HIGH LEVEL GROUP ON
TRANSPORT INFRASTRUCTURE CHARGING

FINAL REPORT ON
ESTIMATING TRANSPORT COSTS

26 May, 1999
MEMBERS OF THE HIGH LEVEL GROUP

<table>
<thead>
<tr>
<th>Name</th>
<th>Position</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mr Gunnar Bjerde</td>
<td>President of Volvo Transport AB, Sweden.</td>
</tr>
<tr>
<td>Professor Rigas Doganis</td>
<td>Aviation Consultant, UK.</td>
</tr>
<tr>
<td>Professor Emilio Gerelli</td>
<td>Environmental Economist, University of Pavia.</td>
</tr>
<tr>
<td>Professor Phil Goodwin</td>
<td>Professor of Transport Policy, University College London.</td>
</tr>
<tr>
<td>Mr Jean-François Poupinel</td>
<td>Chairman and Chief Executive Officer, Cofiroute, France.</td>
</tr>
<tr>
<td>Mrs Barbara Schmidbauer</td>
<td>Member of the European Parliament and Rapporteur on the Parliamentary Committee on Transport.</td>
</tr>
<tr>
<td>Dr José Viana Baptista</td>
<td>Presidente do Conselho de Administraçao, ICAT, Portugal.</td>
</tr>
<tr>
<td>Mr Peter Wagner</td>
<td>Chief Executive Officer of DANZAS and Director of Deutsche Post.</td>
</tr>
</tbody>
</table>

Chairman: Mr Wim Blonk, DG VII, European Commission
Rapporteur: Prof. Peter Jones, University of Westminster, London

All members of the High Level Group participated in a personal capacity.
TABLE OF CONTENTS

1. INTRODUCTION ................................................................................................................ 1
   1.1 The First High Level Group Report ................................................................. 1
   1.2 The Second High Level Group Report ............................................................ 4

2. SUMMARY OF TECHNICAL FINDINGS .................................................................. 4
   2.1 Definition ........................................................................................................ 6
   2.2 Cost categories .............................................................................................. 6
   2.3 Cost drivers and categorisation ..................................................................... 7
   2.4 Cost attribution and method ......................................................................... 7
   2.5 Monetary valuation ..................................................................................... 9
   2.6 Accident cost charging mechanisms ......................................................... 10
   2.7 Availability of estimates ........................................................................... 10
   Table 1: Summary of cost estimation and allocation process .......................... 11

3. ASSESSMENT AND CONCLUSIONS ....................................................................... 12

4. RECOMMENDATIONS ............................................................................................ 15

ANNEX 1: BACKGROUND AND TERMS OF REFERENCE FOR THE EXPERT ADVISORS. ................................................................. 17

ANNEX 2: EXPERT ADVISORS TO THE HIGH LEVEL GROUP ......................... 23
1. Introduction

1. Within the European Union parts of the transport infrastructure are overloaded or poorly maintained, and many of the economic and social costs of transport (air pollution, congestion, accidents, etc.) are not directly met by users. As the White Paper on “Fair Payment for Infrastructure Use” recognises, there are unresolved issues about how to fund major new transport infrastructures in Europe, about the mechanism by which users should be charged for their use of the different modal and inter-modal transport infrastructures, and about the ways in which the monies raised by the various agencies and organisations involved are spent.

2. At present, each Member State has its own procedures for identifying and recovering costs (often through general government taxation), and for determining new investments, which can result in very different cost and charging structures and levels of investment within Europe. It is evident that the present, diverse systems of charging for transport do not encourage efficient or sustainable use, and that much greater transparency and consistency in the area of infrastructure charging in Europe is needed.

3. In response to these concerns, the European Commission convened a High Level Group of transport specialists to examine the extent to which changes in user charging (along the lines proposed in the Commission’s Green paper “Towards Fair and Efficient Pricing in Transport”), might assist in addressing these problems, and how the practical implementation of the recommended changes might best be achieved.

4. The High Level Group on Infrastructure Charging completed its first report in June 1998, which provided an important input to the Commission's White Paper on "Fair Payment for Infrastructure Use". In that report the Group set out a number of broad principles for transport pricing. Subsequently the High Level Group was invited to reconvene and consider in more detail the way in which transport costs can be defined and estimated. The findings of this examination are presented in this second report.

5. The remit of the High Level Group has been to focus on transport pricing issues whilst recognising that the achievement of policy objectives requires a mix of tools, including regulatory measures and physical infrastructure as well as economic policy tools.

6. Chapter one of this report summarises the key findings of the first High Level Group report, and sets out the terms of reference of the current report. Over 30 technical advisors were appointed to support the work of the High Level Group by preparing technical papers on a range of methodological issues. The key findings of these papers are summarised in chapter two. The High Level Group’s own assessment and conclusions are provided in Chapter three, and the report ends in chapter four with a series of recommendations for action.

1.1 The First High Level Group Report

7. The Group concluded that there is a need for a Community level approach to infrastructure charging that includes all the major transport modes which play a significant role in the internal market. The primary aims must be to create efficient transport systems in Europe, in order to strengthen the competitiveness of European industry, and to contribute to the greater sustainability of the transport system in Europe.
8. This approach should be based on the following broad principles:

a. The same basic charging principles should be applied to all the major modes of transport in each Member State of the European Union, while recognising that the resulting structures and levels of charge may differ by mode and location for sound economic and social reasons.

b. Infrastructure charges should be based on the “user pays” principle, charging all users of transport facilities (both operators and final customers) for the costs they impose, at or as close as possible to the point of use.

c. It is essential that charges should reflect the level and pattern of use of the infrastructure. They should be directly related to the costs that users impose on the infrastructure and on others, including the environmental impacts and social impacts (e.g. accidents, congestion, severance) caused by the user.

d. In order to reduce distortions to competition, differences in charges to users should apply only where there are real differences in costs. They should not arbitrarily discriminate between users.

e. It is important that the charging structures be designed to encourage greater efficiency in the development and use of transport infrastructure, leading to patterns of use that are socially and environmentally desirable (e.g. through the adoption of cleaner or safer equipment and practices).

9. The report went on to recommend that when investments in new transport infrastructure are planned for all modes of transport, the investment decision should be made on the basis of a full social cost benefit analysis, covering both the internal and external costs and benefits.

10. The High Level Group has concentrated on the costs associated with the use of existing infrastructure, identifying two primary categories: physical infrastructure costs and external costs. In some cases, the capital costs of infrastructure are paid for directly by governments and can be treated as sunk costs, so that only elements of operating costs need to be recovered. In other cases, both investment and operating costs need to be taken into account.

11. Where the infrastructure already exists and has been paid for, then charging on the basis of total marginal cost (covering both the internal and external marginal costs) will ensure the most economically efficient use of that infrastructure. This is because when marginal cost charges are applied, users face the costs that they directly cause, and everyone who is willing to pay these costs may make use of the infrastructure.

12. The report also discussed the case where the capital costs of infrastructure need to be recovered, in particular where:

- Marginal costs are below average costs, but governments are not prepared to finance through general taxation the shortfall in revenues from users;

- Subsidy of a part of a transport system, or charging prices over many years which do not include external costs, has led to distorted patterns of demand, or distortions in intra- and inter-modal competition (e.g. in the case of ports).
13. In these cases it may be appropriate to set the user charges above the marginal cost level. Rather than simply charging all users the average cost, it was concluded that a market pricing approach could be adopted, based on Ramsey/Boiteux Pricing principles. Here, as a minimum all users are charged the marginal cost, with additional charges being levied in relation to the price sensitivity of each user group and to the level of quality of service offered (where this differs by category of user). Prices are then adjusted so that total revenue equates as far as possible with the costs that need to be recovered.

14. Another cost recovery strategy is to use Two Part Tariffs, with a fixed rate for “entry” or annual use, and a variable charge based on marginal costs. Such a charge may be simpler to implement and simpler for users to understand. A form of two-part charge is common, for example, in the road sector, where goods vehicles pay an annual vehicle excise duty as a fixed entry charge, plus a fuel duty that is mileage related. However, the fuel duty may represent a poor proxy for many elements of external cost (e.g. road accidents or congestion).

15. Where current charges are increased to reflect the external costs, the Group recommended that the additional revenue should in general be used to reduce the external damage caused. First priority must be given to reducing or preventing the externality, but where this is not practical (or cost effective), then the emphasis should be on reducing or mitigating the impact of the externality, or compensating those affected in some way (whilst respecting rules on state aid).

16. With such pricing strategies as these, there is the need to guard against discriminatory behaviour by infrastructure managers exploiting their market power, and practices (such as high fixed annual charges) that form barriers to entry to the market. There is also a need to ensure that, where taxation has been used as a proxy for direct road user charges, these taxes are withdrawn once direct charges have been introduced.

17. The High Level Group report concluded with recommendations to the Commission for six areas of work in developing this approach to charging. These comprised:

I. The elements to be included in a common accounting framework for assessing the various transport infrastructure costs at a national level (both internal and external), applicable to all major transport modes.

II. Guidance on the principles to be used in calculating the agreed elements of transport infrastructure costs; and on how to estimate marginal costs for the various cost elements to be recovered from users.

III. Commission proposals for charging principles for the use of transport infrastructure for different modes.

IV. Common guidelines for cost benefit analysis of transport infrastructure investment projects, covering both internal and external costs and benefits.

V. Guidelines for defining the extent of acceptable cross subsidy, between and within modes, and geographically;

VI. Preparation of a phased programme for implementation; the first priorities being the road and rail networks in the Community, and the major ports.
1.2 The Second High Level Group Report

18. The publication of the White Paper dealt with recommendations three and six. Following publication and discussions with experts from Member States, the Commission invited the High Level Group to reconvene to investigate different methods of estimating the marginal costs of transport. This addresses recommendation two and elements of recommendation four.

19. The focus of the second report is to identify and estimate the various methods of estimating costs. This is a necessary interim step towards developing proposals for the most appropriate methods for charging transport costs to users (bearing in mind the need to avoid distortions from uneven implementation across modes or between geographical areas).

20. For this inquiry, the composition of the High Level Group has been broadened to include a wider range of transport interests. The Second Report will be submitted to the Commission and then to the Committee of Government Experts on Transport Infrastructure Charging.

21. Specifically, the High Level Group has been charged with examining the methods of estimating the marginal costs of infrastructure use, the costs associated with congestion and environmental externalities, and the best means to internalise the costs of accidents. The emphasis is on identifying how broad principles can be turned into practical means of estimating and attributing both internal and external costs.

22. To assist in this task, over thirty senior academics and other experts were asked to act as technical advisors to the High Level Group, operating through three working groups under the chairmanship of members of the High Level Group. These advisors were asked to review existing evidence and to advise the Group on options. Altogether they produced four papers covering infrastructure costs, congestion costs, environmental costs and accident costs. Except in the case of accidents, the emphasis is on identifying cost components, rather than on deciding the most appropriate charging mechanism for recovering these costs directly from users.

23. The Terms of Reference of the working groups are appended to this report, together with a list of the experts who took part. The technical advisors were asked to concentrate particularly on the external costs affecting the road and rail sectors, but to draw on experience from other modes where appropriate.

2. Summary of Technical Findings

24. The four papers prepared by the technical advisors fulfil the terms of reference (Annex 1) and reflect the consensus views of the advisors in their respective areas (listed in Annex 2). Most of the technical advisors are experts currently working in the field of transport economics and are thoroughly familiar with the issues at stake and of each type of cost. The full technical papers contain a great deal of information and technical explanation and are available on request. This chapter summarises the papers' findings.

25. Each paper takes as its starting point a focus on determining the marginal costs of transport (both internal and external) and attributing them in some detail, with a view to passing that cost on to users in the form of a reasonably sophisticated charging mechanism.

26. Each paper begins by defining the marginal cost (in the context of each particular paper). The cost categories appropriate in this context are then discussed and defined. Generally the papers follow with a discussion of the nature of the appropriate method to use to estimate
costs. Based on this approach, the cost causes or "cost drivers" are considered. These general causes are then examined and categorised so that cost allocation becomes possible. The next step involves valuing these costs in monetary terms. Finally, the accidents paper considers a range of tools available for passing on such costs, including taxation, user charges, and insurance premiums. The other papers do not consider charging mechanisms.

27. The papers focus on road and rail issues, but also offer views on the transferability or relevance of the discussion for other modes. An important result of the papers is that there is no impediment to the application of the methodologies outlined across all modes of transport.

28. Whilst the methodology is generally applicable, the cost categories and of course values will differ between modes and with circumstances such as times of day and locations. So the process of analysis is to define the costs and cost categories; to determine the impact (i.e. time lost for congestion, health effects for environmental costs); to take the monetary values where they exist (i.e. for infrastructure) or to calculate values using agreed valuation techniques (such as "willingness to pay" estimates of health, other environmental benefits). This process, using agreed methods, can therefore provide monetary values for the range of transport costs identified, in the form of per "transport unit" costs.

The Cost Estimation and Allocation Process

29. In general, the papers begin by setting out the ideal process and the ideal cost categories and data needs. However it is recognised that the use of multiple cost categories and new data sources can be time and resource intensive and is not practicable in the short term. Member States' existing practices and methods therefore inform the papers to varying degrees, and conclusions are based on a practical mixture of theory and current practice (particularly data sources and categories). The technical advisors believe that in the short term, the use of existing categories and data sources can be used to develop a basis for estimating marginal

---

1 For this report charging mechanisms are only considered in the case of accident costs.
30. All four papers emphasise that determining estimates of marginal costs are vital if more efficient levels of infrastructure use are to be attained.

2.1 Definition

31. Marginal costs are the costs generated by an additional transport unit (vehicle/train/barge/ship/plane) when using infrastructure. The papers begin by assuming that the capacity of infrastructure is taken as given. This means that there are some costs which are "fixed" (the costs of infrastructure construction is the simplest example) and others which are variable. Of the latter, some will vary only loosely with the level of traffic. In other cases there are clear links with traffic flows and between the individual transport units and the costs imposed. It is this sub set of variable costs which are defined as marginal costs.

32. Whilst some of these costs are reflected in current prices (and are “internal costs”), there are many costs which are not borne by those who cause them, but affect third parties and so have not been “internalised” in the charges paid. Most of these “external costs” are marginal costs.

- For infrastructure, marginal costs include the damage to infrastructure (such as maintenance of road surfaces and tracks and some repairs to bridges, noise walls and technical facilities) and the cost of services or other infrastructure operations (such as the cost of supplying power to electric trains). To determine what proportion of variable costs are attributable to traffic flows or to particular vehicles (as opposed to general deterioration/weather related), specific studies of particular costs are necessary (see also section 2.5 below).
- For congestion, marginal external costs include the increased operating costs and the costs of extra time spent travelling as a result of another vehicle entering the traffic flow, an accident or infrastructure maintenance.
- For environmental costs, marginal external costs include the additional damage resulting from emissions of airborne pollutants from an extra vehicle or an upstream power source, including global and local air pollution and noise pollution.
- For accidents, marginal external costs include the repair costs, medical costs, suffering and delays imposed on others as a result of an accident.

2.2 Cost categories

33. Once the nature of the costs is defined, the next step is to determine what different cost categories are appropriate. Categorisation according to different levels of cost is important as it gives meaning to the definition of marginal costs and is a necessary step in allocating costs. The approach has generally been to use existing categories of costs, and/or to adapt these in line with their "marginal" nature. Quite detailed "ideal" cost categories are also defined because the more refined the cost categories, the more detailed and accurate one can be in determining and then passing costs on. However it is recognised that in all four topics there are data constraints. So whilst the technical papers may propose an ideal set of categories that allow the reflection of different marginal costs, data constraints may mean that some categories are joined together. In a sense, different marginal costs are combined, to varying
degrees in the different topics.

- For **infrastructure**, the categories that have different costs are road type (motorway, national, state, regional roads, and urban streets) and track speed and formation (e.g. number of sleepers per 100m) or existing rail categories (main/minor lines, electrified, single/double).
- For **congestion**, the categories of marginal costs should focus on location (inner/outer city, urban, interurban rural), road type and time of travel (peak hour, inter peak, off peak).
- For **environmental costs**, the categories defining marginal costs of damage include different population sub-groups, types of ecological systems, geographical proximity to the source of emissions etc.
- For **accidents**, the categories of marginal costs vary with the mode, nature and severity of accident, characteristics of the vehicle and people involved and the infrastructure type.

### 2.3 Cost drivers and categorisation

34. In some cases it is relatively simple to determine the causes of the different costs. The different cost categories are examined and with the application of engineering, scientific, and medical knowledge the different causes can be defined and the marginal cost element identified.

- For **infrastructure**, axle weight is the chief determinant of road infrastructure damage. Where detailed data on axle weight or even vehicle weight is not available existing vehicle type categories can be used. For trains, the key cost drivers are train weight and speed. Again, existing categories (freight/passenger/wagon load/combined transport/high speed/inter-city/regional/urban) can be used if necessary to proxy these factors. The state of maintenance of the infrastructure is also an important factor.
- For **congestion**, cost varies with the length of time spent travelling, traffic mix, flows and speeds, accidents and road maintenance. Obvious examples of cause include vehicles joining peak hour road traffic flows and delayed trains and planes.
- For **environmental costs**, transport emissions of different types of pollutants must be related to the level of exposure and impact on different groups. Categorising the sources of emissions will depend on engine characteristics, fuel type and quality, transport and infrastructure type and time of travel. More pragmatically, one could use existing categories of vehicle and road/track type.
- For **accidents**, the statistical probability and severity are influenced by a number of factors including speed, road type, user error, traffic and weather conditions, vehicle type/condition and the nature and maintenance level of the infrastructure.

### 2.4 Cost attribution and method

35. Having determined the key causes of the various transport costs, it is clearly important from an efficiency perspective to be able to pass these costs on as closely and as accurately as possible to those who create them. Again, in a pure pricing structure, charges would vary with every variation in cost. For practical implementation however, broader categories are sufficient. For each category, the cost (or fraction of the cost) must be attributed to the appropriate network user. This process involves the application of scientific, engineering and environmental knowledge and the technical advisors have outlined how such processes can be
determined.

36. When examining transport costs, this can be approached from the "top" by examining aggregated cost data and then splitting up the costs until per unit costs are approximated ("working down"). Alternatively, one can start at the "bottom" and examine the costs associated with individual transport units and then aggregate up. These two methods of analysing costs are known as a "top down approach" and a "bottom up approach". The availability of cost data, categories, and technical knowledge of cost attribution determines which method is more feasible.

37. The bottom up approach can be more appropriate when trying to determine a total cost function from which to derive marginal costs, when the detailed relationships, the "functional form" is known. However as such relationships are often site-specific, in practice a certain averaging or generalising of results is necessary. Where total costs are known, but individual costs are uncertain, it is practically easier to follow the top down approach.

- **For infrastructure**, matching the cost category with the cause category uses knowledge of the physical, engineering relationship between vehicle and road/track. For road, the "4th power rule" is a standard method of relating the axle weight to the degree of damage caused to the road\(^2\). For rail, it is also possible to determine which classes of wagons (according to weight and speed) impose a particular damage to the track, and which classes (passenger and freight for instance) that demand different types of services. Whilst a detailed model linking costs to users through such relationships is ideal, the aggregated nature of most infrastructure cost data implies that the top down approach is more practical. Costs can be broken down into categories, and allocated or attributed according to the general engineering relationship.

- **For congestion**, for roads, "speed-flow" curves are generally determined, which relate traffic speeds for certain areas or road types to different levels of traffic volume. The technical advisors focused on the cost of time. The allocation therefore requires matching the cost of time (varying if possible with vehicle/driver type/purpose) with the increased travel time in congested areas. For rail, the cost of delays could be similarly calculated and included in poor performance penalties. The technical advisors also examined scarcity costs and concluded that these should largely be determined by measuring demand for slots, such as through bidding, auctions, and negotiations. For a detailed understanding of congestion, network wide models are useful, but costly. Where this is not possible, a simpler approach for urban areas is to develop area speed-flow relationships for the different categories to determine how travel time (speed) varies with traffic volume; for interurban roads, link based speed-flow relationships may be an adequate approximation.

- **For environmental costs**, there is a chain of events linking transport activity to costs. For all of the categories of transport activity the output of emissions must be determined, along with the concentration of these emissions in the different transport environments. The degree of concentration and exposure then determines the "dose" of pollution received, and the following step is to measure "dose-response" relationships to determine the impact of different pollutants. This physical effect can then be converted into a loss of welfare or monetarised cost (see (2.5) below). The ExternE project discussed by the technical advisors applies the bottom up "impact pathway approach". This assesses activities and emissions and concentrations, and applies dose-response functions to determine impact. In practice, such relationships will be determined for specific categories and then generalised.

\(^2\) This means that a small increase in axle weight results in a disproportionate increase in road infrastructure damage.
For example the relationship between emissions of a particular engine type or vehicle in a particular situation may be determined (a diesel passenger car travelling from Stuttgart to Mannheim for instance), and then applied to generically similar situations.

- For **accidents**, determining costs is a function of accident risk, material cost and non material cost. Causal factors (traffic flow, speed, type of infrastructure, vehicle/driver characteristics and history) must therefore be allocated the risk of the different costs. The costs themselves are estimated by averaging actual medical and repair costs. Non material costs should also be passed to those causing the costs, using "willingness to pay" estimates (see (2.5) below). Accident cost data also tends to be aggregated, whereupon the "average" per accident cost to a hospital, of an ambulance trip, or of suffering can be calculated. (The costs, determined ex ante, must also be weighted by risk factors to determine the marginal cost.)

### 2.5 Monetary valuation

38. The initial unit of measure of transport costs differs between the four cost types (i.e. infrastructure, congestion, environmental and accident costs). Some are straightforward financial estimates, others depend on the likelihood of the event, and others are of a physical or psychological nature. There has been considerable research into providing estimates of costs based on a variety of techniques; these include money transactions in markets, willingness-to-pay and willingness-to-accept surveys, imputed values, shadow values and other methods. The technical advisors report that with careful judgement about the use of appropriate methods in each case, a suitable value or range of values can be produced. There is a degree of consensus that carefully constructed estimates of costs can provide reasonable and practical values for environmental, health and non material accident costs.

- For **infrastructure**, this step is straightforward, as costs are calculated in monetary terms to begin with.
- For **congestion**, it is necessary to calculate the value of time. For business and working travel time estimates related to wage rates and overhead labour costs are commonly used. For leisure and commuting journeys, estimates can be obtained using willingness-to-pay or similar techniques.
- For **environmental costs**, some costs are incurred in monetary terms such as crop damage from acidification and eutrophication. For other costs willingness-to-pay techniques could be used, e.g. to value health costs and other forms of suffering such as disturbance from noise. Some environmental costs are of a very long term nature and therefore will be subject to discounting. The technical advisors recommend that the relevant discount rate should be that used in social cost benefit analysis, and will normally be lower than the discount rate observed in capital markets.
- **Accident costs** fall into two categories: medical and repair expenses are purely financial costs and are in monetary form. The "non material" costs of injury and suffering and delays to others, however, are not. These are the focus of the technical advisors' recommendations. Values for these costs, as with the health costs resulting from environmental emissions, can be estimated using willingness-to-pay techniques, although some Member States use ex post "human capital loss" such as net earnings lost, as the basis for valuing such costs. However this focuses on narrow economic rather than on personal welfare loss, and so underestimates the real value of non material costs.
2.6 Accident cost charging mechanisms

39. Charging mechanisms focus on the user causing the costs, rather than the context in which the costs are incurred. For infrastructure, environmental costs and congestion, the costs are directly attributable to traffic, and the working papers assume that appropriate tools, most able to send correct pricing signals, are infrastructure user charges (of varying sophistication). For accident costs the use of the same mechanism may not be appropriate. Approaches based only on general taxation or specific transport taxes such as fuel and vehicle taxes are very poor proxies, as they are not based on the costs of accidents and provide no signals to users to alter their behaviour with regard to accidents (two requirements of an efficient economic policy tool).

40. The use of insurance premiums is also used to partially cover accident costs. Insurance can, by its nature, weaken the link between user and cost (and may introduce ambiguous behavioural effects). However the technical advisors believe that greater variability of insurance premiums and refined bonus/malus systems can send a signal to transport users and can clearly be set to reflect the costs involved (including both material and non material costs).

41. This topic illustrates how the choice of charging mechanism can affect the choice of cost category: were accident costs to be passed on through user charges, then vehicle type and road type would probably be the chosen categories. However as the technical advisors have determined that insurance premiums are the most satisfactory mechanism available, the insurance industry should refine its premium categories as accurately as possible, to reflect vehicle/driver/(train or airline) company characteristics, history and distance driven. The deregulated UK insurance industry finds that detailed categories are in fact the most efficient means of reflecting risks and costs.

2.7 Availability of estimates

42. The four technical papers demonstrate that in many research studies the methodologies described have already been implemented to produce detailed estimates of marginal internal and external costs of infrastructure, congestion, environment and accidents. These estimates, of course, vary greatly in level according to local conditions and vary in precision according to the current state of scientific knowledge. Readers are referred to the technical papers for a detailed discussion of the results and their interpretation.
Table 1: Summary of cost estimation and allocation process

<table>
<thead>
<tr>
<th>TOPIC</th>
<th>Infrastructure</th>
<th>Congestion</th>
<th>Environmental costs</th>
<th>Accidents</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cost definition</td>
<td>Damage cost (maintenance and repair), some services and operations.</td>
<td>Cost of time delays and any increased operating costs caused by an extra transport unit joining the traffic flow, (accidents or maintenance.)</td>
<td>Deterioration in human health crop damage etc. resulting from vehicle generated air, noise and water pollution</td>
<td>Vehicle repair and medical costs and the cost of &quot;suffering&quot; associated with accidents.</td>
</tr>
<tr>
<td>Cost categories</td>
<td>Road type (motorway, national, state, regional roads, urban streets) Track speed limit and formation, existing categories (main/minor lines/electrified, single/double)</td>
<td>Infrastructure type, vehicle type, user characteristics and time of travel (peak/inter peak/off peak).</td>
<td>Population characteristics, types of ecological systems, proximity to emissions sources.</td>
<td>Road type, time of day, vehicle type and driver/passenger characteristics.</td>
</tr>
<tr>
<td>Cost driver categories</td>
<td>Axle weight (proxy: vehicle type); train weight and speed (proxy: freight/passenger wagon load, high-speed/inter-city/ regional/urban): state of maintenance of infrastructure.</td>
<td>Infrastructure characteristics, traffic mix and flow, accidents and road maintenance, rail/air delays.</td>
<td>Vehicle type (motorcycle, car, bus, HGV), with/out catalyst, by fuel type and quality (petrol, unleaded, diesel, LPG), engine type (diesel/electric), road type, vehicle speed and time of travel. (proxy: road, vehicle type). Upstream power source (e.g. electrified rail)</td>
<td>Infrastructure condition, speeds, vehicle/driver characteristics and history, traffic density, (or proxy: vehicle, road type).</td>
</tr>
<tr>
<td>Cost attribution Method</td>
<td>Engineering relationships between axle weight/speed and damage(e.g. 4th power rule), then applying top down, disaggregated infrastructure costs according to this rule (similar for rail).</td>
<td>Bottom up but generalised area speed-flow relationships for road types and values of time for user type (business/worker/personal), journey purpose (work/leisure) similar process for rail/air delays.</td>
<td>Bottom up impact pathway approach linking emissions to costs: concentrations of pollutants; dose-response relationships of impacts.</td>
<td>Disaggregated data of medical and hospital costs and estimates of suffering, weighted by a risk factor and attributed to user categories (vehicle type) [chiefly using insurance premiums as the mechanism].</td>
</tr>
<tr>
<td>Monetary valuation</td>
<td>Financial costs directly incurred.</td>
<td>Wage rate/WTP estimates of values of time</td>
<td>Financial costs, e.g. crop damage, estimates of health risk often based on WTP, using standard SCBA discount rates.</td>
<td>Financial costs of repair/medical care, WTP often used for estimating non material costs (injury and other suffering).</td>
</tr>
</tbody>
</table>

3 Most examples in this table refer to road and rail, however the principles apply equally to other transport modes.
HGV = heavy goods vehicle; LPG = liquid petroleum gas; WTP = willingness-to-pay; SCBA = social cost benefit analysis.
3. Assessment and conclusions

43. This second High Level Group report has examined the various components of cost associated with the use of existing infrastructure, and has identified in particular those costs which vary with the volume of vehicle movement (i.e. the marginal costs). It has focused on the external costs of transport use, since unlike some of the infrastructure costs these are not currently paid for directly by users.

44. For convenience, the marginal cost categories associated with infrastructure, congestion, environmental impacts and accidents have been examined by technical advisors in separate working groups.

45. However, it is evident that in practice these categories are closely interrelated:

- Traffic speeds and levels of congestion affect accident rates and severity, as well as air pollution and noise levels;

- Congestion arises not only where the volume of traffic exceeds the design capacity of the road, but also from temporary reductions in capacity due to road maintenance work and traffic accidents;

- Infrastructure can be designed and constructed at additional cost in order to reduce externalities, such as noise (e.g. through barriers and quieter road surfaces), accidents (e.g. dual carriageways and skid resistant road surfaces) and congestion (e.g. using signal control and variable message signs);

46. It is important that analysts take into account these interrelationships when forecasting transport externalities and allocating costs, and determining appropriate charging mechanisms. For example, the congestion-induced air pollution may be most appropriately collected as part of the congestion charge rather than as an air quality charge; similarly, congestion resulting from road accidents would be recovered as part of the accident charging mechanisms.

47. Such interrelationships also need to be explicitly recognised when deciding what features to build into new transport infrastructure: it may often be more appropriate to build in externality-reduction at the construction stage than to adopt mitigation strategies once the infrastructure is in operation. The optimum balance of investment in such features should be determined as part of the social cost-benefit analysis.

48. The work assumes a fixed infrastructure, of given capacity. In some cases the construction costs can be treated as a sunk cost, whereas in other cases they will need to be recovered directly from users. Where infrastructure construction and operating costs need to be fully recovered, then consideration needs to be given as to how to service any debt arising from infrastructure construction, provide a return on assets and meet full on-going operating costs.

49. In some circumstances, marginal social cost pricing will yield sufficient income to cover all of these costs. Where this is not the case, then in its previous report the High Level Group recommended the use of Ramsey/Boiteux Pricing, or a two-part tariff; the working group papers identify several instances where this type of approach is currently used to recover costs (e.g. in the air industry). The Commission’s White Paper recommends that, where new infrastructure can be justified and cannot be otherwise funded, then charges should be set to recover all
50. The technical advisors report that these unpaid marginal costs can be identified and broadly estimated, and in the main be attributed to various existing categories of vehicle type and of road/track from available data - although important data gaps were identified in some instances. While precise estimation of marginal external costs in all situations would be impractical, the technical advisors have agreed that reasonable approximations are possible in most cases, to provide a more accurate basis for allocating costs and for recovering charges than the current ad hoc and widely varying procedures.

51. The illustrative cost estimates provided in the technical papers are often sufficiently high to be of policy significance and vary in nature and degree from one mode to another and also between Member States. This suggests that their lack of internalisation at the present time is resulting in a number of distortions between different transport modes in the charges incurred by users across the European Union, thereby reducing efficiency and sending out incorrect pricing signals.

52. The technical advisors were charged with estimating and attributing unpaid marginal costs, rather than recommending how these costs might be passed on to users. However, the group dealing with accidents was asked to go further and consider what mechanisms are available to recover costs from users, particularly in the case of road transport. While accident costs do vary by vehicle type and category of road, the technical advisors concluded that the individual driver is central to accident risk and therefore that personal insurance premiums provide a suitable cost recovery mechanism - where possible, taking into account previous accident history (generally on a no-fault rather than a no-claim basis), vehicle type and annual distance driven.

53. It is generally appropriate to leave the actual derivation of marginal costs for different parts of the transport infrastructure to individual Member States (using an agreed accounting framework and allocation and valuation methodology). However, there are some externalities that transcend national boundaries - notably CO₂ emissions and some other air pollutants. Here it will be necessary to derive common valuations for costing purposes at the European Union level.

54. The issues addressed in this report need to be set in the more strategic context of achieving a broad set of policy objectives where pricing is only one of the available tools. In attempting to meet this diverse set of objectives, policy makers need to strike an appropriate balance between the use of pricing, regulation and the physical design of infrastructure. The introduction of marginal cost pricing of external costs does not, for example, obviate the need for regulations on vehicle manufacturing to meet given emissions and safety standards, nor the need for speed limits or drink driving regulations.

55. Pricing acts to recover costs and moderate behaviour in areas where society accepts that there should be discretion, and provides a price signal that offers guidance as to when other action (e.g. additional infrastructure investment) might be appropriate. Other mechanisms can be used to complement pricing, in particular where users cannot be directly charged to reflect a variation in cost; for example, accident rates increase during bad weather, and in some countries (e.g. France) speed limits on main roads are reduced at such times to compensate for the increased risk.

56. Given the principles set out in the First Report and the findings outlined in section 2, the
High Level Group believes that a **practical basis for charging** for different elements of cost - including external costs - could be developed in most cases, drawing on the results of the working group papers. This could be done on the following basis:

- **For accidents**, transport insurance should be asked to cover:
  - medical costs,
  - fairer standardised injury compensation costs,
  - additional congestion costs (such as Cofiroute in France for example, where the insurer of the vehicle that causes an accident has to pay for the lost toll revenue resulting from the tolls being waived for other vehicles delayed by the accident).
  - environmental costs (e.g. fuel spillage, contaminated water run-off), particularly in the case of HGVs, oil tankers, or rail wagons.

  The High Level Group believes that making insurance costs more closely reflect the marginal costs of accidents caused would be an important step forward, with care taken to avoid unintended effects. Insurers should be encouraged to refine their premium/bonus/malus structures to improve driver behaviour incentives.

- **Urban congestion** charges should reflect time delay costs and possibly an element for additional wear and tear, varying by time of day, road type, etc. Where slots are pre-allocated (as in the case of rail and air), then a scarcity charge should be introduced.

- **Infrastructure** costs should ideally be charged for all major infrastructure (both track and terminals). For roads, this would include all major roads - otherwise there is a distortive effect of charging just on motorways. A programme of cost recovery should be developed for all categories of vehicle, acknowledging the differences in road infrastructure damage caused by HGVs and other road users. Depending on the sophistication of the categories used, the charge should reflect (per kilometre) infrastructure damage costs for different vehicle types.

- Many **environmental** costs are related to the energy sources used and in the case of petroleum products are directly proportional to fuel consumption and quality (e.g. CO₂ emissions); these are best recovered using fuel duties. However, following the introduction of other forms of direct charging to recover the marginal costs identified in this report, most fuel duties should be reduced to compensate.

57. On the basis of the work submitted to the Group by the technical advisors, we conclude that:

- Utilising existing data, it is now feasible in a number of cases to broadly estimate the marginal costs of infrastructure and the external social costs, sub-divided by different categories of user (either using a ‘top-down’ or a ‘bottom-up’ approach).

- Pricing instruments increase the efficiency of infrastructure use, but to achieve wider policy objectives in a cost-effective and politically acceptable way, they need to be appropriately combined with regulations and physical measures.

- Marginal cost pricing needs to be supplemented by additional charges to fund infrastructure and its maintenance in some circumstances where construction costs need to be recovered.

58. In some cases the technical advisors have highlighted specific instances where additional
data collection will be needed to ensure consistent availability of data across Member States, if a common accounting and cost recovery framework is to become a reality.

4. Recommendations

59. The research summarised in section 2 indicates that there is already sufficient knowledge to move towards the identification of marginal costs for different transport modes in each Member State, recognising that more work is needed in particular on the valuation of some types of external cost.

60. We recommend that the Member States:

- Adopt common definitions for the various elements of transport costs for each mode, based on the technical advisors’ work reported here;
- Adopt standard methodologies for the identification and valuation of the impacts of various externalities; where impacts are trans-national, agreement on common values across Member States will be necessary;
- Prepare national cost accounts for the main modes, with an emphasis on including external costs, together with estimates of traffic volumes;
- Calculate marginal costs for the main modes on a common conceptual basis, for all Member States and modes.

61. The next task is to develop appropriate charging mechanisms to recover marginal external costs in order to meet Community objectives of increasing fairness and efficiency, improving European competitiveness and the economic and environmental sustainability of the transport system. In the case of accidents, we are already in a position to recommend a refinement of the current personal insurance premium. For other external costs, some combination of vehicle type, distance travelled and track/road type is likely to be appropriate as the basis for a charging system, and should be the subject of further investigation.

62. The first High Level Group report also considered the case where there is a proposal to build new infrastructure. The previous recommendation still stands: that the decision should be based on a full social cost-benefit analysis, with funding provided to cover any net external benefits of the investment. Where it is necessary to recover costs of investment from users, this may require that charges be set above marginal cost using Ramsey/Boiteux or two part tariffs.

63. The submission of this Second Report contributes to several of the recommendations of the First Report of the High Level Group (see paragraph 17). Remaining areas requiring further work involve determining:

- The most appropriate methods of charging transport infrastructure costs to users (part of recommendation III); for example, in the roads sector, investigating the most appropriate successor to the Eurovignette scheme; and in rail developing infrastructure charges including slot allocation mechanisms.
- Common guidelines for social cost benefit analysis of transport infrastructure investment projects (recommendation IV).
• Guidelines for defining the extent of appropriate and acceptable cross subsidisation (recommendation V).

• Appropriate user friendly mechanisms for collecting user charges and allocating any net funds resulting from internalising external costs (arising from recommendation VI).

64. The High Level Group recommends that this report is discussed with a wide range of stakeholders, in order to move towards successful implementation.
Annex 1: BACKGROUND AND TERMS OF REFERENCE FOR THE EXPERT ADVISORS.

The first report of the high level group on infrastructure charging was published in June 1998.

The report proposed the pricing principles of user pays and marginal cost pricing as adopted by the Commission in the White Paper "Fair Payment for Infrastructure Use". (The White Paper explains the Commission’s position that transport charges are not efficient unless they reflect all the costs, including the external costs, of the use of transport.) The high level group report concluded with recommendations for further analysis of key aspects of the approach to charging:

1. The elements to be included in a common accounting framework for assessing the various transport infrastructure costs at a national level (both internal and external), applicable to all major transport modes.

2. Guidance on the principles to be used in calculating the agreed elements of transport infrastructure costs; and on how to estimate marginal costs for the various cost elements to be recovered from users.

3. Commission proposals for charging principles for the use of transport infrastructure for different modes.

4. Common guidelines for cost benefit analysis of transport infrastructure investment projects, covering both internal and external costs and benefits.

5. Guidelines for defining the extent of acceptable cross subsidy, between and within modes, and geographically;

6. Preparation of a phased programme for implementation; the first priorities being the road and rail networks in the Community, and the major ports.

The publication of the White Paper fulfilled recommendations three and six. Following publication and discussions with experts from Member States, the Commission proposed, and the high level group has agreed to investigate the different methods of estimating the marginal costs of transport. This will meet recommendation two and partly four. Once the best means of estimating the costs of transport are determined, the high level group will consider the remaining recommendations and specifically, the most appropriate methods for charging transport costs to users (bearing in mind the need to avoid distortions from uneven implementation). Determining methods of estimating costs is a necessary interim step.

To address the technical issues associated with the estimation of external transport costs, three working groups of technical experts have been established, to report to the high level group. They are to investigate and report on the methods of estimating infrastructure costs, congestion and environmental costs, and accident costs (distinguishing between freight and passenger costs where relevant). Details of these working groups' terms of reference follow:
Estimation of the infrastructure costs that vary with use ("working group 1", WG1)

It is generally agreed that one set of costs which should clearly form part of the charges for transport is the actual cost of infrastructure: the operating and maintenance costs associated with the use of infrastructure.

The aviation sector has already gone some way towards implementing use-related charges, and the Commission and others are investigating costing and accounting procedures in the ports sector. In the rail sector however, there is no clarity or consistency of accounting or cost estimation. And in the roads sector there are few use-related charges and no agreed costing procedures. For this reason the high level group proposes that whilst maintaining a multi-modal perspective, the working group’s initial investigation should concentrate on identifying the infrastructure costs of railways and roads.

A recent study for the Commission by DIW, “Infrastructure Capital, Maintenance and Road Damage Costs for Different HGVs in the EU”, reviews road infrastructure costs in all Member States. Considerable differences between Member States are highlighted. A key conclusion is that there is a need for a harmonised methodological framework which could respect national circumstances. The role of the working group will be to advise and provide draft guidelines on the best methods of defining or estimating:

- Capital costs
- Infrastructure lifetimes
- Depreciation
- Types of vehicle classes
- Infrastructure operating costs (fixed/variable/marginal)
- Maintenance costs (fixed/variable/marginal)
- The allocation of cost to vehicle types
- Road classifications

Similar categories exist for the railways sector (these will be clarified after consulting experts) and will form the basis for the investigation of railway costs.

The working group will draw on the DIW report, Member State experience and other relevant literature. The guidelines will recommend the best means of estimating particular marginal costs and the compatibility and relationship between different methods. Recommendations on minimum data requirements should also be produced (as a basis for amending Regulation 1108/70).

The working group should draw on all relevant literature and views, from all modes of transport. Whilst the initial focus of the working group is on the rail and roads sectors, the ability to develop methods consistent, if not the same as used in other modes, should be emphasised.

The group is to prepare a draft interim report for the High Level Group by 7 March 1999 and a final report by 7 May 1999.
The estimation of costs associated with congestion and environmental pollution ("working group 2", WG2, producing 2 reports)

Of the non-financial external costs associated with transport, the two that are of major public concern and of consequent policy prominence are congestion costs and environmental pollution. Congestion costs impose serious time delays to traffic flows in the aviation, road and railways sectors and raise environmental costs. Environmental pollution imposes direct human health costs, building damage and global warming risks. Part of such costs are clearly borne by transport users and are therefore internal costs. However as one user entering traffic will increase the travel time or environmental cost to others, the Commission believes an element of these costs is external and should therefore be reflected in transport charges.

The discussion regarding aviation congestion and environmental costs necessarily occurs at an international level, and the Commission is contributing positively to the debate and promoting the use of efficient, cost-based charges (for instance through the proposed directive on airport charging). In the railways sector, charging for congestion or scarcity is already under discussion in the Commission’s “railways infrastructure package”. Because of these activities, and as several Member States are very keen to explore and develop railway scarcity pricing and road congestion charging schemes, the working group, whilst maintaining a multi-modal perspective, will concentrate initially on preparing draft guidelines on methods for measuring road congestion costs in urban and inter-urban areas, railway scarcity costs, and transport related environmental costs.

The DIW study “Infrastructure Capital, Maintenance and Road Damage Costs for Different HGVs in the EU” reviews current road congestion costs in Europe, as well as infrastructure costs. Along with other current literature, the working group should draw on this report. A large body of literature also exists on methods and practices of estimating transport related environmental costs. Such literature will form the basis of the report and the group's views in considering and establishing draft guidelines on the best methods of estimating:

- The value of time (according to different users and place)
- Speed-flow relationships
- External congestion costs
- Value of reliability
- The pecuniary cost of delays and train cancellations
- The cost of noise and vibration
- The cost of air and water pollution (local pollutants (e.g. particulates), regional pollutants (e.g. NOx) and global pollutants (e.g. CO2))
- The cost of visual intrusion

The guidelines will recommend the best means of estimating particular costs and the compatibility and relationship between different methods. Recommendations on minimum data requirements should also be produced (as a basis for amending Regulation 1108/70).

The working group should draw on all relevant literature and views, from all modes of transport. Whilst the initial focus of the working group is on the rail and roads sectors, the ability to develop methods consistent, if not the same as used in other modes, should be emphasised.

The group is to prepare a draft interim report for the High Level Group by 7 March 1999 and a final report by 7 May 1999.
The estimation of costs associated with transport accidents  ("working group 3", WG3)

The cost of transport accidents is also a very serious and high profile policy concern. As with congestion and environmental costs, there is obviously an element of transport accidents which is borne by the users themselves. However there is also clearly a cost to others. This cost can be a direct health cost (directly involved in an accident), direct financial costs (the cost to the emergency services and health service), as well as indirect health or social costs (including pain and suffering to friends and relatives). There is also a clear link with congestion cost issues, as traffic accidents contribute significantly to congestion.

The working group is therefore requested to investigate methods of estimating the costs of transport accidents and to propose draft guidelines on the best methods for estimating all such costs. The working group will then consider how to ensure the cost of accidents are borne by those who cause the accidents. This includes the possible use of charges and insurance coverage as means of reflecting the cost of accidents, using current literature on health costs and Member State experience (such as the recent UK changes allowing National Health Service costs to be recovered from insurers). The working group will consider and establish draft guidelines on the best methods of estimating:

- The health cost of accidents
- The wider economic and social costs of accidents
- The external congestion costs of accidents (in conjunction with the congestion costs working group)
- Possible charging mechanisms, including the use of insurance coverage and the issue of "no fault liability"
- Variations or considerations necessary (if any) when addressing different modal applications

The working group should ensure that every effort is made to develop methods appropriate for all modes of transport, whilst dealing initially specifically with road and rail accidents.

The group is to prepare a draft interim report for the High Level Group by 7 March 1999 and a final report by 7 May 1999.
Annex 2: Expert Advisors to the High Level Group
(All these technical experts participated in a personal capacity.)

**Infrastructure costs advisors**
- Mr Francis Babé
  Fédération Nationale des Transports Routiers (FNTR)
- Dr Chiara Borgnolo
  Economist
  TRT – Trasporti e Territorio SRL
  Milan.
- Dr Heike Höhnscheid
  Economist
  University of Cologne - Institute for Transport Economics
- Mr Peter Koning
  Deputy Director, European Affairs
  Railtrack Europe
- Mr Daniel Paris
  Mouvement des Entreprises des France (MEDEF), Paris
- Professor Marco Ponti
  University of Milan
  TRT Trasporti e Territorio Srl
- Mr Ivar Schacke
  Ministry of Transport - Denmark
- Dr Günter Schneglberger
  Austrian road hauliers association
- Mr Jean-Luc Schneider
  Chef de bureau
  Ministère des Finances
- Dr Henrik Swahn
  Director of Research
  SIKA - Swedish transport research centre
- Dr Rolf Tuchhardt
  Economist
  Deutsche Bahn
- Mr Tom Worsley
  Head of Division
  UK Dept of Environment, Transport & Regions

**Congestion and environmental costs advisors**
- Dr John Dodgson
  Consultant
  NERA, UK
- Professor Rainer Friedrich
  IER, Stuttgart
- Dr Lars Hansson
  Research Leader
  Lund University, IIIEE
- Dr Heike Link
  Department of Transportation
  Deutsches Institut für Wirtschaftsforschung
- Dr Marcus Maibach
  Economist
  INFRAS Consulting Group
- Professor Chris Nash
  ITS, Leeds University
- Dr Markus Pennekamp
  Deutsche Bahn AG
- Mr Stephen Perkins
  ECMT
- Professor Stef Proost
  Centre for Economic Studies
  Katholieke Universiteit Leuven
- Professor Rémy Prud’homme
  Université Paris XII
- Professor Emile Quinet
  Ecole Nationale Ponts et Chaussées
- Dr Andrea Ricci
  ISIS, Italy
- Professor Dr Werner Rothengatter
  Inst. for Economic Policy Research (IWW), University of Karlsruhe

**Accident costs advisors**
- Dr Rana Roy
  Adviser
  UIC – International Union of Railways
- Professor Michel Savy
  ENPC
- Mr Pentti Ajo
  Managing Director
  Finnish Motor Insurers’ Centre
- Mr António Brito da Silva
  President
  NAT/Associação Industrial Portuguesa
- Mr Charles Crawford
  Technical Services Director
  CEA -Churchill Insurance
- Dr. Rudolf Krupp
  Leitender Regierungsdirektor
  bast – Bundesanstalt für Straßenwesen
- Dr Gunnar Lindberg
  V T I
  Borlänge Sweden
- Mr Manuel Rui Osório Nunes
  INSURTRAM, Portugal
- Dr John Peirson
  University of Kent
  Canterbury UK
- Mr Wim Smolders
  International Road Transport Union