re-named to access pricing, since it sounds more positive) has to be introduced as one of several methods to manage transport demand in larger cities. He referred to civil aviation, where such measures are quite natural.

A major problem is that this commitment is a property of the central ministries and authorities, while a more reluctant attitude can be seen among the city officials, for good reasons. The first reason is that the current proposed legislation regards road pricing as a tax under complete parliament control (see below under legal issues). The second argument being that if funds are raised locally, there is a considerable risk that the cities share of governmental funding will be lowered. The cities require a guarantee on governmental support, before they are willing to commit to any local pricing scheme.

Beside the specific aspect of fund control, public officials in the cities of Stockholm and Gothenburg are convinced about the advantages of road pricing, and positive that it will be introduced. A recent unofficial survey on expected time horizon showed that the expected time to deployment was 5-10 years in this group. This would change radically if another city “close enough” (e.g. Copenhagen) would introduce road pricing.

Since the National Investigation on Road Tolls in 1994 concluded that road user charging applied to existing public roads should be considered as a tax (with the argument that a fee requires an obvious service in return), a new situation arose. Following from the constitution only the government can raise taxes, and the right cannot be delegated (although there are of course exemptions). This means that every implementation (i.e. every site) of road pricing has to be subject to a specific law following a decision in the parliament. In theory, every change of fee has also to be subject to a decision in the parliament. Because of this situation the government has now decided to hold back propositions for legislation until it can be applied to specific cases.

Although not turned into legislation, the results pf an investigation in 1998 give a good understanding of what a law on implementation of road pricing could look like. The Swedish National Road Administration (SNRA) is appointed as supervising authority giving concessions for implementation of systems for fee collection. This means that SNRA in practise will have the right to decide on technical solutions etc., and is responsible for maintaining a certain level of know-how. SNRA is also the controlling authority after implementation.

The tariffs may be proposed by the local (city) authorities, but are subject to be accepted by the national parliament. To avoid a multitude of decisions, tariffs may include principles for automatic raising according to specific consumer-price index.

The use of the funds raised should be defined in the parliamentary decision taken for each implementation, but some basic rules apply. The first rule is that the fee is subject to VAT (which ensure that the government gets a fair share of the money collected). The second is that a certain percentage of the income shall be handed over to the SNRA to finance the organisations costs as a supervising authority (including R&D). All in all, it was concluded that up to 50% of the collected money could end up in the governments budget which met quite a lot of local opposition.

The (expected) institutional structure follows from the description above:
1. A framework legislation describes the global conditions for road pricing.
2. The SNRA issue guidelines on implementation of technical and administrative solutions for road pricing.
3. A municipality (city) requests to introduce a pricing scheme. The request is sent to the Ministry of Transport.
4. The municipality propose a technical and administrative solution.
5. The solution proposed is studied, changed and finally approved by SNRA.
6. The Ministry of transport prepare a bill for the parliament detailing the pricing scheme concerned.
7. The parliament approve the bill.
8. The municipality (city) can start implementation while continuously being supervised by SNRA.

The Policy Context in Gothenburg

The Traffic plan and circulation programs contain a series of investments in both public transport systems and road networks:

- Prioritising and increasing the competition of the public transport system into the regional centre.
- Construction of higher capacity in the regional road network.
- Introduction of road user charges.
- Special environmental protection measures.
- Improvement of the regional commuter train traffic.

Some new light rail links will be built around the inner city, “Kringen”. Some strategic terminal points will be reconstructed and improved. Park and Ride facilities will be built near the public transport passages and a network of bus lanes to and within the Gothenburg city will be built. The regional commuter train traffic will be improved. The vehicles will be modernised and time schedules will be adapted to demand, rail road capacity and economic conditions.

A5.4 The Plan

Gothenburg demonstrated distance-based pricing scheme using VPS technology, supported with modelling work. A number of pricing strategies were analysed and from these two scenarios were selected for demonstration, each with a different focus:

- a congestion-based scenario; and
- a scenario focused on environmental improvement and mobility management.

Both scenarios utilised distance-based charges, made possible by the application of VPS technology. Volunteers agreed to have vehicle fitted with On-Board Equipment, which provided them feedback on the charge levels being levied, as they drove on routes in the trial area.

For congestion based charging the main alternative was to find another departure time before or after the morning peak period. For this reason, the charging period was set as short as possible, from 07:30 to 08:30 in the morning. The main concept was to trial a reduction of marginal trips by car in the peak period and to change average conditions as little as possible. Charges were levied on congestion prone major road links. In order not to redirect traffic onto environmentally sensitive city streets, charges were also needed in other zones in the city.
Two levels of charges were set for the PRoGRESS field trial: SEK 7/km for congestion prone roads and SEK 5/km for all other roads within the defined area.

The alternative, environmental scenario, aimed at improving the local environment and particularly the city centre. Improvement of the local environment is here defined as reduction of exhaust emissions and noise, but also increased space for pedestrian and cycle movements. As the local environment is influenced by off-peak traffic, charges were applied in all time periods. Zones were defined to limit route choice and avoid the undesirable effects of additional congestion. The zone boundaries were set to be logical for motorists in Gothenburg and areas within the zone boundaries with a similar character and had the same charge level.

The inner area (black cordon) delimits the central parts of Gothenburg, the middle zone (red cordon) encircles the semi-central parts of the City and the outer zone (blue cordon) delimits the coherent urban areas of Gothenburg.

The Gothenburg PRoGRESS demonstrator could be regarded as a ‘state-of-the-art implementation’ in a distance-based charging scheme for road transport. The on-board equipment consisted of three parts:

1) On-board unit containing computer, the application software, a GSM telephone with antennae and software for the GPS positioning. This unit is installed out of sight, typically under one of the front seats;

2) Palm Pilot containing software for the user functions and the user interface. The Palm is installed on the dashboard with the screen visible for the driver;

3) GPS-antennae receiving signals from the GPS satellites.

**Complementary Measures**

**Park and Ride**

Advanced technology will be used for payment of charges. All users have to register to Tele-P, the parking service provider. The user needs a vehicle, a cell phone and an account. The parking areas are tagged with a login telephone number. When the user wants to park, he/she needs to call the number for that area and gets logged in to the Tele-P system. When the logout number (all the parking areas have the same logout number) is dialled, the fees are calculated and transferred from the users account to the parking operator.

**Parking System**

The vehicle units will contain a parking application and a parking map and when a user wishes to park, GPS is used to get the surrounding parking locations. The parking locations are shown on the display in a scroll menu with the nearest as default, followed by the second nearest and so on. The user chooses one of the parking locations and confirms the parking. The user is also able to get information on the areas such as time intervals when parking is forbidden, parking operators and parking fees.

The parking application is software in the vehicle unit. It handles dialogs with the user and
communication with Tele-P. It also calculates the parking location based on a GPS position.

A5.5 Modelling and Simulation of Pricing Schemes

The SAMPERS model system has recently been developed by Transek AB and subcontractors on request from Swedish transportation authorities. The main data source for the travel behaviour to be modelled was the national Swedish travel survey, RiksRVU 94-98, which is a continuous travel survey containing 30,000 interviews for the entire interview period. The travel survey contains a one-day diary including all trips, supplemented by trips over 100 km made the last month, and trips over 300 km made the second last month.

SAMPERS contains regional, long distance domestic and international demand models, all of which are in the discrete logic type. The regional model produces estimates of trips or the following modes: car driver, car passenger, bus, commuter train, bicycle and walk. There are separate models for different trip purposes, which make it possible to study effects on trip generation in many dimensions. The traffic flows and resulting speeds from the assignment step can be used as input for emission calculations.

The effects of road user charging can be calculated in the SAMPERS model system, by weighing in the cost on links in every driver’s choice of route. In addition, the user charge is added to the rest of vehicle costs for every OD-pair and thus affecting the travel demand (e.g. travel frequency, modal- and destination choice). The effects of a road pricing scheme are dependent on the value of time of each potential road user. The value of time in turn may vary for a certain individual depending on his trip purpose. It is therefore necessary to perform a segmentation of car trips according to time value.

With zones and cordon or trajectory based pricing, it is possible to get very strong traffic reductions in the central area. If there is a political consensus, it is also possible to limit traffic for instance to address environmental concerns. Trajectory based pricing has the greatest impact on the number of vehicle-km as well as on the mean velocity inside these zones. Zonal and Trajectory based pricing within geographically limited zones, will lead to an increase of road transport outside these zones. This will bring down the global reduction in car usage from introducing fees to 3%, which is approximately the same as one or two years of natural growth in road transport. It is important to point out that the PRoGRESS project in Gothenburg also will include new simulations which will be based on the new PRoGRESS scenarios.

A6 Helsinki

A6.1 Introduction

The Helsinki Metropolitan Area (HMA) includes four cities: Helsinki, Espoo, Vantaa and Kauniainen totalling over 950,000 inhabitants. The city centre of Helsinki is the focus of the area providing commercial and cultural services for the whole of HMA. The city centres of Espoo, Vantaa and Kauniainen are of a smaller scale.

According to the latest forecasts, the population of the metropolitan area will increase by some 180,000 until the year 2020 reaching 1.1 million inhabitants. If the increase in the municipalities surrounding the HMA is taken into account, the total increase might be over 200,000 inhabitants.

It is clear that the present traffic infrastructure can not cope with the increasing demand.
Infrastructure investments may bring some relief to the traffic congestion but will not solve all foreseeable problems. More sophisticated solutions need to be studied. It is more important than ever before to guide land use and traffic planning and to introduce traffic guidance systems in a manner, which prevents the scattering of urban structure, decreases the need for private car usage, shortens trip lengths and, above all, influences the modal split for the benefit of more effective and environmentally friendly means of transport.

A6.2 The Existing Situation in Helsinki

Travel Behaviour

The inhabitants of the Helsinki Metropolitan Area make over 2.6 million trips per average weekday. Almost half of the trips are made by passenger car. The share of public transport is approximately one third. The rest of the trips are made by foot and bicycle. The public transport share is significantly higher (70%) for the trips to and from work in Helsinki city centre.

Car ownership in the Helsinki Metropolitan Area and in the whole of Finland is 350 and 400 passenger cars per 1000 inhabitants respectively. The main reasons for the low car density in the area are a dense urban structure, an efficient public transport system and a lack of parking space in the central business district.

High automobile and fuel tax added with an annual user fee make owning and using a car relatively expensive in Finland even though there are currently no road tolls. In addition, roadside parking is fairly expensive.

The main routes are partly congested during morning and evening peak hours. The situation is worst on Ring Road I, which is congested in both directions in the peak hours, and on the radial streets close to the city centre. Due to heavy traffic volumes, the transport network is also relatively sensitive to incidents and poor weather conditions.

The bus network is very extensive and comprises bus lanes on most radial main roads and the main streets in the central business district. Approximately 1400 buses operate on almost 300 bus lines guaranteeing access to nearly every suburb from the central business district. However, cross-region bus services are still quite limited. The tram network (110 carriages) covers extensively the central business district reaching most suburbs within the range of approximately 5-6 kilometres from the city centre.

The Helsinki underground system comprises one line from the western periphery of the central business district to the Eastern Commercial Centre, where the underground line splits in two leading to suburbs nearby. Local trains carry commuters westbound, north-westbound and north-eastbound. The pedestrian and bicycle path network is relatively extensive in the central business district. In the Helsinki area the share of cycling is some 12% during the summer months (1997). Table A11 shows the modal split of traffic crossing the central business district cordon line in 1998.

<table>
<thead>
<tr>
<th>Mode</th>
<th>Number of persons total</th>
<th>Share (%)</th>
<th>Number of persons from 6 a.m. to 9 a.m.</th>
<th>Share (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>PT total</td>
<td>452 000</td>
<td>62%</td>
<td>63 000</td>
<td>70%</td>
</tr>
<tr>
<td>Train</td>
<td>85 500</td>
<td>12%</td>
<td>15 000</td>
<td>17%</td>
</tr>
</tbody>
</table>
A6.3 Current National Policy Situation Regarding Urban Road Pricing

The timing of PRoGRESS seems ideal in the light of the latest developments at the national level. It seems now that the lack of financing for infrastructure investments has increased the awareness of "the user pays" principle and of road pricing as a means of implementing this principle. The strong support of the European Commission pushing this issue forward cannot be underestimated.

A6.4 The Policy Context in Helsinki

Road pricing proposals have been developed for the Helsinki Metropolitan Area a number of times in the past, the most serious of these being in 1993. All proposals were however discarded before reaching the final political decision-makers as a result of political and public opposition. However, a "low profile" interest among the core authorities and transport planning experts has kept the issue very much alive and Helsinki has been an eager participant in many European projects concerning transport pricing in recent years. It therefore seemed natural that the city should take part in the PRoGRESS project.

The Helsinki Metropolitan Area Council carries out an integrated transport plan every fourth year covering the Helsinki Metropolitan Area. Financing comes partly from the State budget, which is based on annual decision making. This makes it difficult to commit to a specific implementation schedule regarding the major development investments, because no promise can be given by the state that the financing is available during a specific year in the future.

Urban pricing is not yet mentioned as an objective of this transport plan but as an issue which should be studied further in order to reach a situation, where the decision to proceed can be taken if so decided by the politicians.

Helsinki decided not to carry out an actual demonstration for road pricing. Instead, the city’s participation in PRoGRESS is being seen as an ideal step towards developing and implementing a demonstration sometime in the future.

A6.5 The Plan

Helsinki used the modelling concept from the PRESS project for developing several pricing strategies for the Helsinki metropolitan area. Helsinki did not implement a pricing scheme or trial, but instead completed a modelling study. A final pricing scheme has not been selected, but several alternative schemes were developed for local consideration. The site’s participation in PRoGRESS allowed the profile of road user charging in Finland to be raised, and a number of interviews were held with local stakeholders and politicians.

At the beginning of the project, three main scenarios were defined, based on previous work and experiences. Each of the main scenarios was considered by two alternative pricing methods, trip-based and distance-based. The work carried out through PRoGRESS allowed the elimination of...
one of the three main scenarios originally defined for the project, allowing work to focus on the two remaining.

The two remaining Helsinki Metropolitan Area road user charging schemes cover the whole region (see Figure 2.15). The work in PRoGRESS has tested how the trip-based and distance-based schemes differ from each other regarding the impacts on road network. This has resulted in a definition of rather dense trip-based zoning system as well including also radial borders aiming to simulate the distance-based scheme.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Road pricing tariffs</td>
<td>1.7 / 0.85 euro/passage (inner / outer border) / 0.03 euro/km (inner / middle / outer border)</td>
<td>1.7 euro/passage (inner / outer border) / 0.07 euro/km (inner / middle / outer border)</td>
<td>1.7 euro/passage (inner / outer border) / 0.03 euro/km (inner / middle / outer border)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Charging</td>
<td>All users pay. Morning peak 6–9am</td>
<td>All users pay. Morning peak 6–9am</td>
<td>All users pay. Morning peak 6–9am</td>
<td>All users pay. Morning peak 6–9am</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Present PT and parking fees</td>
<td>1.5 euro/trip within city limits and 2.5 euro/trip within HMA.</td>
<td>1.5 euro/trip within city limits and 2.5 euro/trip within HMA.</td>
<td>1.5 euro/trip within city limits and 2.5 euro/trip within HMA.</td>
<td>1.5 euro/trip within city limits and 2.5 euro/trip within HMA.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

These two main alternatives (trip- and distance-based) have been studied further in terms of impacts by complementary actions relating to the public transport and parking fees and supply as well.

Although no immediate implementation of road user charging is foreseen in Helsinki, the pricing scenarios which were studied in PRoGRESS were defined taking into account the technical and
functional feasibility of an implementation of the scenarios. It is likely that were pricing to be implemented then it could be achieved using DSRC or GPS based technologies.

Complementary Measures

Public Transport

Public transport service is one of the three main instruments (road pricing, parking charges and public transportation), which has been tested as an integrated part of the urban transport pricing package. The tested measures were the fares and improved/reduced level of service. Changes in the level of service will be described as shorter journey times and increased number of services. All tests were carried out by making the respective changes to the calibrated traffic model. The following indicators will be used to evaluate the impacts:

- Total distance travelled (km).
- Average speed.
- Modal shares.
- Revenue changes.

Parking Fees and Park and Ride Facilities

Various parking fee policies were tested as part of the integrated urban pricing package. Introduction of improved Park and Ride policy had to be disregarded as the model dimensions did not allow it without extensive downscaling of network description. Tested actions consisted of changes in the parking charges. The model structure including networks and functional principles is described in Chapter F.5. The following indicators will be used to evaluate the impacts:

- Total distance travelled (km).
- Average speed
- Modal shares.
- Revenue changes.

A6.6 Modelling and Simulation of Pricing Schemes

The City of Helsinki and the Finnish Road Administration already monitor traffic volumes and journey times frequently and a mobility survey was conducted by the Helsinki Metropolitan Area Council in 1995 therefore a lot of data is available.

The Macro scale Transport Chain Planner (MTCP) from Helsinki Metropolitan Area is not suitable for the analysis of road pricing schemes, and a new multimodal model has been developed starting from the existing information.

The MTCP model consists of three modes:

- **CAR layer** for private users (users of cars and motorbikes), including main urban roads at increasing detail as approaching the city centre.
- **BUS + TRAM layer** for users of transit service.
- **RAILWAY layer** for users of train and metro service.
MTCP Analysis Parameters

MTCP analysis parameters are mainly traditional mode specific cost and time parameters. In the Helsinki case, the cost of travel is defined by the sum of the following terms:

- Cost of time term (computed on the basis of a unique user category), equivalent to the product of the unit cost of time and the total time of the travel. The latter is the sum of: accessing the network, car travelling, car parking, bus waiting, transfer time (where applicable).
- Indirect monetary cost due to private vehicle usage.
- Cost of the public transport ticket.
- Cost of parking.
- Road pricing fee.

A7 Rome

A7.1 Introduction

The Rome Metropolitan Area has 4 million residents over an area of 5300 km\(^2\). It is located on the west coast of Italy in the Lazio Region, which is the third most populous region and the third most important industrial area in Italy, with over 5 million people.

The historical centre has been made a Restricted Access Zone (ZTL, Zona a Traffico Limitato) and has an area of about 6 km\(^2\). This area contains the highest concentration of business activities (21 thousand workers/km\(^2\)). The central area is densely populated and presents a great deal of business activities. In the three-year period between 1996 and 1999 a 1.5% reduction in population saw 45 thousand fewer inhabitants living in the area.

As capital of the country, service industry dominates with administrative and political activities as well as tourism. These activities are particularly concentrated in the central area, especially in its historical centre. In spite of this concentration of activities, a sufficiently developed radial system of public transport services has not been implemented. Both pedestrian and public transport shares are only 20% each of the total mobility, while 60% trips are travelled by private transport; in the historical centre this modal share changes into 34% of pedestrians, 29% public transport and 37% private transport.

There is a dominance of registered private cars and motorbikes despite the lack of parking spaces. Fleet renovation and daily traffic reduction produced better environmental impacts: the average daily emissions have decreased for some pollutants (i.e. CO –6%, VOC –14%, PM –21%) while showed an increase for some others (i.e. \(\text{No}_x +5\%\)).

A7.2 The Existing Situation

At present one of the biggest problems is the noticeable imbalance between transport demand and supply, which has determined a dramatic modal split in favour of private vehicles. Public transport in 1964 served 56% of the total motorised trips, now this percentage has lowered to 25% whilst walking has declined considerably. A transport demand is basically structured on radial lines with negligible orbital links which, coupled with insufficient public transport supply leads to high levels of congestion on the radial infrastructures.
The Rome transport network development in the period from the Fifties to the Seventies has been mainly car-oriented and private road transport still remains the main transport mode used by Roman citizens.

Observed and simulated traffic flows in 2000 highlight the lack of adequate transit supply especially in the eastern and northern sectors which induces high traffic levels on the radial routes. The local public transport network comprises:

- 258 bus lines.
- 6 tram lines.
- Regional railway and metro on most important corridors in the town.
- 6 thousand taxis.

The railway network is served by two different operators, the national operator FS and the regional operator METROFERRO S.p.A. The metro system has two lines. The network, with a length slightly over 36km, serves 48 stations with 80 trains which are at capacity during peak times serving over 220 million passengers per year.

Mobility Data and Indicators

Between 1996 and 1999, the overall mobility showed a reduction of about 10%, from 6.2 to 5.6 million trips per day. The average number of trips per capita has consequently decreased from 2.6 to 2.3 units per day. Modal split shows 21% pedestrian trips, 59% trips on private vehicles and 20% trips on public transport. Parking charges in the inner areas and car access restrictions in the historic centre have contributed to traffic reduction, even though cars have been partly substituted by motorbikes and scooters. The use of public transport to reach the central areas is strongly correlated to the users’ habits: the longer the paid parking areas have been in operation, the more people use public transport to reach these areas. The average travel speed for cars is 17 km/h (19 km/h for motorbikes) against 10 km/h of public transport. The lower traffic densities observed have resulted in better environmental conditions – a reduction in CO emissions of about 6 thousand tons per year.

A7.3 Current National Policy Situation Regarding Urban Road Pricing

Today, the act explicitly addressing access limitation/pricing is section 7 of the Vehicle Circulation Code which gives municipalities the power to regulate private vehicles circulation “for checked and motivated preservation and preventive measures”, defined only in very general terms.

Other legislation which can be used for introduction of road pricing is focused on the protection of historic cities and so does not support road pricing across a range of different situations.

It is noted that, in Italy, national legislation already exists to support road pricing initiatives. However, the legislation is sufficient to provide the legal foundations for instituting a road pricing program in Genoa (first case in Italy together with Rome). The two pieces of national legislation which can be used are:

- "Codice della Strada" (road code) which authorises road pricing when used to protect private vehicle entrance historical centres.
- "Decreto Bassanini" that authorises the remote issuance of tickets for non-compliance with restricted areas (that corresponds to the possibility to use ITS technologies for enforcing these
areas or for protecting them by pricing entrance).

A7.4 The Policy Context in Rome

The main objective of the City Council is detailed in two general goals:

- To improve mobility conditions, while increasing circulation safety and decreasing air and noise pollution.
- To retain urban spaces, by rationalising public space use, safeguarding citizens health and preserving historical and architectural heritage.

The strategy to decrease private car use is developed as an extremely flexible instrument - the transport policy is aimed at discouraging private vehicle usage in the central areas with higher density of activities, and restricting car usage to locations distant from the historic centre. The long term instrument is the Mobility Integrated Program (PROIMO). The main objective of the program is to define a planning tool which gives coherence to all private as well as public urban mobility issues supporting the ongoing new General Masterplan.

In 1997 the City Council adopted the Urban Traffic General Plan (PGTU, Piano Generale del Traffico Urbano). The general implementation strategy foresees that radial corridors will serve traffic to and from the central areas by strengthening and re-designing radial railway systems.

The ambitious program involves:

- Two metro new lines and extension of the two existing ones.
- Redesign and integration of the existing railway and tram network.
- Completion of the internal ring (Green Ring) with interchange with radial railway lines. Traffic calming measures are programmed on all routes.
- Interchanges in peripheral areas aimed at guaranteeing modal change between private and public transport.

New high speed radial lines served by tram, trolleys and electric vehicles will be added to the existing ones, which will be strengthened and extended. Priority will be guaranteed to radial public transport through:

- New reserved lanes.
- Traffic calming measures, and other specific measures, to discourage car usage to access central areas.
- Traffic light regulation giving priority to public transport at crossroads with reserved lanes.

The above scheme will work only if accompanied by complementary restrictive measures on traffic and management in the form of an access control system to the historic centre to be implemented together with pricing policies, applied with equity to residents and non-residents, aimed at discouraging private vehicle usage.

Existing Access Control Scheme

Automated access control has been in operation since 11 August 2001 and full enforcement against violations will be in place by the end of the year 2001. Surprisingly, it is only recently that the City Council has begun to consider the opportunity to impose a charge to access the historic centre. A specific zone called the “blue area” was defined in 1989 and implemented started 1992, when the
real extension of the area and time restriction segments were defined. The National Act 122/89 empowered city councils to define instruments such as the Urban Parking Plan (PUP, Piano Urbano Parcheggi) to increase and regulate public as well as private parking supply.

The Urban Traffic Plan is the relevant program concerning the co-ordination regulating private vehicle circulation and restrictions, such as restricted access zones and on-street paid parking. Restricted access zones and parking fees in Rome were adopted in 1994, when the Urban Traffic Plan was implemented and permits to enter the restricted access zones were distributed free of charge to residents and essential users (e.g. disabled). From 1998 authorised non-residents are required to pay an annual fee equivalent to the price of annual public transport passes in order to obtain the permit. Parking is free for residents near home or within their designated neighbourhoods.

A7.5 The Plan

The PRoGRESS demonstration was undertaken in the Limited Traffic Zone (LTZ) sectors east of the Tiber, the central area in Rome and one of the larger historical centres in the world. The pricing zone has an area of 4.6km$^2$ and is controlled through 22 entrance gates. The area contains about 42,000 residents and over 116,000 workers, in six sectors.

The system implemented in Rome derives from two independent systems. The first is the access control system, operating the identification of car plates accessing the Restricted Access Zone and already adopted in Bologna. The second is a payment system, based on the automatic toll collection system applied to motorway users (TELEPASS). The integration between the two systems generated the system called IRIDE.

When a vehicle approaches the gate (the approach is captured by inductive loops), the on-board unit communicates information to a local gate control system. If the smart-card in the on-board unit is not valid or the vehicle does not have the on-board unit, the video cameras are activated and a photo is taken of the rear vehicle number plate. Data and images are then communicated to the central access control system and processed.

LTZ access permits in Rome were adopted in a systematic way in 1994, with access control operated automatically from October 2001 using the IRIDE system. The main objective was to restrict the number of vehicles accessing the LTZ to those strictly necessary, and promote public transport and intermodality along rail lines to the historic centre. Enforcement is active during the weekdays from 6.30am to 6.00pm, and on Saturday from 2.00pm to 6.00pm.

A significant demonstration element undertaken in PRoGRESS was the assessment of impact from the results of introducing different road pricing schemes (based on both per-trip and time-based charging structures) in the Limited Traffic Zone, during the current operational time of the access restriction (from 6:30am to 6:00pm).

The simulation results showed that the replacement of the current scheme, based on the annual fare system, with a per-trip or time-based scheme would not lead to substantial changes in terms of overall modal split, unless mopeds are also charged.

The main assessment then became a study of road user charging application in the evening period (from 6:00pm to 11:00pm). This was used as the basis for the main volunteer research, together with extensive consultation and surveys of residents and business owners in the area.
Complementary Measures

Pricing in all schemes will be accompanied by the following complementary measures:

- Improvement of public transport in the central areas.
- Improvement of private–public transport intermodality in the outer areas.
- Public transport integrated fare system.
- Parking pricing system.

Public transport in the restricted access zone will see new express lines (high capacity buses crossing the restricted access zone) and a new tramway, while the existing express lines boarding the area will be improved; new trolley lines and electric/hybrid vehicles will be purchased to operate the distribution network in the centre (three lines at present serve the restricted access zone). A parking management and pricing system is being implemented aimed at making journeys to the centre by car more costly while favouring all users who travel by Park & Ride. There will be 12,000 two-wheels free parking places spread over the city. The system comprises integrated pricing for access, parking and use of local public transport.

At the end of 2001 the areas of focus are development of on-street parking policies (e.g. ‘telepark’, flexibility) and the design of complementary measures, e.g. diesel and electrical buses, extension of networks.

A7.6 Modelling and Simulation of Pricing Schemes

The existing models used for the analysis of the transport systems in Rome are two: a model for the simulation of traffic flows on the transport networks, based on the TransCAD software package implemented and commercialised by Caliper Corporation (US), and a model for the evaluation of transport demand starting from the territorial asset, that is the proprietary software STIT implemented by SINTRA (IT). TransCAD is a software package, based on four main components:

- A geographic information system (GIS), designed specifically for transportation systems.
- A data model that includes storage of information on: flows, delays, restrictions for turn movements at intersections, routes systems, flow matrices, travel time matrices, and cost matrices.
- A collection of transportation network analysis and operations research models, advanced analytical models for specific applications, supporting tools for statistical and econometric analysis.
- A development language for creating macros, add-ins, server applications, and custom front-ends.

The simulation model of the transport networks uses a demand modelling based on 530 traffic analysis zones. The road transport supply is represented through a graph consisting of nodes and links. The traffic assignment models reproduce, in the present state scenario, and predict, in the planning scenarios, the network flows associated to each link and generate estimates of the travel times and other attributes that are the basis for benefits estimation and air quality impacts. The demand assigned to the network is contained in the modal OD matrices. The model evaluates separately the OD matrices by trip scope (journey-to-work, journey-to-school, other trips) and transport mode (cars, motorbikes, public transport, pedestrians).
The user is represented as a trip consumer assuming that he: a) considers a positive finite number of travel alternatives; b) associates to each travel alternative of his choice set a utility represented through a random variable; c) chooses by optimising his own individual utility. It follows that user’s behaviour is to be described in terms of the probability that the generic travel alternative of his choice set has the maximum utility.

A8 Trondheim

A8.1 Introduction

The population of the Trondheim municipality (The City of Trondheim) is 145,000, covering a widespread urban area. In fact, the built up area per inhabitant increased from 200m$^2$ in 1960 to 350m$^2$ in 1990. The total area of the municipality is 342km$^2$. Trondheim is the urban centre of a commuting region a population of 180,000 and also the only city in the much larger South Trøndelag County with a total population of 260,000. Trondheim is often mentioned as “The Technology Capital of Norway” hosting the Norwegian University of Science and Technology, with approximately 20,000 students, and SINTEF which is a technical R&D institute with about 2000 employees. Trondheim is a centre for regional public administration as well as commerce, while the number industrial companies is limited.

The PRoGRESS demonstration in Trondheim will cover both cars and public transport, and the trials will be done in a real life situation, i.e. the charges are real and users have to pay with their own money. Included in the local initiative is testing of a dynamic information system. This will secure that the users have full knowledge about the real transport services available.

The objective of the existing tolling system in Trondheim is to raise revenue for “The Trondheim Package” which is a strategic plan to obtain a sustainable transport system for the city. The income is earmarked for construction of missing links in the road network (80%) and for public transport, safety and environmental measures (20%). The latter part has become more important over the years.

In the agreement between the state and the city of Trondheim about the toll ring, the charging period will end in 2005. This is an important date in the political discussions. New local road user charging initiatives should be accepted before this date. PRoGRESS is locally introduced as a project that can give input to this decision.

This document is the first detailed description of the demonstration in PRoGRESS. Before running the demonstration, it must be accepted by the local politicians. It might also be that elements of the scheme would have to be adjusted during this process. This document is therefore only the first description of the PRoGRESS-demonstration in Trondheim.

A8.2 The Existing Situation

Trondheim does not have the same congestion problems as can be seen in many European cities. These problems are limited to a few road sections of the main network in peak periods. In the city centre traffic may occasionally cause environmental problems, aggravated in winter when a large number of vehicles use studded tyres. This creates a lot of dust, which is considered a health problem. The capacity of the transport system is only stretched during peak periods so the main objective for urban pricing is to make it possible to control the transport demand in the peak periods. There is especially high demand for travel on public transport at peak periods.
Trondheim is the connection point of four railway lines; including one with daily services to Stockholm and other cities in Sweden. The regional public transport services are mainly provided by buses. There is one regional train service (Troenderbanen) The municipal bus company operates 29 ordinary bus routes and 8 express services. Car ownership has increased largely since the 1970s. Today the number of cars per 1000 inhabitant is about 400. This figure has been relatively steady since 1985.

The modal split data below is from a revealed preference study carried out when the toll ring was opened in 1991 (Table A12).

**Table A12: Modal Split in 1992**

<table>
<thead>
<tr>
<th>Mode</th>
<th>% share City</th>
<th>% share Region</th>
</tr>
</thead>
<tbody>
<tr>
<td>Car</td>
<td>60</td>
<td>65</td>
</tr>
<tr>
<td>Public transport</td>
<td>9</td>
<td>9</td>
</tr>
<tr>
<td>Pedestrians/Two-wheelers</td>
<td>31</td>
<td>26</td>
</tr>
<tr>
<td>Total</td>
<td>100</td>
<td>100</td>
</tr>
</tbody>
</table>

On a daily basis about 100,000 vehicles enter and exit the city centre (Midtbyen), 70,000 vehicles make inbound crossings of a cordon defined by the charging points of the old toll ring and 30,000 vehicles cross the municipal border on the main national highway, E6. A total of 17 million passengers are carried in one year, by the local bus lines and the tram line.

Petrol cost in Norway is approximately NOK 10 per litre. An annual road user tax of NOK 2250 is collected every year for all cars. Taxes when purchasing a car are among the highest in Europe.

There are now some twenty charging points around Trondheim. Charges apply only Monday-Friday when making inbound crossings between 06.00 a.m. and 06.00 p.m. Table A13 shows the charging profile of the Trondheim Toll System.

**Table A13: Charging Profile in the Toll System**

<table>
<thead>
<tr>
<th>Mode of Payment</th>
<th>Price</th>
<th>06.00 am – 10.00 am</th>
<th>10.00 am – 6.00 pm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manual payment</td>
<td>NOK 15</td>
<td>NOK 15</td>
<td>NOK 15</td>
</tr>
<tr>
<td>Prepayment Group 1</td>
<td>NOK 50</td>
<td>NOK 12</td>
<td>NOK 9</td>
</tr>
<tr>
<td>Prepayment Group 2</td>
<td>NOK 25</td>
<td>NOK 10</td>
<td>NOK 7</td>
</tr>
<tr>
<td>Prepayment Group 3</td>
<td>NOK 50</td>
<td>NOK 7</td>
<td>NOK 6</td>
</tr>
<tr>
<td>Post payment Group 4</td>
<td>Auto giro</td>
<td>≤ 5 pass. NOK 15</td>
<td>≤ 5 pass. NOK 12</td>
</tr>
<tr>
<td></td>
<td></td>
<td>≤10 pass. NOK 10,80</td>
<td>≤10 pass. NOK 10,50</td>
</tr>
<tr>
<td></td>
<td></td>
<td>≥11 pass. NOK 9,60</td>
<td>≥11 pass. NOK 9,00</td>
</tr>
</tbody>
</table>

*Note: All charges are for a small vehicle. Large vehicles pay double*

In addition the highway from Trondheim to the airport (Vaernes) is an integrated part of the urban tolling system. The charging level for the highway section nearest the city is done 24 hours per day, all days and both directions.

Daytime charges for on-street parking in the city centre are progressive; NOK 10 for the first hour, NOK 25 for two hours and NOK 45 for three hours. A flat hourly fee of NOK 10 per hour is
charged for off-street parking in centrally located facility and NOK 8 for less centrally located facilities. A new environmental tax on vehicles equipped with steel studded tyres is expected be introduced from the 2001/2002 winter season.

For an area covering most of the urban part of the municipality a flat fare of NOK 20 is charged for use of the bus system.

Trondheim was the third and latest city in Norway to introduce a toll ring in October 1991, after Bergen (1986) and Oslo (1990). The Trondheim scheme was unique in two aspects, (i) it was fully electronic with non-stop toll lanes from the start, and (ii) it had time-differentiated charges. The introduction of the Trondheim toll ring came after a six year long planning and decision-making process. The Public Roads Administration played a major role as an innovation promoter, and a prerequisite for political acceptance seems to have been the initial co-operation between the road authorities and influential local politicians.

The aim of the scheme was primarily to raise revenue to feed an urban transport investment package. However, the differentiated charges that were introduced had a secondary demand management objective. Political preferences particularly concerned the demand management bias of the charging scheme, and the percentage of revenue earmarked for public transport, safety and environmental measures.

The planned implementation date was delayed for almost a year, due to international court proceedings through GATT about the competition for the delivery of the charging equipment. This allowed the Public Roads Administration a period of nearly two years before the tolling started, to complete some infrastructure projects in the investment package. These investments soon relieved some of the most serious congestion, and were financed mainly by the take up of loans through the toll road company.

A8.3 Current National Policy Situation Regarding Urban Road Pricing

In Norway, all road user charging require approval from local and regional bodies, and sanctioning by the Parliament. The implementation has to be initialised by local political bodies. At the time of planning and introduction of the Trondheim toll ring, the Norwegian Road Act did not accept demand management to be the main rationale for implementation or design of road user charging projects. This is proposed to be changed in a revision. Revenues from road user charging can be used for investments in the transport sector only.

On the national level in Norway a new law about tolling and road pricing has just been sanctioned by the Parliament. Through this law user charging is accepted both as a mean for revenue raising and demand management, but the two objectives can never be mixed.

A8.4 The Policy Context in Trondheim

Local debate about transport user charging has recently become more polarised. This is unfortunate because the introduction of any charging system will require broad political support. The former majority in favour is not at the moment, but this can change rapidly.

In the Transport plan for the Trondheim region four key issues are focused:

- Less transport intensive land use policies - The number of city centre dwellings is to be increased with intensive land use in the city centre to improve the competitiveness of walking,
cycling and public transport.

- More environmental friendly transport - Improved public transport, bicycle paths, bypass for the city centre, effective parking policy.
- Reduced number and seriousness of accidents - 30 km/h speed limits when necessary.
- Good accessibility.

Over the course of several years, major decisions have been made concerning the principle of road pricing, the design of the cordon and the charges, the use of revenues, and division of responsibility between different institutional levels. The institutional structure for road pricing in Trondheim is therefore well established. Opinion polls on the Trondheim toll ring indicate decreased opposition after implementation.

A8.5 The Plan

Previous Road Pricing Schemes

Road user charging has been collected in Trondheim for the last decade. The toll ring has been gradually developed over the years since the introduction in 1991 giving the city great experience in this field. The new tolling system being introduced in 2001 is the fourth generation tolling scheme in Trondheim. Previous tolling systems have included toll roads, an urban toll ring and a zonal toll system. The local transport administration is using charging and ITS generally as a means to get better transport services for more people at a lower cost.

The objective of the existing tolling system is to raise founds for road construction. Road pricing for demand control has so far not been locally accepted, but there is an ongoing political debate about the issue.

Some key figures of the Trondheim toll ring are:

- 60% of the total population of 140,000 live outside the ring.
- 11 new toll stations one was manually operated.
- Time-differentiated tolls operate.
- 82% of funds raised is to be used for road building. The rest is to be invested in public transport, safety and environmental improvement project.
- There has been a 10% decrease in traffic passing the ring.
- Travel surveys give no indications of significant changes in shopping trip destinations.
- There has been a slight increase in the use of public transport and cycling.

One important result of the toll ring is that trips are adjusted to the pricing system. The change in time of travel is largest in home-shopping trips. It is a great increase number of trips outside the charging period in the afternoon. Also for work-home trips users have adjusted their travelling according to the charging system.

In 1998 the road pricing system was revised. Firstly, more revenue was needed to fulfil the transport investment plans. Secondly, a more “equitable” scheme was called for (interpreted as a system charging a higher proportion of the motorists). To some extent, the revised system is designed to provide daily service facilities inside each zone. The revised fee structure includes extended opening hours from 5 to 6 p.m. and a lowering of the maximum number of charged passings per month from 75 to 60.
The demonstration

A main part of the demonstration in Trondheim was the evaluation of the long-term effects of the existing RUC system. According to the current tolling agreement between the state and the city of Trondheim urban tolling will be brought to an end in 2005, thus this was an important period for political discussions. Any new local road user charging initiatives will need to be agreed before this date, and PRoGRESS has giving impetus to this decision process.

The demonstration in Trondheim consisted of the following three parts:
- Evaluation of long-term effects of the existing tolling system;
- Implementation of a new toll ring around the city centre, a CBD ring;
- Stated Preference survey for a through-traffic charging system in the city centre.

The first part of the demonstration addressed the existing RUC system. No new technical implementations were needed. The second part of the demonstration involved implementation of new road user charging equipment around the CBD area. This was an extension of the existing tolling system, using the same technology and infrastructure. The final element was undertaken by a Stated Preference survey of a through-traffic charging scheme instead of a demonstration.

The introduction of a Central Business District (CBD) toll cordon was a major part of the Trondheim PRoGRESS demonstrator. The measure was a continuation of the development of the charging system, from the 1991 single toll cordon and the 1998 zone based system. Hypotheses were formed that the CBD ring would facilitate:
- Improved access to CBD for car drivers with demand and willingness to pay;
- Improved environment in CBD and main arteries, through traffic calming;
- Improved conditions for public transport;
- Increased equity in the charging system.

As this part of the demonstrator consisted of a real, full-scale system, the schedule for the data collection and after survey had to be adjusted according to the project plan for implementation of the CBD ring. The evaluation of the CBD ring was based on transaction data from the operator of the Trondheim RUC scheme.

The operating hours and pricing scheme for the new CBD cordon were identical to the previous RUC system in Trondheim. However, the new CBD ring mainly affects the residents living between the river defining the city centre, and the bypass road to the east of the city. Under the previous charging scheme this part of the Trondheim population can take their car to the city centre free of charge (except for the parking fees). Most other car users had to pay road tolls to bring their car to the city centre. When the CBD ring was implemented, all drivers had to pay tolls to take their car into the town centre.

Applicable Pricing Schemes

The pricing scheme for the new CBD cordon will be identical to the pricing regime in the existing RUC system in Trondheim.
### Table A14: Charging profile in the demonstrator

<table>
<thead>
<tr>
<th>Charging period</th>
<th>06:00 - 10:00</th>
<th>10:00 - 18:00</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Base toll</strong></td>
<td>NOK 15</td>
<td>NOK 15</td>
</tr>
<tr>
<td><strong>Discount per crossing, based on method of payment</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Manual (cash, card):</td>
<td>0 %</td>
<td>0 %</td>
</tr>
<tr>
<td>Subscription</td>
<td></td>
<td></td>
</tr>
<tr>
<td>S1: NOK 500 pre-paid</td>
<td>20 %</td>
<td>40 %</td>
</tr>
<tr>
<td>S2: NOK 2500 pre-paid</td>
<td>30 %</td>
<td>50 %</td>
</tr>
<tr>
<td>S3: NOK 5000 pre-paid</td>
<td>40 %</td>
<td>60 %</td>
</tr>
<tr>
<td>S4: Direct debit, level according to use</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 - 5 crossings per month</td>
<td>0 %</td>
<td>20 %</td>
</tr>
<tr>
<td>6 - 10 crossings per month</td>
<td>10 %</td>
<td>30 %</td>
</tr>
<tr>
<td>11+ crossings per month</td>
<td>20 %</td>
<td>40 %</td>
</tr>
</tbody>
</table>

Charges apply to vehicles with gross weight less than 3.5 tonnes. Heavier vehicles pay double.

The demonstrator period is planned to last for one and a half month, following one and a half month of pre-registrations. Through traffic charges are proposed for the peak periods only, 07:00-09:00 and 15:00 – 17:00, with a uniform level of NOK 20. This is approximately the cost of a single bus ticket.

An electronic card will be valid pay option for all public transport units in the county will be approximately NOK 25,-. Additional costs depend on the user’s choice of functionality. One of several options can be activated in the card:

**Periodical card:** The card is valid for any number of trips within a given area and for an agreed period of time. The period card is similar to the present season ticket, but the user will be able to freely select the period for which the card shall be valid. (This may be two days, three weeks, a month or more.) Renewals may take place at any given time; thus ending the queues that often is experienced when renewal is required at the start of each month.

**Student card:** Valid for two trips per day, within a given area in 190 schooldays, between 07:00 and 18:00 hours.

**Value card:** The customer pays in a freely chosen amount in advance. Every time the card is used, its value is reduced with the cost of the ticket. The card entitles to a 15% discount. The value card for adults may either be personal or usable by others, all other cards are personal (with name, month and year of birth and category of card printed on the card; in addition, certain information about the card holder and category information are stored electronically).

**Transport account card:** The trips are registered, added up and automatically deducted from the customer's transport account on the agreed date. The user will always have a valid bus ticket available and will not have to worry about renewals.

**Choice of Technology**

Everybody living in the county of Sør-Trøndelag, of which Trondheim is a part, will be eligible to purchase an electronic payment card, called the "t:card".

Transfers of travel data, route information, fares and blacklist between the vehicles and the
companies will be handled by the GSM-net and a microwave link.

The security system is necessary to ensure against external threats and internal cross companies access. The public transport companies will be issuing the IC-cars in co-operation with the clearing operator.

For security and functionality reasons the t:card is an IC cards (Integrated Circuit cards) with two interfaces between card and card reader:

Contact (standardised ISO-7816). The contact possibility is desired primarily for the charging function and the need for integration with the rest of the system.

Non-contact (pre-standard on several elements, ISO 14443). Non-contact allows achieve quicker ticketing. In the card is a transponder that communicates with the ticketing machine in the bus when hold up against the reader. Physical contact between card and reader are unnecessary.

The t:card includes options for processing and storing data.

**Complementary Measures**

*Dynamic Information System*

Readily available and accurate information about all available transport services is vital to all users for an effective use of the urban transport system. The existing Electronic Ticketing system will be developed to include the dynamic information system for public transport.

It will be very important for the urban pricing demonstration that travellers are familiar with the charging system. As the user charges will be differentiated during the day, it is important to give travel information to all users so they know their real travelling alternatives. The dynamic information system for public transport will be a big improvement and it is hoped that the investment will stimulate higher public transport ridership.

*Parking*

Some of the existing coin machines accept credit cards but the use of tolling tags and IC-cards for parking payment is being investigated.

*Integration of the Payment Systems*

Trondheim will get an updated electronic charging infrastructure during 2001, the basis for the PRoGRESS trials. For the recruited households a special accounting system is planned where all charging transactions in the urban transport system are gathered in an integrated system and a bill will be sent to users.

A8.6 Modelling and Simulation of Pricing Schemes

Greater modelling or simulation tasks in Trondheim are not planned. In the present situation the demonstrations are based on experience from existing systems. The existing transport model for Trondheim has the functionality needed for analysing the planned scheme, and it might be run later in the final fine tuning of the pricing levels. The reference list included reports, articles and other documents mainly written in English, but some Norwegian references are also included.