ORIGAMI

Optimal Regulation and Infrastructure for Ground, Air and Maritime Interfaces

DELIVERABLE D6.4

TECHNICAL SOLUTIONS FOR THE IMPROVEMENT OF CO- AND INTERMODALITY FOR LONG-DISTANCE TRAVELLERS

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TABLE OF CONTENTS

TABLE OF CONTENTS (Continued)

TABLE OF CONTENTS (Continued)

TABLE OF CONTENTS (Continued)

TABLE OF CONTENTS (Continued)

LIST OF FIGURES

LIST OF TABLES

EXECUTIVE SUMMARY

This deliverable reports the work completed by ORIGAMI partners in Work Packages (WP) 5 and 6. WP5 is focussed on the identification of best practice examples of transport solutions with potential to improve long-distance passenger mobility in relation to most relevant system needs identified in WP4. In WP6, solutions have been analysed in-depth and discussed with the Stakeholder community over several participatory activities. Most relevant findings of WP5 and WP6 have been applied in WP7 to model transport solutions at an EU level under alternative future passenger mobility scenarios.

This deliverable D6.4 is the paper version of ORIGAMI deliverable D6.3, which is the Online Solutions Library, accessible via the ORIGAMI project website (http://www.origami-project.eu). The solutions library includes the full collection of identified Best Practice and Suggested Solutions examples, as well as the applicability and transferability analyses, the reports of all participatory activities with Stakeholders, and references and links to learn more on upcoming transport solutions.

The structure of this report corresponds to the different activities performed in ORIGAMI WPs.

- Following a general introduction in chapter 1, chapter 2 is the collection of gathered solutions in WP5, both currently in service in different areas of Europe or the World (ORIGAMI Task 5.1), or being under development or just in a conceptual stage (Task 5.2). All solutions are documented and illustrated in the Best Practice Library accessible from the ORIGAMI website (www.origami-project.eu).
- Chapter 3 contains the analysis of Gaps and Bottlenecks undertaken in Task 5.3. It brings together the two sets of solutions found in Task 5.1 and Task 5.2 and systematically compares them against the most relevant problems and requirements of the transport system established in WP4. This analysis leads to the identification of requirements that are not yet being met by any of the solutions, and hence to the identification of gaps and bottlenecks, for which new solutions still have to be found.
- Chapter 4 contains the transferability analysis of solutions undertaken in Task 6.1. It explores to which extent previously identified solutions can be useful in different contexts to solve similar problems, and later on potentially be standardised for a general application. First a definition of detailed set of criteria to be used to define applicability is provided, and then these criteria are applied to the ORIGAMI identified solutions. The criteria and the subsequent applicability analysis covers aspects that restrain a solution that has been effective in a given case (engineering, financial, regulatory and legal), to be standardised as a useful solution to all similar cases. Legal aspects, third-party impacts, risk management, and stakeholder interest are also analysed in this context. Analysis is based on Stakeholder input resulting from participatory activities in Task 6.2.
- Two Annexes document the ORIGAMI participatory activities with Stakeholders in Task 6.2. Starting from an initial applicability assessment of all solutions in Task 6.1, a number of them were selected as strategic to be included in the two stakeholder consultations. Two workshops (May 2012 and November 2012) brought together actors that implemented solutions and actors that theoretically could implement them, in an approach aimed at the transfer of knowledge between different actors. Stakeholders selected included market regulators (public institutions), transport operators and infrastructure owners and managers, members of the scientific community and transport consultants.

The following provides some highlights of chapters 2, 3 and 4, grouped under the headings of families of solutions.

Families of solutions

Interconnections between long-distance transport networks

14 solutions have been selected by ORIGAMI as examples of initiatives aimed at improving interconnections between different long-distance transport networks (e.g. rail services to airports, connections between railways and ferry lines).

Similarly to local interconnections, enhanced long-distance interconnections have obvious positive impacts on long-distance travellers. In some cases, a proper interconnection may save large amounts of time to passengers on transit, especially when saving users the trip to the closest city to transfer to another long-distance transport network. However, with investments typically large (e.g. 225 million euro for Frankfurt airport's ICE terminal without considering cost of access railway infrastructure; 180 million euro for Düsseldorf Skytrain people mover) and demand for long-distance transits relative low compared to typical urban public transport ridership figures, these solutions are only cost effective in very specific cases. Analysis of alternative technologies to provide such interconnection becomes necessary, and in some cases simpler solutions such as shuttle buses may prove to be just as good as more complex and costly solutions.

A majority of transport stakeholders having participated in the ORIGAMI workshops have manifested the need for ad-hoc approaches to undertake long-distance transport network interconnections, mostly in relation to transits, already available infrastructure and possible territorial constraints; a solution which has proved to be efficient in one case may not work in another context (e.g. ICE connections in Frankfurt compared to TGV connections in Lyon or many AVE connections in Spain). Interconnections may not raise relevant legal issues but may have considerable organisational complexity due to a large number of stakeholders typically involved (e.g. central public administration, various municipalities, at least two infrastructure managers, transport operators, user associations). Finally, improving air/rail interconnections may tend to increase the modal share of the air mode[1], and consequently, GHG emissions and noise (increased externalities).

Long-distance interconnections have a low level of transferability. According to experts involved in ORIGAMI workshops, a market niche will develop spontaneously in the future for such solutions though it may not be expected to be a very big.

Access and egress to long-distance transport networks

28 solutions have been selected by ORIGAMI as examples of initiatives aimed at improving access and egress to long-distance transport terminals from cities and metropolitan regions, most of the times via public transport solutions or proper terminal design. Terminals considered include airports, ferry ports, bus and coach stations, and railway stations.

Enhancing the public transport access and egress conditions to airports, rail and ferry terminals have an obvious positive impact on users in terms of travel time savings and increased comfort. When using a car, solutions aimed at increasing traffic flow in congested areas (via management or new infrastructure solutions) result in travel time savings and reduced fuel consumption. On the other side, public administrations responsible for financing investments and service subsidies face very large economic costs and are forced to establish priorities among different transport alternatives, whenever possible with clear and transparent cost-benefit methodologies. Solutions exclusively dedicated to serve long-distance transport terminals, like high speed shuttles to airports, are likely to incur high, sometimes unsustainable, financial costs, while making best use of already existing infrastructure provides much higher social profitability (e.g. using suburban trains or buses to reach airports). The interest of transport operators to manage such services is usually high as minimum economic profitability for service exploitation is granted through public subsidies

Local interconnections may not raise relevant legal issues but as they often need to be built in heavily populated and urbanised areas, they often have a high level of organisational complexity, especially when agreements among multiple stakeholders are needed (city halls, transport operators, user associations). The design of the Barcelona airport interconnections, for instance, was long discussed over the 1990s and 2000s, with a dozen project alternatives proposed and no overall final agreement ever reached. On the other hand, solutions are technically relatively easy to be transferred from one area of Europe to another, but they always have specificities which need to be closely taken into account to obtain a good project. Access and egress public transport to long-distance terminals can also be used by other users than merely long-distance travellers, like metropolitan commuters, increasing the scope and the interest of these solutions.

1 See Deliverable D5.2 and D5.3 of INTERCONNECT 7FP. Ulied A, Biosca O, Català R, Franco N, Larrea E, Rodrigo R, "Metamodels for the analysis of interconnectivity" Deliverable D5.2 of INTERCONNECT, Co-funded by FP7. TRI, Edinburgh Napier University, Edinburgh, May 2011

Local interconnections have a high level of transferability.

New transport links: megaprojects

9 solutions have been selected by ORIGAMI as examples of initiatives aimed at addressing missing links. Only examples relevant at a European scale are included. Consequently, most of the solutions discussed in this chapter fall in the category of the so called megaprojects: tunnels or bridges overcoming major natural obstacles like large mountain ranges or ocean straights. These very unique and particular projects are usually worth over ú5 billion.

While the impact on users is likely to be important in most of the cases, with large travel time savings and increased comfort and convenience, costs are also likely to be important for a relatively limited number of users benifitting. With these hypotheses, social cost benefit ratios are often very low or even negative. Large investments required for mega-projects for instance, often way above 5 or 10 billion euros, make them only possible when a strong political will is able to compensate for all other poor financial performances (e.g. Channel Tunnel or Öresund bridge-tunnel).

The very specific nature of mega-projects makes their transferability difficult. Even when legal obstacles or externalities may not be especially relevant, the specific local approach required by these solutions makes them difficult to be generalised across Europe.

The transferability level is lowest for mega-projects.

Dual mode solutions

5 solutions have been selected by ORIGAMI as examples of initiatives aimed at designing hybrid vehicles that can use the classic infrastructure of different transport modes without requiring travellers to tranship from one mode to another. These solutions are typically cars and buses able to run on train tracks, tramways able to run on railways and trains able to run on tramway networks, or even trains able to transfer to ferries.

Dual mode transport solutions may only be socially cost effective when required investments are relatively low, like in the Karlsruhe tram train case, but unlike many of the other tram train experiences in Europe. Train ferries face increasing financial problems and also car train services are cut back as passengers move to other modes such as low-cost aviation.

The very specific nature of dual mode transport solutions makes their transferability difficult. Even when legal obstacles or externalities may not be especially relevant, the place based approach required by these solutions makes them difficult to be generalised across Europe.

Enhanced vehicle performance

9 solutions have been selected as examples of initiatives aimed at enhancing the performance of vehicles, i.e. for instance by increasing their speed or making them more reliable.

With clear benefits for users (shorter travel times, increased comfort, convenience and safety), not all solutions may be equally interesting to transport operators or public administrations. Investments in some case may be very considerable (e.g. high speed programmes).

No major feasibility issues are to be expected for these kinds of solutions. When the approach is on a vehicle basis like for car multiple driving assistants or automatic subways, transferability across Europe is relatively easy, even if technologies may be often mode specific. If the approach is infrastructure intensive, like the high speed rail programs, difficulties may be much higher. Standardisation of technologies is a basic precondition for transferability.

Transferability is to be expected high for those solutions with a market interest and providing high traveller benefits. These solutions will mostly be developed by the private sector.

Traffic management

19 solutions have been selected as examples of initiatives aimed at better managing traffic flows, either for road, rail, air or ferry.
There are many positive impacts of these solutions. For users, proper management of transport infrastructure allows for increased average travel speeds, increased travel reliability, increased safety. For operators, solutions aimed at improving management allow for increasing capacity of existing infrastructure with relatively low investments. For instance, implementing a system of managed lanes in a motorway such as London's and Birmingham's in the UK, including variable speed limits and hard shoulder management, allows better driving conditions with investments being about one third of the cost of enlarging motorways with one additional lane. However, investments required for the implementation of systems allowing for better management of transport infrastructure are not to be underestimated (e.g. ICTs in motorways or ERTMS).

Despite the fact that some adjustments in the legal framework might be necessary for the implementation of certain management solutions (e.g. hard shoulder driving, variable speed limits), these legal adjustments should not be insurmountable. Although ICT technologies applied to traffic management are relatively mode-based, making it difficult to transfer them across modes, they can be exported relatively easily from one region to another, all across Europe. Implementation of such solutions is only expected to be cost efficient in areas with important traffic congestion, like in metropolitan motorways and railways, European airport hubs and a very limited number of long-distance rail lines across Europe. Externalities are likely to decrease with improved management. For the road mode, decreased congestion results in decreased accidents, emissions and noise, with particularly positive impacts for communities living close to large transport corridors, like metropolitan motorways. Improved management strategies for the air space, like point to point routing (FRAM) and optimisation of airplane landing procedures (REACT) has shown that fuel savings are also possible through management in the air mode.

Traffic management solutions have the highest level of transferability. Spontaneous implementation by transport operators is relatively likely according to experts. There are already several examples of such practice in Europe

Organisational arrangements

10 solutions have been selected as examples of initiatives which change the formal organisation of specific transport services aiming at increasing their efficiency. These initiatives may be originated on liberalisation processes such as concessions, franchises, privatisations, de-regulation, or on agreements reached between operators to provide overall better services like in the case of agreements between rail operators and taxis or car sharing providers serving rail stations.

The impact on the efficiency of the transport system of public-private partnerships (PPPs), privatisations or liberalisation is uncertain according to most experts having participated in ORIGAMI workshops. Some claim that PPPs should reduce prices for the consumers, bring additional funding resources for transport investment and put less pressure on the public sector. Others claim that PPPs are just a mechanism to postpone the payment of the infrastructure by the public sector with much greater cost in the end, and that it transfers profits to the private sector while keeping risks for the public bodies.

Time is required to acquire enough evidence to draw sensible conclusions on the impact of liberalisation. It is necessary to contrast and compare approaches taken in various EU countries and various initiatives. However, it is clear that no single formula exists that can be applied across modes and territories in Europe. A good regulatory framework to transport sector liberalisation is necessary.

For all these reasons, organisational arrangements are given a medium low transferability potential.

Segregation of freight and passenger traffic

4 solutions have been selected as examples of initiatives to segregate passenger and freight transport, or at least decreasing the volume of freight transport in infrastructures shared with general passenger transport. Freeing passenger transport networks from freight traffics can contribute to an

overall increase of traffic safety and better traffic flows, especially in most congested corridors. This family of solutions mostly considers the construction of dedicated roads and railways for freight, but also considers those initiatives aimed at transporting larger quantities of goods using a reduced number of trucks, e.g. the modular truck concept or road trains in Scandinavia.
Large investments required for providing dedicated freight motorways or railways can only be socially profitable when transported freight volumes are very important and need to go through very congested transport infrastructure (e.g. to connect largest ports with leading economic regions throughout major metropolitan areas). Benefits of dedicated freight infrastructure are more likely to come from alleviated congestion in the passenger network (few minutes saved by millions of vehicles or passengers) rather than direct benefits for freight transport.

The very specific nature of these solutions makes their transferability relatively difficult. Even when legal obstacles or externalities may not be especially relevant, the specific local approach required by most of these solutions makes them difficult to be generalised for other modes or areas of Europe.

Ticketing schemes

10 solutions have been selected as examples of initiatives related to travel tickets or vouchers. The several examples are aimed at increasing the transparency and balance of transport fares across modes and territories, to allow passengers to travel on multiple means of transport using integrated tickets, or making it easier to purchase travel tickets e.g. via smartphone applications or in-vehicle sales booths.

Initiatives aimed at providing more comprehensive fare structures on transport are expected to provide highly positive impacts for users. However, solutions like integrated ticketing may have substantial organisational complexity, proportional to the number of different operators involved. Complexity is likely to come from the system used to distribute costs and revenues of integrated systems. The cost of integrated ticketing can be considerable high for the public administrations.

General orientations to integrated ticketing schemes and operations may be relatively easy to transfer across modes and territories, but specificities for each case are likely to be very important. Legal frameworks may be complex and may require adjustment. Overall success of such systems will depend on the capacity to overcome such specificities.

Ticketing solutions are granted a medium level of transferability.

Travel planners and user information

21 solutions have been selected as examples of initiatives aimed at increasing the quantity and quality of information provided to travellers, allowing them to do most adequate route choices when travelling. Information may be related to a single mode (e.g. rail schedules, terminal orientation) or to multiple modes (e.g. multimodal travel planners).

Solutions allowing for multi-modal trip planning and ticket purchasing in Europe can have an important role in optimising passenger routes in the future. Providing real-time trip information in smart phones or car navigating systems that will change the suggested route in case of road congestion or delayed public transport promotes increasingly accurate decision making in transport. As users are better informed about alternative route choices, they can optimise their trip itineraries saving time and money. Transport operators also benefit from this solution as they are able to easily sell tickets and facilitate user information using less human resources (employees), and can also make a profit from publicity appearing in the travel planner applications. The market is already spontaneously promoting these solutions without regulation or public support required. The social benefit of such solutions at EU level may seem rather marginal, but as costs are also low, the social profitability of these initiatives is likely to be positive.

New ITS protocols for trip planning (like EU-spirit) allow for the distributed computation of alternative cross-border journeys. Different networks of existing local and regional journey planners are used for computing segments of the journey corresponding to specific regions or modes. This makes the technical side of this solution simpler to implement. Additionally, the inclusion of environmental indicators such as CO2 emissions in travel planners, like in routeRank, might promote more responsible behaviour by travellers, decreasing the level of externalities of transport. This technology can be applied for different modes and different regions of Europe, or for all modes and all Europe simultaneously in an integrated approach.

Considering relatively high interest for travellers, operators and public authorities, and being easy to implement, Travel Planers and Passenger Information have the highest level of transferability.

Enhanced security and fee collecting procedures

14 solutions have been selected as examples of initiatives aimed at preventing the generation of cues in bottlenecks of the transport network generated by the need to undertake specific formalities such as security checks or transport fare payment. Most of the examples are aimed at making faster the security and check-in procedures at airports, the road toll payment, or the purchasing of public transport tickets.

For users, these solutions tend to improve service quality, provide travel time savings, increase transport comfort, and transport reliability. Most of the time, operators aim at keeping the system working efficiently to attract more users and save operating costs: for instance, increasingly automatic motorway tolls to prevent congestion and increase road demand; reducing delays caused by formalities at airports can make medium distance flights more competitive respect to rail. In other occasions, it may be the interest of the operator to keep passengers as long as possible within the transport system, e.g. to increase profit of retailing spaces at airports or to increase revenues from car parking. Public administrations are likely to seek transport solutions as efficient as possible.

Solutions considered can easy be implemented all over Europe, and may also be easy to be transferred across different modes: security procedures from the air mode are starting to be applied to access high speed services at rail stations, and cue management at road tolls is comparatively similar to airport cue management at security controls, or cue management at urban traffic lights. However, there may be legal obstacles in relation to privacy issues depending on the technologies used, like in the case cell phone tracking via blue tooth IDs.

Transferability is estimated medium-high for these kinds of solutions.

Environmental management

13 solutions have been selected as examples of initiatives aimed at making transport more environmentally friendly and less dependant on fossil fuels. Although these solutions do not have a direct impact on the travel experience, like reduced travel times or travel costs for users, they are a major issue for the transport system as a whole towards meeting the sustainability targets established in the EU2020 strategy (by 2020, 20% GHG emissions reduction; 20% energy consumption from RES; 20% energy efficiency increase) and in the 2011 EC Transport White Paper (60% GHG emissions reduction in 2050).

Environmental solutions, such as in-situ energy generation to power transport infrastructures such as rail or the electrification of motorways are most attractive for public administrations concerned with energy dependency and environmental conservation. Some initiatives developed by the public sector are only aimed at generating the initial necessary conditions (seeds) for the private sector to take over later on. However, there are many alternatives available and some of these are of higher value than others. Some solutions might not prove to be sufficiently cost-effective.

Technologies are easy to be transferred across Europe and across modes. Environmental returns may be positive. No major legal obstacles may be expected. Intensive land occupation and visual intrusion may be some determinant drawbacks.

Because of not having major technical obstacles or insurmountable social barriers to wide-spread application, and having a relatively high public sector interest, transferability is determined medium-high. However, scores may differ widely from one solution to another.

Enhanced safety

6 solutions have been selected as examples of initiatives aimed at making transport safer. Although these solutions do not have a direct impact on the travel experience, like reduced travel times or travel costs for users, they are a major issue for the transport system as a whole towards meeting the safety targets established in the 2011 EC Transport White Paper (transport fatalities close to zero level by 2050)

Not all solutions may be equally interesting to transport operators despite benefits for users. However, public administrations are likely to be supportive of such solutions. Transferability across Europe is more likely to be easy when the approach is on a vehicle basis (e.g. eCall) than on infrastructure.

Standardisation of technologies is a basic precondition for transferability. Transferability is to be expected high for those solutions with a market interest and providing high traveller benefits.

Applicability of solutions to address transport system problems and needs

Overall, it was somewhat unexpected that there were so few of the system needs identified by ORIGAMI in the first place for which no solution has been found that is already available or at least under development somewhere in Europe. Engineers in Europe and worldwide have addressed the user needs of long-distance travellers in a multitude of ways, all that is needed is that these solutions are rolled out throughout Europe. The few identified gaps found concern real-time information: real-time information at rail stations in ports on ferry departures, real-time information on onward travel at ports, and real-time information on trip status and connections for coaches. However, for the latter the Austrian Postbus operator is aiming to install such a system in the near future, and the two former may even already exist somewhere unbeknown to the project team, and in any case can be easily realised with technology already in use for other existing real-time information.

On the other end of the spectrum, there are just a few needs for which, at least in principle, there are universal solutions available. These are:

- Hire cars at airports for the last mile;
- Park & Ride facilities for the first mile;
- Demand responsive public transport services;
- Cars with assisted driving facilities to make cars safer; and
- Electric vehicles to make cars cleaner, even though facilities to reload batteries are in some countries still very rare.

The closest candidates for availability for all of Europe are the routeRANK travel planner, although this does not contain information on local public transport in the publicly available version, and the German Reiseauskunft and DB navigator, which both provide rail information for all of Europe, though door-to-door information only for Germany.

All other solutions identified are only available for certain countries, regions or even cities, although a roll-out to other sites is in most cases technically perfectly feasible. The main obstacle to further developing and implementing solutions that reach across borders is the lack of common standards for data bases and data exchange. Here is a role for the European Commission to help further the development of these standards and providing a central point, for instance through EUROSTAT, where key data could be stored and be made available to all.

1 INTRODUCTION

1.1 APPROACH

This deliverable reports the work completed by ORIGAMI partners in Work Packages 5 and 6. WP5 is focussed on the identification of best practice examples of transport solutions with potential to improve long-distance passenger mobility in relation to most relevant system needs identified in WP4. In WP6, solutions have been analysed in-depth and discussed with the Stakeholder community over several participatory activities. Most relevant findings of WP5 and WP6 have been applied in WP7 to model transport solutions at an EU level under alternative future passenger mobility scenarios. The relationship between the ORIGAMI solutions discussed in this deliverable and the scenarios is briefly introduced in chapter 1.3 and fully reported in ORIGAMI deliverable D7.1.

This deliverable D6.4 is the paper version of ORIGAMI deliverable D6.3, which is the Online Solutions Library, accessible via the ORIGAMI project website (http://www.origami-project.eu). The solutions library includes the full collection of identified best practice and suggested solutions examples, as well as the applicability and transferability analyses, the reports of all participatory activities with Stakeholders, and references and links to learn more on upcoming transport solutions.

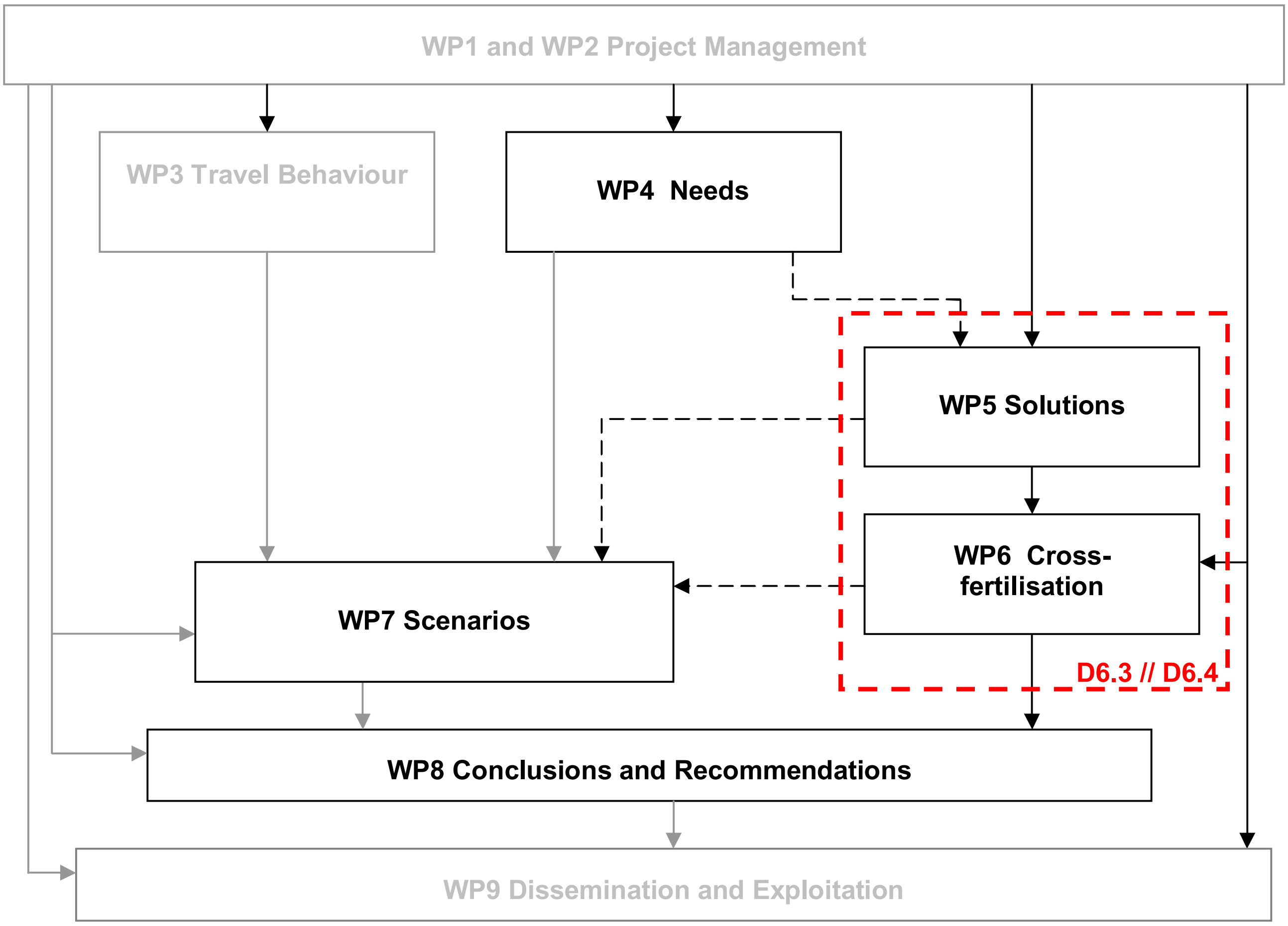


Figure 1-1 Position of D6.3 and D6.4 within ORIGAMI WP Interdependencies

The structure of this report corresponds to the different activities performed in ORIGAMI WPs.

- Chapter 2 is the collection of gathered best practice solutions in WP5, both currently in service in different areas of Europe or the World (ORIGAMI Task 5.1), or being under development or just in a conceptual stage (Task 5.2). They are structured into 13 families of solutions.

The lists of solutions presented are not exhaustive and many additional examples can be identified. However, the ones presented provide insides in the most relevant alternatives currently existing in Europe, or being considered for the near future. Solutions are in most of the cases best practices developed in Europe, but examples from other parts of the World and few unsuccessful cases have also been included to complete the overall picture. All solutions are documented, illustrated and properly referenced in the Best Practice Library accessible from the ORIGAMI website (www.origami-project.eu).

- Chapter 3 contains the analysis of Gaps and Bottlenecks undertaken in Task 5.3. It brings together the two sets of solutions found in Task 5.1 and Task 5.2 and systematically compares them against the most relevant problems and requirements of the transport system established in WP4. This analysis leads to the identification of requirements that are not yet being met by any of the solutions, and hence to the identification of gaps and bottlenecks, for which new solutions still have to be found.
- Chapter 4 contains the transferability analysis of solutions undertaken in Task 6.1. It explores to which extent previously identified solutions can be useful in different contexts to solve similar problems, and later on potentially be standardised for a general application. First a definition of detailed set of criteria to be used to define applicability is provided, and then these criteria are applied to the ORIGAMI identified solutions. The criteria and the subsequent applicability analysis covers aspects that restrain a solution that has been effective in a given case (engineering, financial, regulatory and legal), to be standardised as a useful solution to all similar cases. Legal aspects, third-party impacts, risk management, and stakeholder interest are also analysed in this context. Analysis is based on Stakeholder input resulting from participatory activities in Task 6.2.
- Two Annexes document the ORIGAMI participatory activities with Stakeholders in Task 6.2. Starting from an initial applicability assessment of all solutions in Task 6.1, a number of them were selected as strategic to be included in the two stakeholder consultations. Two workshops (May 2012 and November 2012) brought together actors that implemented solutions and actors that theoretically could implement them, in an approach aimed at the transfer of knowledge between different actors. A preliminary expert consultation was held electronically in November 2011. Stakeholders selected included market regulators (public institutions), transport operators and infrastructure owners and managers, members of the scientific community and transport consultants.

1.2 DEFINITIONS

ORIGAMI WP5 produced a compilation of best practices and suggested solutions, focused on infrastructure, service management and regulatory strategies applied to improve long-distance intermodal and co-modal transport.

The co-modality concept was introduced in the EC 2006 Transport White Paper mid-term revision, referring to the use of different modes on their own and in combination, with the aim to obtain an optimal and sustainable utilisation of resources. Therefore, co-modal solutions do not need to be also intermodal, but intermodal solutions are included into the co-modality approach whenever they are proved to be more efficient and sustainable than unimodal solutions. It is in fact a key objective of the European Common Transport Policy (CTP) to integrate existing transport modes to develop a seamless web of transport chains linking road, rail and waterways aimed at promoting overall efficiency of the transport system, reliability and flexibility.

Accordingly, ORIGAMI not only has to address intermodal, but also unimodal journeys, most notably pure car journeys. Coach and train trips may also be classed as unimodal, if both terminals are in walking distance from origin and destination, and the same is in principle true for bus journeys. Unimodality is not considered for air travel and long-distance ferries, since the number of travellers that live in walking distance from airports and large ferry ports is too low to warrant further exploration.

Long-distance is understood as trips longer than 100km, although the ORIGAMI Library of Best Practices also includes local public transport solutions acknowledging their relevant role in the last mile stage of any long-distance trip.

1.3 SOLUTIONS FOR WP7 SCENARIOS

In WP7, ORIGAMI defines prospective scenarios by 2030 to explore the impact of alternative policies. Policy packages are supply oriented and characterised by different degrees of emphasis on infrastructure investment, infrastructure management, enhanced regulation and more liberalisation. New technologies and upcoming transport solutions identified in WP5 and discussed in depth with stakeholders in WP6 are at the basis for the definition of WP7 scenarios.

ORIGAMI Scenarios are inspired by the scenarios defined by the 2011 Transport White Paper[2]. White Paper scenarios are adjusted to specifically analyse the long-distance passenger segment of EU transport. They are defined qualitatively based on stakeholder interaction and travel survey analysis (WP3, WP6 and WP7), and modelled quantitatively with the MOSAIC network-based model (for 2030) and LUNA system dynamics model (for 2050).

ORIGAMI scenarios are named OR1, OR2, OR3 and OR4. They are briefly introduced below:

- <u>OR1. Better public regulation and infrastructure investment, mostly financed by public funds, with some regulation</u>.

  OR1 considers a rising level of transport infrastructure investment, mostly rail programs aimed to enlarging high speed rail in Europe. Investments are mostly financed with public funds. Most airports in Europe become connected to the long-distance rail network, and enhanced local connections from surrounding cities allow for easy and cheap access and egress by public transport. A regulation framework is set up to encourage the use of more environmentally friendly modes, including generalised road pricing as an extension of Eurovignette to cars and extended air taxation. Subsidies are dedicated to greener transport services or aiming at territorial cohesion.

  In OR1, solutions like the ICE station in Frankfurt airport or the Düsseldorf Skytrain people mover, the VMT Maut road pricing system for trucks in Germany or the vehicle miles travelled pricing system tested in Eindhoven in 2009 become fully spread.

- <u>OR2. Better public regulation, especially on vehicle technological standards, and little emphasis on infrastructure</u>.

  OR2 promotes the introduction of cleaner vehicles, and more responsible user behaviour. Increased public and private research efforts and Euro Standard regulations over the private sector bring down vehicle emissions. More efficient engines and vehicles with less weight lead to much lower gas consumption. Favourable taxation and technological developments promote expansion of alternative fuelled cars fleet. More efficient driving regimes are favoured via user training and technologies such as advanced cruise control systems. More spread car sharing and car pooling favour more rational use of cars and increased vehicle occupancy, and more efficient operator management is able to increase load factors of trains, airplanes and ships.

  Renewable energy plants such as Infrabel's solar farm on the Leuven-Brussels high speed rail line, linked to an increased electrification of transport via EV or solutions such as the implementation of catenaries in motorways, carpooling systems like *carpool.com* and smarter seat allocation on airplanes and trains are paradigmatic solutions of OR2.

- <u>OR3. More liberalisation and more emphasis on infrastructure management. Technology applied to improve efficiency of transport infrastructure</u>.

  OR3 aims at increasing performance of existing infrastructure using better management. ICTs in metropolitan roads alleviate congestion, decreasing access and egress speeds from and to cities and airports; satellite guidance allows optimal routing; revised airport protocols reduce required times for formalities; integrated EU air space management allows accommodating more air movements and enhance flight punctuality; ERTMS allow for faster operating rail. Further liberalisation and consolidation of the air transport sector and increased competition among European airports and airlines contribute to a reduction of fees in largest European hubs and airports, having an impact on flight fares. Agreements between different transport operators increase the offer of integrated inter-modal services (e.g. air and HSR integrated ticketing).

[2] EC (2011), *Impact Assessment. Accompanying document to the White Paper,* Commission Staff Working Paper. SEC(2011) 358 final

The IATA checkpoint concept for airports in the future and the increasing number of self-service processes at airports (e.g. check-in, luggage drop, seat assignment), the managed lanes systems implemented in Stockholm (variable speed) and in Birmingham (hard-shoulder management), or the ERTMS are paradigmatic solutions of OR3.

- <u>OR4. More liberalisation and more investment in efficient infrastructure co-financed by the private sector</u>.

  OR4 is based on further liberalisation of the transport market. The number of rules is reduced and regulation becomes more homogenous for all Member States. The private sector becomes increasingly involved in funding infrastructure projects and providing transport services (PPPs, MACs, project bonds). Cost benefit appraisal is at the core of project selection. Public subsidies to service operation are reduced, forcing each mode to become more economically self-sufficient. Road pricing is introduced across Europe where not already existing. As a result to better adjustment of transport prices to their real costs, competition within modes and across modes is enhanced. A lot of economical unsustainable regional airports go out of operation due to missing public funding. High speed rail is implemented only where services are economically profitable, mostly between selected metropolitan pairs in Europe. Motorway investments mostly aim at addressing bottlenecks and missing links in most congested areas. The spread of a number of ITS applications improves road safety and allows average road flow speeds to increase.

  The Merseyrail Concession in Liverpool is an example of liberalisation practices in OR4, and autonomous vehicles such as Google's, Audi's or Volvo's SARTRE are also assumed common in this scenario.

The figure below shows to what extent each of the ORIGAMI scenarios relies on different solutions analysed in WP5 and WP6 to improve long-distance seamless passenger travel in Europe.

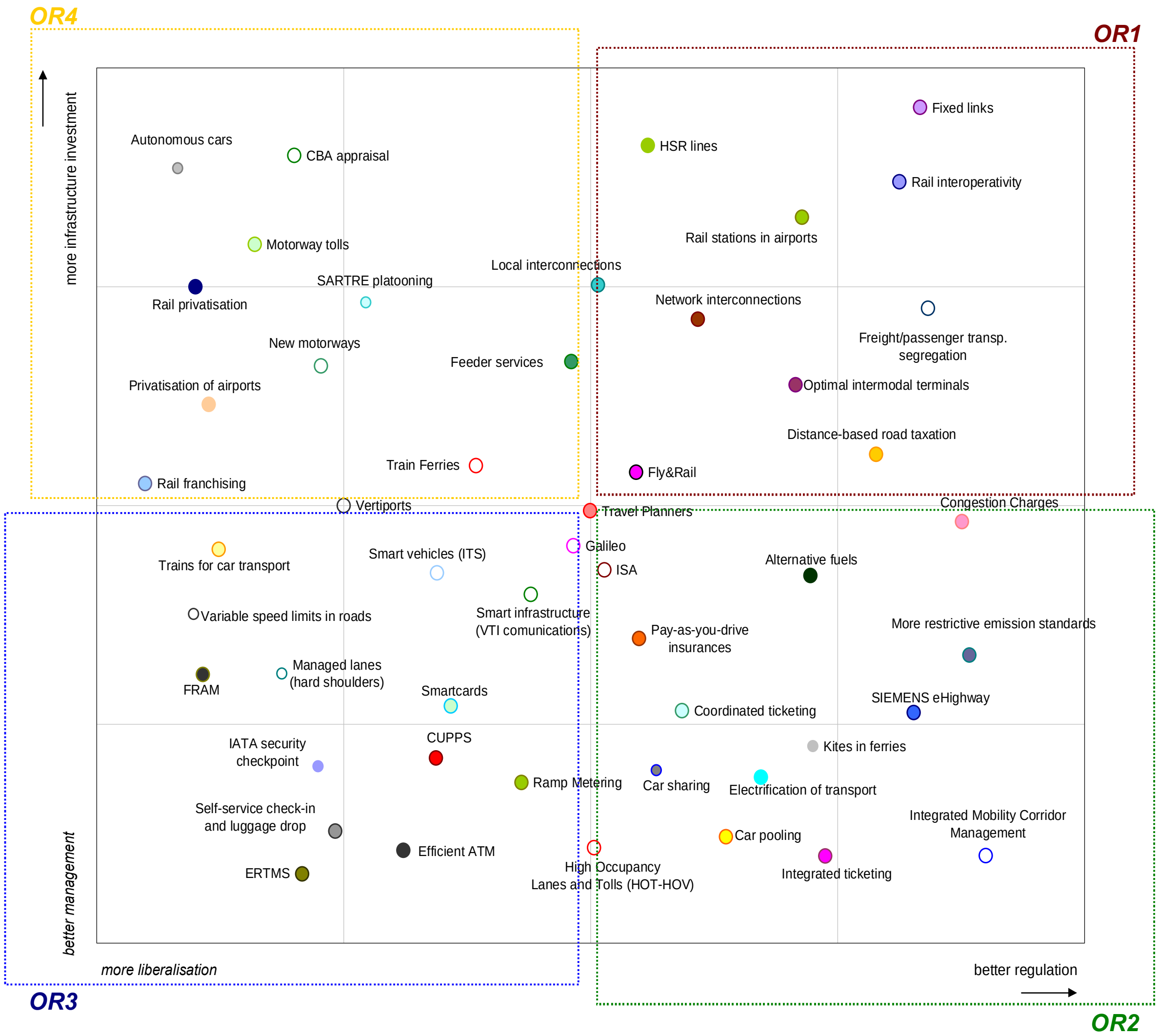


Figure 1-2 WP5 and WP6 Solutions Applied to WP7 Scenarios

2 IDENTIFICATION OF BEST PRACTICE SOLUTIONS

2.1 APPROACH

ORIGAMI examples of best practice and suggested solutions are integrated in a public web database, accessible through the ORIGAMI webpage (http://www.origami-project.eu). All solutions are reported following a systematic structure, illustrated with multimedia materials and including links to reference sources and stakeholders responsible for their development. They are classified according to following families of solutions:

- Long-distance interconnections;
- Local interconnections;
- Missing links: megaprojects;
- Dual mode solutions;
- Enhanced vehicle performance;
- Traffic management;
- Organisational arrangements;
- Segregation of freight and passenger traffics;
- Ticketing schemes;
- Travel planners and user information;
- Security & fee collecting procedures;
- Environmental management;
- Enhanced safety.

The library of solutions has been at the basis of the follow-up discussion and evaluation of solutions in ORIGAMI, and to document participatory activities with stakeholders. The directory was initially developed in 2011 (milestone MS5), and has been continuously maintained throughout the entire project. The COMPASS FP7 project will further elaborate on this directory by further developing ICT based solutions.

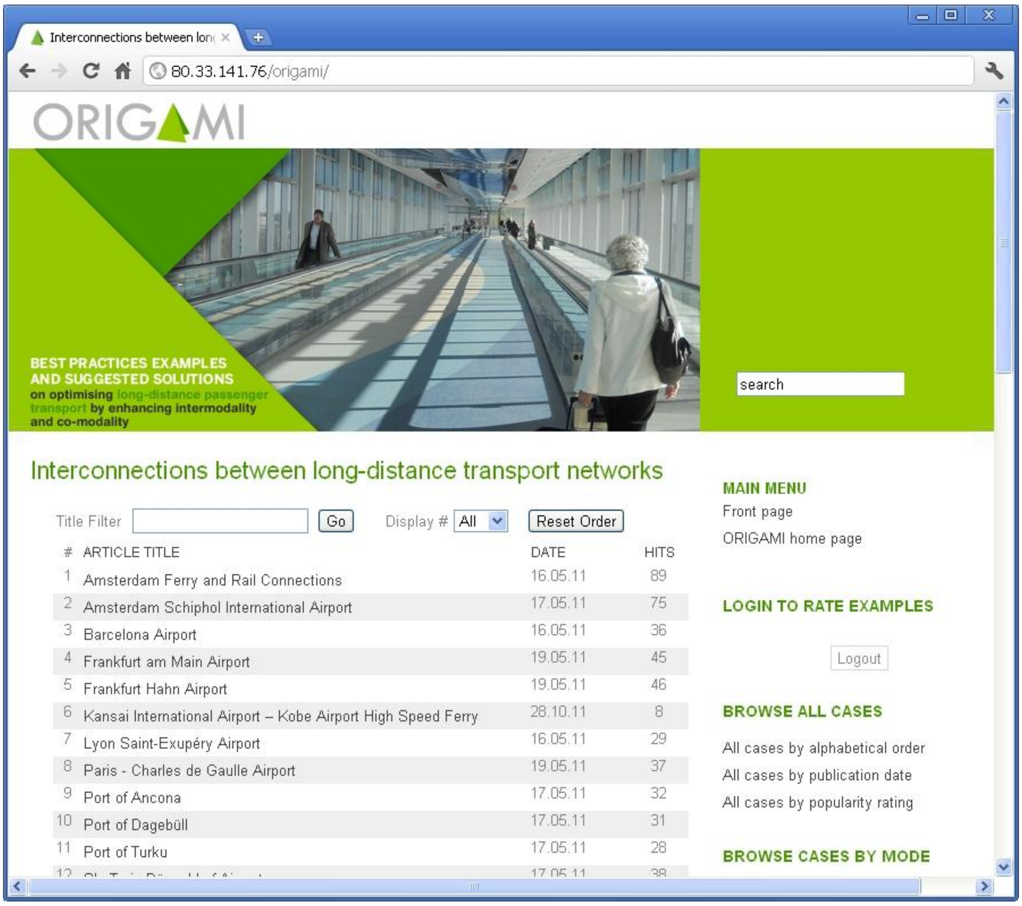


Figure 2-1 ORIGAMI examples of best practice web directory (www.origami-project.eu)

To be included in the web directory, solutions must fulfil the following criteria:

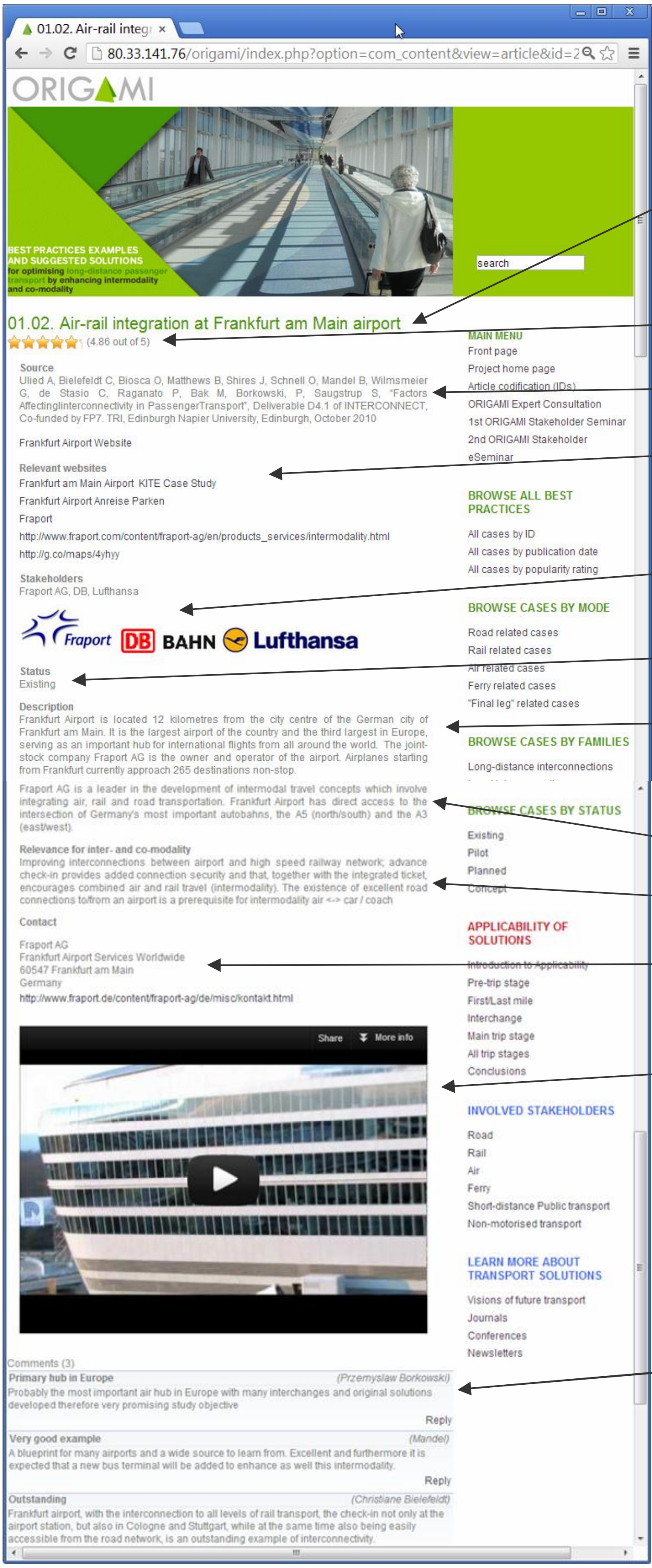
- Solutions need to be relevant, i.e. they need to prove their potential for long-distance transport optimisation beyond comfort improvement to passengers (through intermodality or co-modality);
- They need to be potentially applicable in other situations (possibility to be generalised);
- Focused on new or upgraded infrastructure, on the improvement of the management of modes, regulation/deregulation of transport, or on new technologies.

Stakeholders behind each of the solutions were identified, and whenever possible also contact persons directly participating in the design or implementation of the solution. Identified stakeholders have been involved in the strategic discussion in later stages of the project.

All examples are presented in a consistent format. They include:

- Source references *(e.g. INTERCONNECT case study, Hermes data base, EUROCONTROL….);*
- Relevant website. *Documents or websites available online and which present the solution;*
- Involved stakeholders. *List of major stakeholders directly involved in the case;*
- Status. *To chose between one of the following: Existing, Pilot, Planned, Concept*;
- Description. *In 10 to 20 lines, briefly present the case and major lessons to be learned;*
- Relevance. *How the case study contributes improving either intermodality or co-modality in long-distance passenger transport.*

An example of a completed solution is presented below to illustrate the format adopted:



Solution ID and name

Potential interest rating (as voted by site visitors)

Source references

Relevant websites

Involved stakeholders

Status: Existing / Pilot / Planned / Concept

Solution description

Solution description

Relevance for inter and co-modality

Contact of person involved in development of solution

Illustrative materials (multimedia)

Comments by site visitors

All examples collected in the web directory are synthesised in the next chapters. For full documentation of each example, visit www.origami-project.eu.

2.2 INTERCONNECTIONS BETWEEN LONG-DISTANCE TRANSPORT NETWORKS

2.2.1 Introduction

The first set of solutions has been selected as examples of initiatives aimed at improving interconnections between different long-distance transport networks (e.g. rail services to airports, connections between railways and ferry lines):

- Amsterdam Schiphol Rail Connections;
- Frankfurt am Main Airport Rail Connections;
- Paris Charles de Gaulle Airport TGV Connection ;
- Zürich Airport Rail Connections;
- Düsseldorf Airport Rail Connections with SkyTrain People Mover;
- Barcelona Airport HSR Planned Connection;
- Lyon Saint-Exupéry Airport TGV Connection;
- Vienna Airport International Bus Services;
- Frankfurt Hahn Airport Long-Distance Bus Connections;
- Kansai International Airport ï Kobe Airport High Speed Ferry Connection;
- Amsterdam Ferry and Rail Connections at Amsterdam Centraal;
- Port of Ancona Ferry and Rail Connection;
- Port of Dagebüll Ferry and Rail Connection;
- Port of Turku Ferry and Rail Connection.

2.2.2 Amsterdam Schiphol Rail Connections

Schiphol (IATA: AMS, ICAO: EHAM) (also known as Amsterdam International Airport) is the Netherlands' main airport and located 20 minutes (17.5 km) south-west of Amsterdam. The airport handled 45 million passengers in 2010.

Schiphol train station lies directly beneath the airport with both domestic and international connections. Trains to Amsterdam are regular and the journey time is between 17 and 20 minutes. Thalys International provides commercial passenger rail transport services on behalf of SNCB, SNCF and DB to the following destinations: Paris, Brussels, Amsterdam, and Cologne. Thalys is a joint service offered by the Belgian, French, Dutch and German railways. Fyra is the new high-speed train between Brussels and Amsterdam. It runs on the high-speed line in Belgium (Line 4) and the high-speed line in the Netherlands (HSL-Zuid). Fyra will carry passengers on the Amsterdam ï Schiphol ï Rotterdam ï Antwerp ï Brussels section. Fyra does this stretch at a speed of 250 km/h (155 mph). Brussels to Amsterdam is just 1 hour and 46 minutes. Schiphol to Rotterdam is already 20 minutes quicker than by intercity train and is predicted to save 27 minutes in the future. Generally time savings range between 38% and 59%.

Schiphol airport has an extensive network of direct bus lines connecting it to the surrounding towns and cities. Most of these connections are maintained by the Schiphol Sternet network. These lines operate with high frequency from early in the morning until late in the evening. Some lines also include a night service. Travel times to and from Amsterdam Airport Schiphol seldom exceed half an hour. Passengers on all lines embark and disembark at Schiphol Plaza (directly in front of the Arrival and Departure Halls)

Promotion of all available options to/from airport (co-modality). Links for domestic and international rail including High Speed Rail (intermodality).

2.2.3 Frankfurt am Main Airport Rail Connections

Frankfurt Airport is located 12 kilometres from the city centre of the German city of Frankfurt am Main. It is the largest airport of the country and the third largest in Europe, serving as an important hub for international flights from all around the world. The joint-stock company Fraport AG is the owner and operator of the airport. Airplanes starting from Frankfurt currently approach 265 destinations non-stop. The key solution concerning intermodality at Frankfurt airport is the long-distance railway station of the airport, which connects the airport to the High Speed Rail network in Germany, so that numerous long-distance trains connect the airport to all parts of the country. With time savings of up to 100 minutes generated by the new links, passenger figures for long-distance trains at Frankfurt airport more than doubled within a few years and are at about 22,500 per working day, resulting in a mode share of more than a third for public transport for originating air passengers. Nevertheless this did not stop the trend to increased air travel, as the slots not longer needed for the feeder flights immediately were used to allow additional (long-haul) flights at the capacity constrained Frankfurt airport.

The other important feature is that Lufthansa passengers heading for Frankfurt airport have a check-in facility at Stuttgart and Cologne central stations under the exclusive *AIRail* agreement between Lufthansa and Deutsche Bahn. Furthermore, there are integrated tickets for the rail journey to Frankfurt and the onward flight available.

Improving interconnections between airport and high speed railway network; advance check-in provides added connection security and that, together with the integrated ticket, encourages combined air and rail travel (intermodality).

2.2.4 Paris Charles de Gaulle Airport TGV Connection

Charles de Gaulle Airport (CDG), which is located north-east of Paris, is the biggest airport of France and the second biggest airport of Europe after London Heathrow. In 2007 59.9 Million passengers came to the airport, which is used by Air France as a major hub. With over 600 involved enterprises and 55,000 employees it is an important business location. There are 5 surface modes of transport to access and egress from the three terminals of CDG airport, namely international train, interurban train, urban train, urban bus, taxi and private car. The High Speed Rail station is located in the airport below Terminal 2. Free shuttles and Personal Rapid Transit (CDG-VAL) dispatch travellers from the station to the terminals (1, 2 and 3) as well as to several car parks and vice versa. The service is suitable for passengers who have to transfer to another terminal after they have exited security and luggage claim, but also for passengers on their way to the RER/TGV/Thalys stations or parkers who need to get back to car parks.

Improving interconnections between airport and High Speed Rail network (intermodality).

2.2.5 Zürich Airport Rail Connections

Zürich Airport is located in Kloten in the canton of Zürich. It is Switzerland's largest international flight gateway and hub for Airlines of Switzerland, Lufthansa and all other international airlines. In 2006 19.2 million passengers and 260,000 air craft landings and departures were counted. In 2003, Zürich International completed a major expansion project in which a new parking garage and a new midfield terminal were built. An automated underground train was launched in order to move passengers between the existing terminal complex and the new terminal. The airport is very well embedded into the local and national railway network. Zürich airport railway station (Zürich Flughafen) is located underneath the terminal and was inaugurated in 1980. Frequent S-Bahn (urban railway) services plus inter-regio and intercity services to Bern, Basel, Chur, Geneva, Lausanne, Luzern, Konstanz, St. Gallen and Zug are provided every 30 minutes. Trains for Lugano, Zermatt or St. Moritz start once every hour.

Improving interconnections between airport and railway network (intermodality).

2.2.6 Düsseldorf Airport Rail Connections with SkyTrain People Mover

The railway station for Düsseldorf airport is located at the eastern end of the airport grounds 2.5 km away from the main terminal. Over 350 trains, ranging from the regional S-Bahn to the high-speed ICE, stop daily at the Düsseldorf Airport Station.

The SkyTrain connects the railway station directly with the terminal. The SkyTrain is a fully automatic cabin car, which is hanging from a monorail 10 m about ground; every train consists of two cabins, which all have panorama windows and ample luggage space. The train travel with up 50km-h and can transport 2,000 passengers per hour in each direction. The train leaves every 3.5 to 7 minutes for 22 hours per day and the travel time is 6.5 minutes.

For anybody who has arrived at Düsseldorf Airport Station with a regional train or a range of special Deutsche Bahn tickets, transport on the SkyTrain is free of charge.

The SkyTrain allows fast and direct access to the major German rail network at a station where the railway passes in the intermediate vicinity of the airport (intermodality).

2.2.7 Barcelona Airport HSR Planned Connection

Barcelona airport will be connected to Barcelonaś city centre and the rest of the metropolitan area through suburban rail and subway network. The HSR link to the airport will be implemented either through the construction of a new loop segment departing from the trunk line, or with the metro and suburban rail services which will connect the two airport terminals and the el Prat de Llobregat rail station 5km away where HSR services already stop.

Improving interconnections between airport and high speed railway network (intermodality).

2.2.8 Lyon Saint-Exupéry Airport TGV Connection

The airport was inaugurated in 1975, designed to replace the old Lyon-Bron Airport, which could not be extended as it was located in an urban area. In 2009, the airport served 7.7 million passengers, making it France's fourth busiest airport after Charles de Gaulle, Orly and Nice airports. In 1994 the LGV Rhône-Alpes High Speed Rail line brought the TGV service to the airport, providing direct trains to Paris and Marseille. This airport is historically the first to be served by a high speed station in France together with Charles de Gaulle. Unfortunately, the station sees little use, as passengers mainly use Lyon-Perrache and Lyon Part-Dieu. In 2002, air-rail combined travel represented 10% of total rail traffic in the airport station, 80 passengers per day. 90% of rail users originate in the surroundings of the airport. Today, a total of 24 daily TGV services stop at the Lyon airport station.

Improving interconnections between airport and high speed railway network (intermodality).

2.2.9 Vienna Airport International Bus Services

Vienna airport is located 20km to the south-west of the city centre of Vienna. The airport is served by buses, S-Bahn, the City Airport Train CAT, and taxis and cars. Especially interesting the number of surface connections dedicated to neighbouring countries, something other airports can learn from: apart from local buses to Vienna, there are 29 buses per day to Bratislava, 10 to Budapest, 1 to Heviz in Hungary, 2 to Brno and four to Prague via Brno. The S-Bahn between the airport and Vienna Central, operated by ÖBB, runs every 30 minutes and takes 25 minutes. CAT also operates every 30 minutes, but runs non-stop and only takes 16 minutes from the airport to Vienna Central. CAT is a rather luxurious train which also shows on-line flight information. There is also a CAT-CAB service, which covers travel with CAT and onward travel to any destination in Vienna with a combined ticket. A special feature of Vienna Central station is the City Airport Train Terminal with 10 check-in desks for currently 26 airlines (June 2011) for CAT passengers up to 75 minutes before the flight departure. For 10 of the airlines it is also possible to check-in already on the previous evening after 18:00. Luggage check-in is also available for holders of on-line tickets.

The offer of long-distance buses, S-Bahn and the high-quality CAT, combined with the check-in facility at Vienna Central promotes combined travel (intermodality).

2.2.10 Frankfurt Hahn Airport Long-Distance Bus Connections

Frankfurt-Hahn airport is used by Ryanair, Wizz Air and Iceland Express and serves 54 destinations in Europe as well as Fes, Marrakech, Boston and New York. Frankfurt-Hahn lies in a somewhat remote location with the nearest towns of at least 7,000 respectively 3,000 inhabitants 20 km and 35 km away. Frankfurt, referred to in the official airport name, is 125 km away.

This remote location makes access by public transport difficult, but nevertheless there are not only 4 bus services to 7 towns in the nearer vicinity as well several long-distance ones: to Luxembourg via Trier (14 per day); to Cologne via Koblenz (5 per day); to Heidelberg via Ludwigshafen, Mannheim 7 per day, 3 of which carry on to Karlsruhe) and to Frankfurt via Mainz and Frankfurt airport (15 per day). These bus lines do not only connect the airport to the city centres, but also to the main stations of these cities. However, the travel times required to access these cities by those bus services are relatively high (e.g. Frankfurt/Main ï 1h 45min; Luxembourg 2h, Karlsruhe ï 3h 35min).

Currently the airport does not have a rail connection. However, a regional rail connection is being planned by extending an existing regional rail line to the airport.

Enhancing interconnections between air transport and rail network. (intermodality).

2.2.11 Kansai International Airport – Kobe Airport High Speed Ferry Connection

Kansai International Airport is situated 50 km from the center of Osaka city. Kobe Airport is located on the other side of Osaka Bay and is 8km outside the city of Kobe. Both airports are built on islands and, therefore, have relatively easy water access. They also both have good connections into the road and railway networks. A high-speed ferry links the two airports and gives quick access to transport networks at either side of the ferry link. At each airport, a free shuttle bus (timed to meet each ferry) moves passengers between the ferry terminal and airport terminals. The shuttle bus journey at each end takes 6-8 minutes and the scheduled travel time of the high-speed ferry is 29 minutes. There are 16 departures each day from each airport, leaving every 45-60 minutes.

The high speed ferry provides quick access to the transport networks serving each of the international airports on either side of Osaka Bay, as well as to the flight destinations inland and international offered by the other airport (intermodality). Alternative means of public transport around Osaka Bay include rail (involving a change of train) and a limousine bus with a journey time of 65 minutes (co-modal).

2.2.12 Amsterdam Ferry and Rail Connections at Amsterdam Centraal

The key issue in this good practice example is the integration of high speed ferry services into the regional transport network and also their potential as the interconnection between long-distance rail and international ferry services specifically and as the interconnecting mode to international ferries in general. The case is relevant as public transport in Amsterdam has made continuous efforts to integrate ticketing and fare services, although recent developments and the introduction of new procurement rules have somewhat disturbed previous integration efforts, as new procurement rules are not clear about the role of integration.

Optimising interconnection between ferry and rail transport modes. (intermodality).

2.2.13 Port of Ancona Ferry and Rail Connection

The port of Ancona is a major seaport in central Italy on the Adriatic Coast. Eight ferry operators provide services from three docks in Ancona to eleven destinations in Croatia, Montenegro, Albania, Greece and Turkey. The rail station of Ancona Marittima is located within the port area, 250 m north of the terminal for Montenegro and Turkey, 400 m south of the terminal for the Greek destinations, 600 m south for Croatian destinations and 1.3 km from the terminal for Albania.

The trains do offer a connection from the port into the wider railway network (intermodality).

2.2.14 Port of Dagebüll Ferry and Rail Connection

The port of Dagebüll lies on the North Sea Coast in the very north of Germany. The port serves 12 W.D.R. ferries per day to Wyk on the island of Föhr and 6 to Wittdün on the island of Amrum. Neg, a small private train operator, offers train services directly into the port from the mainline station of Niebüll, and the train timetable is coordinated with the ferry timetable. The train stops 20 metres away from the ferry. During the summer season and Christmas holidays the main German train operator DB also offers a number of direct services from Hamburg. 50 km west of Niebüll is the city of Flensburg. Flensburg is one of the many stations in Germany for the City Night Line, which is a network of overnight trains, and the W.D.R. website advertises an integrated bus and train ticket for bus travel from Flensburg to Niebüll and onward train travel to Dagebüll specifically for City Night Line users.

The fact that there is a train that stops directly next to the ferry will encourage the combined use of rail and ferry, and the integrated bus and rail ticket will also invite City Night Line users to choose this travel option. (intermodality).

2.2.15 Port of Turku Ferry and Rail Connection

The port of Turku lies right within the city of Turku on the south-western edge of Finland. There are two ferry operators, Viking Line and Silja Line, who both run daily services to Stockholm and Kapellskaer on Åland in Sweden. There are also less frequent ferries to other Baltic ports.A train terminal is located adjacent to the main passenger-ferry berths used by the ferries to Stockholm. The services are timed to overlap with the ferry berthing times. The station has direct boat-train services to Helsinki and to Tampere. All services to and from Turku Harbour call at Turku Central railway station. The three kilometre journey between the two stations takes around seven minutes, involving the slow-speed crossing of several main roads with level crossings, passing the city's residential and industrial areas. There are also overnight trains to the north of Finland. Some trains do carry cars, but those must be loaded at Turku central station.

The existence of the trains and the coordination of timetables between the ferries and trains will encourage combined ferry and rail usage. (intermodality). The offer of car carrying trains will encourage ferry passengers to use rail for the long-distance connections to the port, while using their own car for the final stretch to their destination.(co-modality).

2.3 ACCESS AND EGRESS TO LONG-DISTANCE TRANSPORT NETWORKS

2.3.1 Introduction

The next solutions have been selected as examples of initiatives aimed at improving access and egress to long-distance transport terminals from cities and metropolitan regions, most of the times via public transport solutions or proper terminal design. Terminals considered include airports, ferry ports, bus and coach stations, and railway stations:

- Stockholm Arlanda Express Shuttle to Downtown;
- Oslo Gardermoen Airport Flytoget Express Shuttle to Downtown;
- Shanghai Pudong Airport Maglev Shuttle to Downtown;
- Gdansk Airport Railway Rail Link Connection to TRI-City and Railway and Bus Station;
- Copenhagen Airport Metro and Rail Connections to Copenhagen and Malmö;
- Cracowï Fast Tram System Better Access City-Main Train Station;
- Gothenburg City Airport Bus Link to Downtown;

- Marco Polo Airport Ferry Services to Venice;
- Hong Kong International Airport Ferry Services to Mainland China;
- Logan Airport to Boston CBD Water Shuttle Services;
- Vancouver Airport to the Vancouver Island Ferry Terminal;
- Combined Rail and Car Sharing Service with ÖBB VORTEILScard;
- Integrated Public Transport Facility in Bremen;
- Dresden Transport Hub;
- Zürich Central Rail Station;
- Berlin Central Rail Station;
- Liège-Guillemins Rail Station;
- Linz Central Rail Station;
- Helsingborg Ferry and Rail Connections;
- Lisbon Ferry and Rail Connections;
- "Haller Willem" Regional Feeder Rail Line;
- Avenida de América Bus and Metro Interchange Station in Madrid;
- Layout of multimodal transfer points;
- Metro and buses to the Port of Piraeus;
- Prague Main Railway Station;
- Railway Connection between the Airport and the City of Kracow;
- Edinburgh Bus Station;
- Coach parking in Southport.

2.3.2 Stockholm Arlanda Express Shuttle to Downtown

Stockholm Arlanda airport is about 40 km north of the city of Stockholm. There are many public transport alternatives to and from the airport: high-speed trains, long-distance trains, local trains, local buses, airport coaches and other buses and coaches. The Arlanda train station is directly below the centre of SkyCity, which is located between Terminals 4 and 5.

The Arlanda Express connects the city and the airport non-stop in 20 minutes every 15 minutes. The Arlanda Express prides itself for punctuality and high quality service. If the train is only 2 minutes late, passengers receive a free new ticket. The 85 onboard train attendants will have begun their employment at Arlanda Express with five weeks of training. They are knowledgeable about the airport and the city, and operate a surprise patrol that turns up now and then with complimentary buns, coffee or similar.

There is commuter train service between Upplands Väsby and Uppsala via Stockholm Arlanda, with an onward connection to Tierp and Gävle, known as "Upptåget". Upptåget serves the airport every 30 minutes. The trip north to Uppsala takes 20 minutes. The trip south to Upplands-Väsby, where there is a connection to the Stockholm Transport commuter trains, takes eight minutes.

Alternatively, there is the Stockholm Transport bus number 583 to nearby Märsta station and passengers can change there to the SL commuter train, which travels south towards Sollentuna, Stockholm, Älvsjö and Södertälje. During normal traffic hours, the buses and commuter trains depart every 15 minutes. Stockholm Tansport has stops outside all the terminals.

For long-distance access to the airport, there are 70 trains per day to cities in the Lake Mälaren Valley region around Stockholm and to Sweden's Dalarna and Norrland regions to the north. Examples of destinations in Sweden directly accessible by train from Arlanda Central Station are Uppsala, Södertälje, Gävle, Hudiksvall, Sundsvall, Östersund, Åre, Borlänge, Falun, Leksand, Mora, Nyköping, Norrköping and Linköping.

Since February 2011, there are also trains between Gävle and Stockholm via Stockholm Arlanda with Tågkompaniet on Saturdays and Sundays, with two departures in each direction.
Ecotaxis are located directly outside the terminals. The target is for all taxis at Stockholm Arlanda to be ecotaxis by June 2011.

Furthermore, 190 parking spaces with the best locations at Stockholm-Arlanda are reserved for ñclean carsò as defined by the City of Stockholm. To be called a clean vehicle, it must run on renewable fuel, which may be biogas, ethanol or electricity.

The variety and quality of the public transport options encourages air travellers to use of public transport for access to the airport (intermodality). Where cars or taxis are used, the use of clean vehicles is encouraged since they get privileged access to the airport, thereby encouraging environmentally friendly travel to the airport by both private and public modes (co-modality).

2.3.3 Oslo Gardermoen Airport Flytoget Express Shuttle to Downtown

Oslo airport is located 35 km north east of the city of Oslo. Apart from the six bus operators who between them run a whole range of bus services to the airport, the airport is served by regional and local rail and a high speed train.

All NSB regional trains that run between Skien and Trondheim via Oslo and Lillehammer stop at Oslo airport. NSB Local Trains on the Kongsbergï Eidsvoll line also stop at the Airport.

The Flytoget is a high speed train with a top speed of 210 km/h. It runs every 20 minutes between Oslo central station and the airport and takes 19 minutes. Every other 20 minutes there is a train that stops in Lillehammer and therefore takes 22 minutes to the city and goes on from there via five other stops to Drammen; the whole journey from the airport to Drammen takes one hour and one minute

Both the regional and local trains and the high speed train encourage the air-rail combination of travel (intermodality).

2.3.4 Shanghai Pudong Airport Maglev Shuttle to Downtown

Shanghai Pudong International Airport, an international hub airport with an extensive global flight network, is located about 30 kilometres East of Shanghai city centre. With a total of 40.6 million passengers served in 2010, Shanghai Pudong International Airport was ranked as the third busiest airport in mainland China and the 20th busiest in the world.The Shanghai Maglev Train, based on German technology (Transrapid International ï a joint venture between Siemens and ThyssenKrupp), is the first commercial high-speed magnetic levitation line in the world. Construction of the line began on March 1st 2001 with an approximate investment of ú917million and the public commercial service commenced on January 1st 2004. This project is primarily designed to supplement the existing transport connections between Shanghai city centre and Pudong International Airport, where no urban rail/metro services were available until 2010. The maglev operates between Shanghai Pudong International Airport and the outskirts of central Pudong (Longyang Station) with a train departing every 15-20 minutes for the 7.5 minute long, 29.86km ride. It offers the fastest and smoothest journey ar a reasonable cost (RMB 40) for getting in and out of Shanghai when compared to taxi (45 minutes/RMB 160), shuttle bus (75 minutes/RMB 20) and metro (80 minutes/RMB 7). Currently, the Shanghai Maglev Train accommodates an average 7,500 passengers per day between Monday and Friday, and this figure is further increased to 10,000 passengers during the weekend.

Supplementing the available options to/from Pudong International Airport (co-modality). Improving the connection between the airport and the existing Shanghai urban metro network (intermodality).

2.3.5 Gdansk Airport Railway Rail Link Connection to TRI-City and Railway and Bus Stations

Pomeranian Metropolitan Rail is the project aiming at connecting Gdansk airport with central railway stations in Gdansk and Gdynia. Current access from/to airport is rather poor with single road which connects to the Tri-City bypass highway. This road crosses bypass and then follows to the centre ï it is heavily congested in peak but often also in off-peak hours. Public transport system (bus) uses this congested route. Moreover frequency of bus departures is rather low and one of the two lines servicing Gdansk direction takes a detour through suburb build near airport. In direction of Gdynia there is only one bus line operating from/to airport. New rail links connect the airport with the railway and bus stations in Gdansk and in Gdynia. Additionally park&ride facilities in all major stations will be developed and stations will be connected with the existing tram and bus network.

Intermodal solution connecting the airport with the city centre and the rail long distance network as well as with the road network through park and ride facilities at the stations. (intermodality).

2.3.6 Copenhagen Airport Metro and Rail Connections to Copenhagen and Malmö

Copenhagen Airport with about 21.4 Mio of passengers in 2007 is located about 8 kilometres south of the city centre of Copenhagen in Kastrup, a town on the island of Amager. Copenhagen Airport is the main airport of Scandinavia. Direct available connections to a total of 132 destinations worldwide (19 Intercontinental, 84 European, 22 Nordic and 7 Domestic) underline the function as a transfer airport for air traffic between other parts of the world and many national and regional airports in Scandinavia and the area south of the Baltic Sea. The Airport has three passenger terminals, which are connected with a free shuttle bus. The metro line M2 of the Copenhagen Metro links Copenhagen airport with the city centre at 4-6 minutes intervals during day and evening hours, every 15 minutes during the night. The Copenhagen Airport can be reached by train on the Øresund Railway Line at the railway platforms in Terminal 3: there are InterCity, high speed and regional train services to Denmark and Sweden. It takes 12 minutes to travel by train from Copenhagen Airport to the Copenhagen Central Station and 20 minutes to Malmoe (Sweden).

Improving interconnections between airport and railway network (intermodality).

2.3.7 Kracow–Fast Tram System Better Access City-Main Train Station

The Kraków Fast Tram system, KST (Polish Krakowski Szybki Tramwaj) is a premetro/tram system connecting northern and southern parts of the city. Currently two lines of KST are in operation. Line 50 operates between Kurdwanów in the district of Podgórze Duchackie which is south of Vistula River, and Krowodrza Górka in Krowodrza, north of the river. Line 51 operates between Dworzec Towarowy and BieŨanów Nowy in the south east district of BieŨanów.

Work on an underground tunnel for trams in the main railway station area started in 1974 and the 1.5 kilometer-long tunnel was finally opened on 12 December 2008. Dworzec Gǿwny Tunnel is an underground station directly connected to the platforms of the main railway station and to the Galeria Krakowska shopping mall. Politechnika is an underground station located near the campus of the Cracow University of Technology. In July 2010, MPK placed an order with Bombardier for a further 24 Flexity Classic trams.

The KTS Fast Tram system provides a convenient connection to various parts of the city with the main railway station where it is also possible to get with the "Balice Express" train to the airport. (intermodality).

2.3.8 Gothenburg City Airport Bus Link to Downtown

Flygbussarna Airport Coaches offer convenient and comfortable bus services to and from all the major airports in Sweden. Personnel are deployed to help with information and baggage handling at the terminals. The departure times of the airport coach to and from Gothenburg City Airport at Säve are designed to fit in with the timetables of all regular flights. Thus, the Gothenburg City airport bus departs from Nils Ericson Terminal in central Gothenburg 2 hours before every scheduled flight departure. Similarly, the airport bus departs the airport for Nils Ericson Terminal (next to the main railway station in central Gothenburg) after every scheduled flight arrival. The journey takes approximately 30 minutes. At the time of writing, the journey costs 60 Swedish Kroner for adults, one way, or 110 Swedish Kroner for a return ticket. Airport bus tickets are valid for use on Gothenburg city transport (trams and buses) for 90 minutes after arrival in town.

Apart from taxi and private car, this bus provides the only other available transport access to Gothenburg City airport. A number of vehicles in the Flygbussarna fleet run on bio-fuel derived from rapeseed oil and it is the companyϕs stated objective that within three years, it will be totally free from all fossil fuels. It would then make the bus the least environmentally damaging modal alternative for access to Gothenburg City airport (co-modality). The bus obviously provides a direct link between the airport and Gothenburg city centre and its extensive urban bus and tram system. However, by starting and ending its journey at Nils Ericson Terminal, it also links directly into the Swedish rail network at the adjoining main railway station and into the regional and national bus network within the same terminal (intermodality).

2.3.9 Marco Polo Airport Ferry Services to Venice

Marco Polo airport has been built directly on the waterside opposite Venice, and that enabled a ferry stop to be built directly within the airport area. Four frequent ferry services connect the airport with every major ferry stop in Venice as well as with two stops on Murano.

Further to that, the airport is linked into the general bus network of Venice and Mestre, and express buses operate between the airport and the rail stations of Venice and Mestre. Directly outside the arrival area there are also two dedicated parking spaces for the Venice car sharing service

The availability of the ferry service encourages combined air and ferry travel (intermodality). Furthermore, the parallel offer of the ferries, the buses and the car share vehicles allows passengers to choose the mode that is best for their specific destination within Venice (co-modality).

2.3.10 Hong Kong International Airport Ferry Services to Mainland China

HKIA has received close to 40 worldϕs best airport awards over the years. More than 50.9 million passengers used Hong Kong International Airport (HKIA) in 2010 and about 4.1 million tonnes of cargo passed through the airport. About 900 aircraft movements and over 95 airlines link HKIA with about 160 destinations worldwide every day, making it one of the busiest international passenger airports in the world.

The airport offers extensive pre-trip information about potential transport links to/from the airport covering all modes.

The Airport Express takes passengers to Central Hong Kong in just 24 minutes. Quick and comfortable trains depart at 12-minute intervals from 05:50 daily, with the last train leaving the Airport Station at 00:48. The Airport Express offers free In-town Check-in in Kowloon and Hong Kong Stations, allowing passengers to check in from 90-minutes to a day in advance. A free shuttle bus service is available, taking passengers from Kowloon or Hong Kong stations to most major hotels and transport interchanges.

Hong Kong International Airport is well served by public bus routes, taking passengers to and from most parts of Hong Kong. Comfortable and relatively inexpensive, they offer a convenient transport option.

As well as 3,000 parking spaces for cars, the airport offers residentsô shuttles to Discovery Bay and Park Island.

There is a whole section on the website (and transport plan) concerning connections to mainland China. Hong Kong International Airport is a multi-modal transport centre, offering extensive land and sea connections to major cities in the Pearl River Delta region. While cross-boundary ferries provide speedy sea transport to and from eight ports, coach services cover 115 PRD cities and towns.

With its own SkyPier, Hong Kong International Airport (HKIA) provides speedy ferry services for transit passengers, making HKIA a truly multi-modal transport hub for convenient air and sea travel.

SkyPier serves eight ports in the Pearl River Delta and Macao, connecting the region to about 160 destinations worldwide via HKIA.

Combinations of fast rail access with down town check-in, shuttle buses, coach and ferry connections to other destinations (also with airline check-in at ferry stations) promotes the combination of air travel with public transport access (intermodality). Promotion of all available options to/from airport (co-modality).

2.3.11 Logan Airport to Boston CBD Water Shuttle Services

The MBTA Harbor Express Shuttle Boat provides a daily, year-round and continuous scheduled water transportation service to/from Logan Airport and Downtown Boston (Long Wharf), Quincy and Hull. The journey between Logan airport and the Boston CBD takes approximately 7 minutes. The service is part of the Massachusetts Bay Transit Authority (MBTA) system and has the following characteristics: State-of-the-art high-speed catamaran vessels with heated /air conditioned passenger cabins, bow-loading to facilitate wheelchair accessibility, a food and beverage service and restrooms on-board. Discounts for advance and bulk ticket purchases are available. In addition, three water taxi companies (City Water Taxi, Boston Harbor Water Taxi, Rowes Wharf Water Transport) operate from the Boston Logan Airport dock at a fare of $10 one-way and £17 return between the airport and the CBD. Passengers either board a water taxi waiting at the dock or call ahead for a reservation. If no water taxi is present, passengers can call for one using one of the call boxes at the top of the gangway. The Massport shuttle bus #66 makes continuous regular trips between the Logan dock, airport terminals, and the MBTA Blue Line station during regular water taxi and water shuttle operating hours. The ride between the terminals and Logan dock takes approximately 15 - 20 minutes and is free.

The water-based services between Logan airport and downtown Boston link into a courtesy airport bus at Logan dock and into mainstream urban bus and metro services at the dock in the CBD (intermodality). Both the water shuttle and the water taxis provide a scenic, but both rapid and economic, alternative to the more conventional methods of passenger transit that connect the town to the airport (co-modality). The MBTA Silver Line SL1 route is a rapid transit bus service linking Logan Airport and South Station. At South Station there is an interchange with the MBTA Red line metro. The Blue line metro serves the Logan Airport station, which is connected to the airport by a free shuttle bus. Taxis provide another modal choice linking the CBD to Logan airport.

2.3.12 Vancouver Airport to the Vancouver Island Ferry Terminal

Designed to handle the increase in traffic during the 2010 Winter Olympics, the Skytrain is an above-ground monorail-type train that connects Vancouver International airport with downtown Vancouver and Richmond. The Skytrain departs from the airport once every 4 to 6 minutes throughout the day and evening, and about once every 10 minutes during late-night hours. It makes 2 stops before arriving at Bridgeport Station, where passengers alight and transfer to Bus 620 which carries them to Tsawwassen Ferry Terminal. Here, passengers may board ferries to either Victoria or Nanaimo on Vancouver Island. The No. 620 Bus departs once an hour from 5:55 AM to 10:03 PM daily and the trip takes about 45 minutes. The fare paid for the Skytrain at the airport covers the bus journey all the way to Tsawwassen. The BC Ferries ticket booth is a short walk from where the bus arrives.

This provides an alternative, supplementary route for foot passengers wishing to transit from the major international access point in Western Canada, Vancouver International airport, to the important leisure destination of Vancouver Island. Alternative available options include long distance bus, air and helicopter links (co-modality). This integrated transport link with a major ferry element improved the connection between the region's major airport and Vancouver Island (intermodality).

2.3.13 Combined Rail and Car Sharing Service with ÖBB VORTEILScard

The ÖBB VORTEILScard offers an up to 50 % reduction on all trains of ÖBB as well as the private railways, with the exception of the rack and pinion railways and special services. Moreover the VORTEILScard offers some additional benefits such as DENZEL Mobilty Carsharing. The VORTEILScard is the electronic key to car sharing vehicles. There are currently 200 locations throughout Austria. 20 of which are directly located at railway stations. The VORTEILScard is valid for one year and costs 99.90 Euros by year

Directly change from to train to car sharing (intermodality).

2.3.14 Integrated Public Transport Facility in Bremen

Integrated public transport: car sharing, bicycle racks and public transport in one location (Bremen, Germany) facilities.

Special integrated intermodal Car Sharing stations have been created in Bremen and designed with the special brand name mobilpunkt. They are located in inner-city areas with intensive parking problems. The mobilpunkt are a joint effort of the City of Bremen as responsible public authority, the Bremen Parking Management Company (BrePark) to technically manage the station, Public Transport and the Car Sharing operator to provide the Car Sharing service. The two mobilpunkt stations were inaugurated in April 2003 and a third is due in 2007. A basic principle of the mobilpunkt is the location adjacent to a Public Transport stop, the integration of bike racks and some further mobility related information.

Concentrating public and semi-public (car sharing) transport modes in one point encourages intermodality. (Intermodality).

2.3.15 Dresden Transport Hub

The Dresden area is a growing region in the eastern part of Germany, called "Saxony valley", and Dresden is a hub and an interconnection for employees and goods for that commercial environment. Three major motorways meet in Dresden, and Dresden is located on the planned high speed inter-European railway network that connects Berlin to Prague. Dresden is a very popular city and region for tourists, and tourists use local and regional interchanges for visiting the city. Dresden is an interchange for goods and passengers to Poland and the Czech Republic.

Dresden's central rail station combines access to national and international rail, S-Bahn (urban rail), trams and buses. The S-Bahn also connects the airport with the central station and the city in general

The availability of a range of transport modes encourages modal chains (intermodality). The parallel offer of three different local transport modes provides a choice for users (co-modality).

2.3.16 Zürich Central Rail Station

Zürich Central Station is Zürich's biggest railway station. It is in a very central position and it dispatches trains not only from all over Switzerland, but also from other countries in Europe, such as Spain, France, Italy, Austria and Germany.

Passengers can come to or leave the terminal by train, bus, private car (only short term) and taxis. The train station is fully integrated into the urban/national train network which means that the connections of trains which run in more than 30 minutes intervals are adjusted to each other. SBB offers excellent luggage services. In more than 50 train stations luggage can be checked-in for any kind of journey (train or plain). For arriving passengers heading for any destination in Switzerland luggage will be brought to every single train station in Switzerland automatically (by check-in on any airport worldwide). SBB also offers services for intermodal travel partly going by car or bicycle. Vehicles can be left at any train station and be rent on destination. SBB offers combined tickets with nearly all the skiing areas in Switzerland. Since the commuter lines were inaugurated in 1990 the

Central Station is the major hub for the whole local train network of Zürich. On the station Museumstrasse (which is part of the Zürich Central Station) the lines S3, S5, S6, S7, S9, S11, S12, S15 and S16 are operating. Since Zürich Transport Company (Verkehrsbetriebe Zürich VBZ) began to offer outstanding services also by night, the lines SN1, SN3, SN5, SN7 and SN8 are operating at the terminal. The Zürich Main Station is also a major hub for Zürich public transport network. Numerous tram lines (3, 4, 6, 7, 10, 11, 13 and 14) and trolley buses (31 and 46) are operating at the terminal. For passengers arriving at the station by private car, limited parking space is available, for short-term obligations with a maximum of one hour only.

Passengers can come to or leave the terminal by train, bus, private car (only short term) and taxis. The train station is fully integrated into the urban/national train network which means that the connections of trains which run in more than 30 minutes intervals are adjusted to each other (intermodality).

2.3.17 Berlin Central Rail Station

The Central Station of Berlin opened on the 26th May 2006. The station is located on the site of the historic Lehrter Bahnhof (Lehrte Station) and Lehrter Stadtbahnhof. The new Berlin Central Station now is Europe's largest two-level railway station, making connections between different trains very short. The station serves High Speed Rail connections to Munich, Basel, Wiesbaden, Cologne, Düsseldorf, Aarhus, Copenhagen and Leipzig, heavy rail, S-Bahn (urban rail) and U-Bahn (underground rail). The station is operated by DB Station & Service, a subsidiary of DB AG. Every day 261 long distance trains, 326 urban trains and 620 urban trains. The station will also get a quay to connect to a ferry service.

Enhancing interconnections between the High Speed Rail network and the rest of rail transport modes and ferry services. (intermodality).

2.3.18 Liège-Guillemins Rail Station

Liège-Guillemins train station is the main station of the city of Liège, in eastern Belgium. It is one of the most important hubs in Belgium and is directly connected to the High Speed Rail network. In addition to the national traffic, Liège-Guillemins station welcomes Thalys and ICE trains, connecting Liège to Brussels, Paris, Aachen, Cologne and Frankfurt. Two new dedicated high speed tracks HSL 2 (Brussels-Liège) and HSL 3 (Liège-German border) have been built and are already in use. There are also plans for Eurostar and ICE to link Liège directly to London. Liège Guillemins is also served by some intercity trains on the main Belgian East-West axis (Liège-Brussels-Ostend) and several local trains from the Ardennes valleys. The station is connected to the city centre by a local train and buses.

Enhancing interconnections between high speed railway network and the rest of rail transport modes. (intermodality).

2.3.19 Linz Central Rail Station

The central station of Linz is located very close to the city centre. The station is the most important hub for the region of Linz and the surrounding area. Linz is situated between Vienna and Salzburg on the western track. The station is also the junction where the southern and northern tracks meet, leading to Italy, Slovenia as well as to the Czech Republic. The terminal serves interurban and international trains (Westbahn, Pyhrnbahn and Summerauerbahn), urban and regional buses as well as tramways. With approximately 30,000 passengers per day the central station of Linz is one of the most important train stations of Austria.

Enhancing interconnections between the national and international railway network and local public transport. (intermodality).

2.3.20 Helsingborg Ferry and Rail Connections

With more than 11 million annual passengers the port of Helsingborg is one of the busiest ferry ports in the world. In the 1980s a decision was made to create a central terminal for all modes of public transportation in Helsingborg to be located right at the port. This terminal is located right at the port facilitating direct and rapid interchanges between the ferries and all other modes of public transport, mostly rail and bus.

Optimising interconnection between ferry and rail transport modes. (intermodality).

2.3.21 Lisbon Ferry and Rail Connections

The intermodal connections in the case of Lisbon have various dimensions: a) ferry services form a vital part of the local public transport network (short-to-short distance interconnection) and this can either be unimodal within the ferry network or intermodal between the ferry, bus and metro network.; b) ferry services traditionally bridged a gap between long-distance rail services; and c) ferry services today interconnect with long-distance rail travel at the train stations. Lisbon is located on the River Tagus and, despite the construction of the bridge Ponte 25 de Abril which links the two sides and carries both rail and road traffic, the ferry network has continued to play a vital part in Lisbonós public transport network.

Optimising interconnection between ferry and rail transport modes. (intermodality).

2.3.22 "Haller Willem" Regional Feeder Rail Line

"Haller Willem is a revitalised regional rail line with modernisation of tracks and railway stations, improving intermodality by bringing bus and train stations together, offering corresponding train and bus connections with matching timetables and tickets, and providing Park and Ride and Bike and Ride facilities. The line connects the region to the major stations of Bielefeld and Osnabrück with access to the national and international rail network as well as the international airport of Münster Osnabrück.

Haller Willem encourages rail travel in general, but also provides rail access to the local airport (intermodality)

2.3.23 Avenida de América Bus and Metro Interchange Station in Madrid

The Avenida de América interchange station allows passengers changing from long-distance coach and regional bus systems to local bus and metro networks in Madrid. The station opened in the year 2000 and represented an investment of 25,4Mú. In 2010 there were 45 million users per year (150.000 users on an average labour day), but the interchange station has a capacity to manage a volume of up to 120 million passengers per year.

At Avenida de América station converge 19 long distance bus lines to different destinations in Spain, 14 regional bus lines to different destinations in the Madrid and Guadalajara provinces (Henares Corridor), 11 urban bus lines, 4 metro lines (4,6,7 & 9), and 7 night bus lines. There are also shuttle services to Barajas airport and taxis. The station is located in the centre of the city, in one of its main access routes from the North-East, the motorway A-2, and the Madridós ring road M-30. A 480 m long access tunnel serves the interchange providing buses with direct entry and exit from these motorways, which can save them as much as 15 minutes in rush hours due to congestion.

The interchange was built underground, in order to create an extensive pedestrian area at street level. The only elements above ground are a domed access pavilion to the interchange and some windows designed to provide the interchange with natural daylight. The building has four underground floors. In the -1 level, the main concourse leads off to all other levels, the shopping area and the long distance coach station, with 18 bays; at the -2 level are located the urban and metropolitan bus stations, with 19 bays and connections to the bus entry and exit tunnels; at the Level -3, there is the access concourse to Metro, shopping area and public car park for 269 short-stay vehicles; at the level -4, there is a local residents long-term park with 396 spaces.

The creation of this multimodal interchange was a joint initiative of the Regional Transport Consortium of Madrid and the City of Madrid. The development of the interchange was privately financed, following an invitation to tenders for the construction and the operation (25 years for the interchange, and 50 years for the parking). The sources of revenue for the concession include the operation of the interchange (buses pay a fee to use the interchange), the parking facilities, the commercial areas and publicity.

Improving the interconnection between long distance transport networks and local/regional transport networks of all modes, reducing total travel time, increasing efficiency of individual trips, but also of the system as a whole. (intermodality).

2.3.24 Layout of Multimodal Transfer Points

Multimodal transfer points are complex transport nodes which also have an important function as meeting point and Aufenthaltsort with versatile requirements. In this research project the components of these transfer points have been rearranged with special focus on the user needs resulting in recommendations for their planning and construction

Improving the quality of transfer points pushes forward the acceptance of intermodal travelling. (intermodality).

2.3.25 Metro and Buses to the Port of Piraeus

Piraeus is the ancient port of Athens and still functions as the chief exit point from the city by sea for a wide range of national and international destinations. Piraeus occupies a huge territory and it may take 30 minutes of walking to reach one end of the port from the other. Since privatisation passenger facilities have improved greatly: air conditioned tents have been set up at departure locations around the port and free wi-fi internet access is now available.

Most travellers arriving in Piraeus from Athens make use of the very convenient metro. Line 1 terminates at the Port, from there it's a short walk to the Saronic Gulf ferries, hydrofoils and catamarans, or a free shuttle-bus ride to the ships sailing to Crete and the Dodecanses. Central Cyclades ferries conveniently sail from just across the metro station. Direct Airport Express buses run 24 hours between the port of Piraeus and Athens International Airport. Other public buses connect Piraeus with its outlying suburbs, the southern coastal zone and with central Athens.

The existence of metro and bus services provides a range of multimodal travel options (intermodality).

2.3.26 Prague Main Railway Station

The Prague Main Railway Station is rare example where functionality combines with design creating pleasant atmosphere for travellers switching at the station.

The positive impression is result of Art Nouveau structure which houses a lofty dome, stained glass windows and carved faces of women representing Prague as the "Mother of Cities". The functionality is provided by different facilities split over several levels. Facilities include 24 hour luggage storage, both over the counter and in large lockers, shops, fast food outlets, bureaux de change, ATM and information services.

Praha Hlavni Nadrazi also has a metro station, Hlavni Nadrazi (line C) and several public bus lines are operating from the stops next to the station entrance.

Making interchange more pleasant experience (inter and co-modality).

2.3.27 Railway Connection between the Airport and the City of Kracow

The John Paul II International Airport Krakow-Balice is situated in the west side of the town near the small town of Balice 11 km from Krakow city centre. The airport was opened for civil aviation in 1964 and since then it was dynamically developed into an international airport. In 2001 thanks to expansion of the Krakow-Balice Airport Terminal abilities of the airport have increased. After the completion of the new terminal in 2005, the Balice Airport is able to service over 3.5 million passengers. The airport is accessible by public transport:

- train ï about 18 minutes by "Balice Express" that leaves every 30 min,
- bus ï the bus runs every half hour from the main railway station in Krakow,

Quick travel between the International Terminal T1, the Domestic Terminal T2 and the railway station is possible using the airport shuttle bus, free of charge.

Running direct train and bus connections from the airport to the city centre and the main railway station (intermodality / co-modality).

2.3.28 Edinburgh Bus Station

The Edinburgh bus station/bus interchange facility is located in the city centre for local bus services to the towns surrounding Edinburgh, and longer-distance coach services. It also serves as an interchange between these bus services and the city bus services of Lothian Buses that stop just outside of the station in the surrounding streets. Facilities provided within the bus station include: toilets, left luggage lockers, ticket desks, ATM machine and vending machines. The waiting areas are heated and air-conditioned and separated from the buses by automatic doors. A newsagent and coffee shop are also located within the bus station. The bus station is covered by CCTV and has on site security in attendance. Scheduled bus service information is displayed on screens at the entrances, the central ticket hall and at the departure gates. Touch screen kiosks connect to journey planners, bus and train operators, Edinburgh airport and other useful web sites. Timetables for the major operators that serve the bus station, including Lothian Buses, are available on the passenger concourse. Information on all services using the bus station is available from the ticket desks.
The bus station is located within 600m of the main concourse of Edinburghõs main rail station.

A comfortable and user friendly interchange, the availability of a journey planner in the station and the proximity between bus and rail station all encourage intermodal travel (intermodality). The quality of the waiting facilities also makes bus or coach travel more user friendly (co-modality).

2.3.29 Coach Parking in Southport

Southport opened its first designated coach park in 1994 and the extension of the ôPark & Rideö facility and the Southport Eco Visitor Centre was completed in 2004. Together with incentives offered to group organisers, Southportõs travel trade offer is one of the most comprehensive and attractive in the UK. Some of the key features are:

- Coach park situated within easy walking distance of the town centre and on the same site as the Eco Visitor Centre and Park & Ride facility. Parking is only £4.00 for 24 hours, with only one price increase in fourteen years;
- Parking for approximately 65 coaches;
- Secure coach park with CCTV and illuminated at night;
- One of only a few coach parks awarded ôPark Markö status by reaching standards agreed by ACPOS and the British Parking Association;
- Drivers rest room, including lounge, kitchen and shower facilities;
- Four designated coach ôset downö points situated at key points in the town centre;
- Coach driverõs passport scheme encouraging drivers to collect stickers each time they park, then redeem them for high street shopping vouchers;

- Team of four Coach Hosts who provide a free ómeet & greetô service from Easter until the end of October, handing out booklets of discount vouchers to each passenger, along with useful advice on what to do and where to go during their visit;
- Familiarisation visits organised for Coach Operators/Group Organisers, showcasing Southport as an ideal ógroup friendlyô destination;
- Free coach parking for most events and free entry for the driver.

This resulted in a record growth of coach tourism visits, including during the low tourist season, i.e. from no single coach having visited the city in January and February 1995, to more than 300 coaches in 2008.

The central parking and set-down locations and the care for the tourist coach drivers attracts coach operators, and encourages offers for environment friendly group travel (co-modality).

2.4 NEW TRANSPORT LINKS: MEGAPROJECTS

2.4.1 Introduction

The next solutions have been selected as examples of initiatives aimed at addressing missing links. Only examples relevant at a European scale are included. Consequently, most of the solutions discussed in this chapter fall in the category of the so called megaprojects: tunnels or bridges overcoming major natural obstacles like large mountain ranges or ocean narrows. These very unique and particular projects are usually worth over ú5 billion:

- Øresund Bridge;
- Great Belt in Denmark;
- English Channel Tunnel;
- Saint Gotthard Base Tunnel;
- Brenner Base Tunnel;
- Fehmarn Belt;
- Transalpine Tunnel Lyon;
- Pyrenees Central base tunnel;
- Tunnel under Gibraltar Strait;
- Gedser-Rostock Fixed Link.

2.4.2 Øresund Bridge

The Øresund Bridge is a combined twin-track railway and dual carriageway bridge-tunnel across the Øresund strait. The bridge connects Sweden and Denmark, and it is the longest road and rail bridge in Europe. The Øresund Bridge also connects two major Metropolitan Areas: those of the Danish capital city of Copenhagen and the major Swedish city of Malmö. Furthermore, the Øresund Bridge connects the road network of Scandinavia with those of Central and Western Europe. The construction of the Øresund Bridge began in 1995, and was finished 14 August 1999. The cost for the entire Øresund Connection construction, including motorway and railway connections on land, was calculated at DKK 30.1 billion (~US$5.7bn) according to the 2000 year price index, with the cost of the bridge paid back by 2035.

The opening of the Øresund Bridge in 2000 has led to a dramatic increase in traffic across Øresund as a whole. In the 1990s, between two and three million vehicles were crossed the Øresund waterway. By 2009, the figure had risen to 9.3 million with a total of 35.6 million travellers crossing Øresund by car, coach, train or ferry per annum.

Reducing travel time overcoming important natural barriers, diminishing the changes between transport modes required and offering two alternative transport options (co-modality).

2.4.3 Great Belt in Denmark

The Great Belt Fixed Link (Danish: *Storebæltsforbindelsen*) is the fixed link between the Danish islands of Zealand (Copenhagen location) and Funen across the Great Belt. It consists of a road suspension bridge and railway tunnel between Zealand and the island Sprogø, as well as a box girder bridge between Sprogø and Funen. The link replaces the ferry service which had been the primary means of crossing the Great Belt.

The fixed link across Storebælt is 18 km long . Construction work on Storebælt took place from 1988-1998. The motorway across Storebælt opened in 1998 and the railway opened in 1997. The construction costs for the entire Storebælt project totalled DKK 21.4 billion in 1988 prices. The costs were more or less equally apportioned between the road and rail link.

Reducing travel time overcoming important natural barriers, diminishing the changes between transport modes required and offering two alternative transport options (co-modality).

2.4.4 English Channel Tunnel

The Channel Tunnel is a 50.5-kilometre undersea rail tunnel linking Folkestone, Kent in England with Coquelles, Pas-de-Calais near Calais in northern France beneath the English Channel at the Strait of Dover. The section under the sea is 38km long. The three tunnels, each 50km long, were bored at an average 40m below the sea bed. Eurotunnel shuttles, Eurostar and national freight trains run in the two single track and single direction tunnels. These are connected to a central service tunnel by cross-passages situated every 375m. The service tunnel allows access to maintenance and emergency rescue teams and serves as a safe haven if passengers need to be evacuated in an incident. Tunnelling commenced in 1988, and the tunnel began operating in 1994. In 1985 prices, the total construction cost was £4.650 billion (equivalent to ú12 billion today), an 80% cost overrun. At the peak of construction 15,000 people were employed with daily expenditure over £3 million. Groupe Eurotunnel S.A. manages and operates the Channel Tunnel between Great Britain and France. The Company operates the car shuttle services and earns revenue on other trains (freight by DB Schenker (formerly EWS) and SNCF and passenger service by Eurostar) passing through the tunnel.

Reducing travel time overcoming important natural barriers, diminishing the changes between transport modes required as an alternative to ferry travel; the car shuttle also provides travellers with a choice between combined car and rail use or rail use only (co-modality).

2.4.5 Saint Gotthard Base Tunnel

AlpTransit Gotthard is creating a flat rail link for future travel through the Alps. At the heart of the new transalpine rail route is a tunnel, which should become operational at the end of 2016. Future rail services will be improved not only by the superior railway network but also through new rolling stock. The main passenger axis will be between the centres of Zürich and Milan. The shorter travel times will benefit approximately 20 million people living in the immediate catchments area of the new line through the Gotthard.

Nowadays, 150 freight trains cross the Gotthard today. Construction of the AlpTransit Gotthard will increase this capacity to more than 200 trains per day and also allow longer trains. Compared with the present, these will just about double the amount of freight which can be transported to around 40 million tonnes per year.

What makes the Gotthard tunnel stand out from the many other rail tunnels is that with 57 km length it is the world´s longest tunnel.

Reducing travel time overcoming important natural barriers; filling in missing links is also applicable in other modes of transport (co-modality).

2.4.6 Brenner Base Tunnel

The Brenner Base Tunnel is a planned 55-kilometre long railway tunnel through the base of the Brenner massif. It will run from Innsbruck Hauptbahnhof in Austria to Franzensfeste (Fortezza) in Italy, replacing part of the current Brenner railway. The line is part of Line 1, the Berlin to Palermo route, of Trans-European Transport Networks (TEN-T). It is predicted that 320 freight trains as well as 80 passenger trains will traverse the tunnel daily after its completion. The travel time from Innsbruck to Bolzano will be reduced from 2 hours to 50 minutes.

The shift of heavy freight traffic from road to rail is particularly important here. This requires policy changes and the introduction of a uniform toll policy in the traffic corridor from Munich to Verona and over the Alpine arc. An efficient new railway with the Brenner base tunnel and its access routes will allow a shift from road to rail of heavy freight traffic. Besides the new railway, however, freight handling terminals along the line will also be needed.

Reducing travel time overcoming important natural barriers (co-modality).

2.4.7 Fehmarn Belt

The Fehmarn Belt Fixed Link (Danish language: Femern Bælt-forbindelsen, German language: Fehmarnbelt-Querung) is an immersed tunnel (in earlier design iterations a bridge) that is proposed to connect the German offshore island of Fehmarn with the Danish island of Lolland. This would cross over the Fehmarn Belt in the Baltic Sea ï 18 km wide ï hence providing a direct link by railroad and highway between northern Germany and the Danish island of Lolland, and thence to Zealand. This route is known in German as the Vogelfluglinie and in Danish as the Fugleflugtslinjen.

The fixed link will considerably reduce the travel time between Scandinavia and continental Europe: Whilst the current ferry transit takes 45 minutes (plus waiting time), train passengers will require only 7 minutes, car drivers no more than 10. The duration of a train journey between Hamburg and Copenhagen will be cut short from about 4.5 to merely 3 hours. According to current plans there will be one passenger train and two freight trains in each direction per hour.

The construction estimate from November 2010 shows that a cable-stayed bridge will cost 5.2 billion EUR, an immersed tunnel will cost 5.1 billion EUR (2008 prices).

Reducing travel time overcoming important natural barriers, diminishing the changes between transport modes required and offering two alternative transport options (co-modality).

2.4.8 Transalpine Tunnel Lyon – Turin

The Lyon ï Turin transalpine is a key element in the European transport network. What makes it stand out from other rail tunnels is that it is the missing rail link which will bring 5,000 km of existing lines into a network linking 250 million Europeans. The programme is essential for the economic and cultural growth of the regions of southern Europe and for the improvement of traffic conditions in the south European arc which consists or regions with a great potential for development from the Iberian Peninsula to east-central Europe via the Po Valley.

The Lyon ï Turin transalpine link is a new freight link, respectful of the environment and complementary to other modes of transport, allowing the transport of at least 40 millions tons of freight per year (more than 2 million lorries). It is also a new passenger link allowing 7 million passengers per year to save two hours on their journey compared to today.

Reducing travel time overcoming important natural barriers; the filling of missing links is applicable also to other modes of transport (co-modality).

2.4.9 Pyrenees Central Base Tunnel

Originally, to develop a freight rail link between the priorities southwest of Europe and the rest of the continent, on the axis Sines / Algeciras-Madrid-Paris. Today it is about a railway line with mixed traffic (freight / passenger). This infrastructure should help meet the growing needs of trade within Europe. The passenger and freight rail line will have a mixed traffic in high capacity will increase by nine tunnels, including one called Central Crossing the Pyrenees which will have the following characteristics: a length of over 41 kilometres.

Reducing travel time overcoming important natural barriers (co-modality).

2.4.10 Tunnel under Gibraltar Strait

The Strait of Gibraltar is a narrow strait that connects the Atlantic Ocean to the Mediterranean Sea and separates Spain in Europe from Morocco in Africa. Europe and Africa are separated by 7.7 nmi (14.3 km; 8.9 mi) of ocean at the strait's narrowest point. Ferries cross between the two continents every day in as little as 35 minutes.

In December 2003, Spain and Morocco agreed to explore the construction of an undersea rail tunnel to connect their rail systems. The tunnel would have linked Cape Malabata near Tangier with Punta Paloma 40 km west of Gibraltar. The project would be financed by two publicly-owned companies, SECEGSA Spain and SNED in Morocco, with the assistance of the European Union.

It is projected to carry 9 million passengers in its first year of operation, expected to be 2025. No official figures about the cost of the project had been announced by 2007, but previous estimates were at least five billion Euros.

Reducing travel time overcoming important natural barriers, diminishing the changes between transport modes required (co-modality).

2.4.11 Gedser-Rostock Fixed Link

The Gedser-Rostock Bridge is a proposed project to link the Danish island of Falster with the German city of Rostock, stretching 40-45 kilometres across the Baltic Sea. The proposal is an alternative to the Fehmarn Belt Fixed Link. The bridge (or tunnel) would complete the European route E55 and be the main link between Scandinavia and Berlin. Today, Gedser and Rostock are linked by the Scandlines ferries. If built as a bridge, it would be the longest bridge in the world over a body of water. If built as a tunnel, it would still be the longest underwater tunnel in the world, but measured by total tunnel length the Seikan Tunnel and the Channel Tunnel are longer. It would also be the only bridge across open sea and not a named strait, belt, sound or channel. Although the distance is twice as long as across the Fehmarn Belt, the bridge could be built in part as a low bridge since water depths are shallower than in the Fehmarn Belt. The Gedser Reef offers depths of less than 10 metres for some 15 km to the southeast of Gedser.

Reducing travel time overcoming important natural barriers, diminishing the changes between transport modes required and offering two alternative transport options (co-modality).

2.5 Dual Mode Solutions

2.5.1 Introduction

The next solutions have been selected as examples of initiatives aimed at designing hybrid vehicles that can use the classic infrastructure of different transport modes without requiring travellers to tranship from one mode to another. These solutions are typically cars and buses able to run on train tracks, tramways able to run on railways and trains able to run on tramway networks, or even trains able to use ferries:

- Long Distance Car Transport on Board of Trains;

- Puttgarden - Rodby Train Ferry;
- Train Ferries in Italy;
- Train Ferries in China ï Yuehai Railway;
- The Karlsruhe Tram Train (Karlsruhe Model);
- The Toyota Bus-Train.

2.5.2 Long Distance Car Transport on Board of Trains

The concept of trains carrying both passengers and there cars was developed in the 1940s, but the first one was actually brought into service in 1956 between Hamburg and Chiasso, and that could carry 930 cars at a time. The peak was reached in the early 1970s, when there were up to 163 connections served. Since then the number of offers has strongly declined, and many countries have totally stopped that service again.

Currently in Europe there are for long-distance travel 18 rail stations in France where cars can be loaded onto trains, 14 in Italy, 8 in Austria, 7 in Germany and 3 in Finland, as well as the Eurotunnel and a number of tunnels in the Alps for crossing short distances.

Carrying the car on the train offers the best of both worlds: on the long-distance leg, the environmental as well as comfort advantages of rail travel are being used, while the car is still available for the first and last leg of the journey, where rail travel would often not be an option at all (co-modality).

2.5.3 Puttgarden - Rodby Train Ferry

A train ferry is a ship designed to carry railway vehicles. Typically, one level of the ship is fitted with railway tracks, and the vessel has a door at the front and/or rear to give access to the wharves. A train ferry terminal was built in Puttgarden in 1961 after the old ferry from Germany lay to Denmark between Rostock and Gedser beyond the iron curtain in East Germany. This solution improves the interconnections of tri-modal rail-sea-rail trips from Germany to Denmark.

Optimising interconnection between ferry and rail transport modes (intermodality).

2.5.4 Train Ferries in Italy

Italian Railways operate train ferries to the islands of Sicily and Sardinia (the later only for freight), although the Sardinian service did not begin until 1961. Railways came to Sicily in 1860, the same year that the island joined the kingdom of Italy. As early as 1872, there were serious plans to connect Sicily to the mainland via a bridge or tunnel, but only now in the 21st Century do such ideas look like being realised, with the completion of a bridge to Messina originally being planned for 2008. Construction never started, for various reasons, and a new government in 2007 cancelled the project, despite huge investment already.

Optimising interconnection between ferry and rail transport modes. (intermodality).

2.5.5 Train Ferries in China – Yuehai Railway

Yuehai Railway, Chinaø first-ever maritime rail service was launched in January 2003, carrying both freight and passenger trains and enabling direct train services between the mainland and Hainan Island. The line linking Hainan and Guangdong province has a total length of 345 kilometres and comprises the 139 kilometre stretch of track running from Zhanjiang to Hai-an, the 24 kilometre ferry crossing of the Qiongzhou Strait, and the 182 kilometre west ring service along the west coast from Haikou to Sanya, Hainan province. There are currently 3 train ferries in operation with a frequency of 9 services per day in each direction. In terms of capacity, the ferries were built for an average standard load of 4,200 tons, which translates to about a 40-carriage train fully loaded with freight or an 18-carriage train with more than 1,300 passengers.

The Yuehai railway plays a significant role in Hainanǿs economic development. In the first half of 2010, total traffic flow crossing the Qiongzhou Strait reached 694,000 vehicles, with 185,000 (26.7%) carried by train ferry services. In terms of passenger transportation, more than 1,558,000 passengers used Yuehai railway for getting in and out of Hainan Island, which represents about 39.3% of total passenger flow crossing the Qiongzhou Strait.

Optimising interconnection between ferry and rail transport modes. (intermodality).

2.5.6 The Karlsruhe TramTrain (Karlsruhe Model)

The Karlsruhe model reflects urban and heavy rail trains running on the same tracks. It was initially developed and implemented in the city of Karlsruhe, Germany by the local transit authority, Karlsruher Verkehrsverbund. It provides a connection between the regular railway network and the city's network for its trams. The whole network is now called Stadtbahn Karlsruhe. Passengers may travel from distant towns such as Baden-Baden directly into the city centre of Karlsruhe, bridging the inconvenient distance between the main station and the city centre. For most trips, the number of train changes has reduced significantly. The model has led to the creation of similar tramtrains.

The core of the model is that instead of the passengers changing vehicles, a bimodal vehicle changes between the modes at the system borders from classic rural railway lines to the urban tramway system.

2.5.7 The Toyota Bus-Train

A dual mode road/rail vehicle is being tested in Japan by Toyota and its truck-manufacturing division Hino Motors. The bus bridges the gap between road and rail with 4 rubber tires for road use and 4 steel wheels for riding on rails. It can hold 25 passengers and is based on the Toyota Microbus. The bus has been in service in Japan for the past 18 months. Dual-mode vehicles have four rubber tires for road use and four steel wheels for the rails, and it takes less than 15 seconds to go from road to rail and back again. It drives just like a bus on the road, and a hydraulic system raises the tires and lowers the steel wheels as the driver guides the vehicle onto the tracks.

Optimising interconnections between bus and rail transport (inter-modality).

2.6 ENHANCED VEHICLE PERFORMANCE

2.6.1 Introduction

The next solutions have been selected as examples of initiatives aimed enhancing the performance of vehicles, i.e. for instance by increasing their speed or making them more reliable:

- Japan Maglev Train between Tokyo and Osaka;
- High Speed Rail Network in Spain;
- Vertiports;
- Water-Trams in the Tri-City;
- Gothenburg-Kiel Ferry;
- Automated Metro;
- High Speed Rail (HSR) in Europe;
- SIM TD - Safe and Intelligent Mobility Test Field;
- SARTRE project: automated road trains.

2.6.2 Japan Maglev Train between Tokyo and Osaka

The world's fastest trains, maglev trains travel without touching the ground. Instead, they run levitated above their guide way by using repulsive and attractive electromagnetic forces between superconducting magnets on board the vehicle and coils on the ground.

Running at 505 kilometres (313 miles) per hour, the maglev trains will cover the distance between Tokyo and Nagoya in about 40 minutes. When the line is completed, maglev trains will travel the 514 km (320 mile) distance between Tokyo and Osaka in 67 minutes.

The maglev trains are expected to start carrying passengers between Tokyo and Nagoya in 2027 and between Tokyo and Osaka in 2045. Project budget is 9 trillion yen

Increasing rail speed (co-modality).

2.6.3 High Speed Rail Network in Spain

The High Speed Railway network in Spain currently consists of four dedicated passenger train main lines. Unlike the rest of the Spanish broad-gauge network, the AVE uses standard gauge, permitting direct connections outside Spain in the future. All AVE trains are currently operated by RENFE, the Spanish state railway company. Some TGV-derived trains do run on the broad-gauge network at slower speeds, and these are branded separately as Euromed.

The first line to open was the Madrid-Seville High Speed Rail line, followed by the Madrid-Valladolid High Speed Rail line, the Cordoba-Málaga high speed rail line and the Madrid-Barcelona high speed rail line. In December of 2010, the Madrid ï Valencia was inaugurated. The network is to be greatly expanded during the next decade with most of the Spanish peninsula being connected.

Madrid-Seville High Speed Railway line, with a length of 472 km, links two cities in 2 hours and 20 minutes. In 2009, it transported around 3 millions of passengers.

The Madridï Zaragozaï Barcelona line was inaugurated on 20 February 2008, after parts of the line had operated since 2003 (Madridï Zaragozaï Lleida) and 2006 (Lleidaï Tarragona). Non-stop trains covering the 621 km (386 mi) between the two cities in just 2 hours 38 minutes. In 2009, it transported 2.6 millions of passenger and it represented a 50% shared market.

Infrastructures for transport Master Plan (PEIT) expected will build 10000km of HSL in 2020. The 90% of population will live within 50km of HST station. And all province capitals will have a HST station and will link with Madrid in 4 hours or less.

Improving population accessibility to high speed railway network; increasing the speed to make them more attractive is also possible in other modes (co-modality).

2.6.4 Vertiports

Vertiports are airports for VTOL (Vertical take of and landing) aircrafts. This classification includes fixed-wing aircraft that can hover, take off and land vertically as well as helicopters and other aircraft with powered rotors, such as tiltrotors. Besides the ubiquitous helicopter, there are currently two types of VTOL aircraft in military service: craft using a tiltrotor, such as the Bell Boeing V-22 Osprey, and aircraft using directed jet thrust such as the Harrier family. A CarterCopter Heliplane Transport (CCH-T) carrying 120 passengers is outbound for another vertiport located in a city 400 miles distant. In less than one-hour it will have arrived and unloaded all passengers. After less than 30 minutes total time on the ground, it will quietly depart for yet another vertiport. With only six commercial gates and a maximum of 288 flights, over 50,000 people can move though each of these small transportation hubs in a 24-hour period with smooth, quiet efficiency. The concept requires a quiet VTOL aircraft able to haul 120 passengers plus cargo at low cost for 2,000 miles at speeds up to 450 MPH.

Optimising the combination of Vertiports with other modes of transport such as High Speed Rail or aircraft. (intermodality).

2.6.5 Water-Trams in the Tri-City

Water-trams are ferries, but named so in order to distinguish them from other ferries and emphasise their local transport function. The water-trams are an alternative to the road and railway connections between the cities of Gdansk, Sopot and Gdynia and the peninsula of Hel, which is located on the opposite side of the Bay of Gdansk both for local travellers and commuters and for tourists arriving by rail or air. The road link does not have sufficient capacity, while the railway link is not very convenient. Water-trams are operated by Gdynia's and Gdansk's urban transport companies. Additionally in Gdynia a free bus from the city centre to the terminal is offered.

Water-trams, in addition to offering a good alternative way to connect the Tri-City and Hel Peninsula, are also perceived as a very attractive product for tourists and citizens wishing to visit Hel, e.g. for a weekend. Water-tram stops are located in the centers of Gdansk, Sopot and Gdynia.

The water-tram offers an alternative to the existing rail connection to Hel and travellers can choose between the two options depending on personal preference (co-modality).

2.6.6 Gothenburg-Kiel Ferry

The ferry service between Gothenburg and Kiel was inaugurated as a "booze cruise" to allow travellers to take advantage of duty free allowances. With the abolition of intra-EU duty free allowances, this ferry service reinvented itself to attract holiday makers and freight vehicles seeking to move between Sweden and Germany. The route is now operated using two luxury cruise ships, the Stena Germanica and the Stena Scandinavica. Both ships are fitted with many facilities, including bars, restaurants, night club, Shop, Casino, Video Lounge, a children's play area and a lounge. The service operates overnight between the two ports, departing at 1930 and arriving at 0900 in both directions. The unique attraction of the service is the amount and quality of onboard entertainment provided and that, for both car and lorry drivers, it provides a significant break and change of environment in what otherwise would be a long and time-consuming road trip. Although the ferry service itself is not perceived as a cheap alternative, there are packages available which combine with entry to leisure facilities across Europe and these may be perceived as exceptionally good value.

Although there are links into public transport services at both ends of the ferry service, since the primary target market is drivers, it is the link into the road network that is most important (intermodality). The service supplements the main modal alternative of a long-distance car or lorry trip, but rail and air are also options for foot passengers (co-modality).

2.6.7 Automated Metro

To date, over 30 cities in the world have constructed and satisfactorily operate automated light or heavy metro systems, and many more have well-advanced plans to do so. The first experiments in automated metro systems date from the beginning of the nineteen-eighties, and since then they have expanded continuously. Today there are automated lines in cities as diverse as Paris, Copenhagen, Singapore and Vancouver, among others. The automated metro systems include light ones, such as those of Lille and Toulouse in France, and large-capacity or heavy systems such as the Line 14 (or Meteor) in Paris.

The Barcelona Metro is on the road to automation. Metro lines 9 and 10 currently under construction (partly operative already) are examples of automated heavy metro systems, while Line 11 is adapted for driverless operation and is an example of a light system. The medium- or long-term perspective is for 43% of the TMB network (70 kilometres out of 160) to be automated.

The introduction of automated metro systems not only provides more safety, reliability and flexibility to adapt the service supply to the demand of passengers, but it also enables more efficient management of the system as a whole and an increase in the capacity of the networks. An automated metro system can run with high journey frequencies, even at intervals under two minutes, considerable higher than a traditional system. Automation doubles the safety provision as it reduces the chance of human error on the operational side and it incorporates new methods of preventing intrusions onto the tracks on the user side (physical separation between the platforms and the tracks).

The operators in the control centre monitor the trains at all times by remote control. They can see the interior by means of video cameras that transmit in real time, they can send and receive messages to and from passengers by public address and intercom, and they can even perform remote assistance tasks. Constant surveillance of the network status is also carried out from the control centre, so that the service provision can be adapted to any pickup in demand by adding more trains whenever necessary

Automated metro lines perform better than traditional lines when demand is very high and there is a need to maximise service frequencies. It is an example of co-modality in attempting to optimise the functionality of a transport means. (co-modality).

2.6.8 High Speed Rail (HSR) in Europe

The current High Speed Rail (HSR) network stretches from Madrid to London, Hamburg, Vienna and Rome. Apart from the various national operators there are also a number of alliances (e.g. Railteam with seven operators) that aim at facilitating international travel.

HSR makes rail more competitive against car and air travel and makes travel, in particular for single travellers, more sustainable. (co-modality).

2.6.9 SIM ^{TD} - Safe and Intelligent Mobility Test Field

The sim^{TD} research project researches and tests car-to-infrastructure and car-to-car communication and its applications. The project started in September 2008 and will run for four years. Realistic traffic scenarios will be addressed in a large-scale test field infrastructure around the Hessian city of Frankfurt am Main. The project will also pave the way for the political, economic and technological framework to successfully set up car-to-car and car-to-infrastructure networking. The project aims at improving both road safety and traffic efficiency.

With the help of communication technologies, individual vehicles can be connected, and thus the detectable sector around the vehicle can be enlarged. This often allows relieving critical situations by means of an informed and ï in the true sense of the word - foresighted way of driving.

Car-to-infrastructure communication individualises traffic monitoring and traffic control by utilising individual vehicles for data acquisition. At the same time providing individual information and suggesting routes for each vehicle ï based on its destination and the specific traffic situation.

Making road transport more efficient and safer. Principle of improving communication between vehicles and infrastructure as well as directly between vehicles can be transferred to other modes. (co-modality).

2.6.10 SARTRE Project: Automated Road Trains

The SARTRE project envisions a future with intelligent transport networks traversed by so-called ñroad trainsò six to eight driverless cars guided along by a lead truck of some sort. Motorists could automatically become a part of such a train by driving to the right place and then letting go of the steering wheel; to leave the train, they would retake the wheel and resume driving the old-fashioned way. Such ñassisted convoysò would not only free motorists from the hassle of actually having to drive for parts of trips, but could improve highway safety and reduce fuel consumption, experts involved in the project say. By falling into formation behind one another, a group of travellers can reduce the amount of energy each individual would otherwise have to expend alone to cover the same distance. Translating that concept onto ñroad trainsò could cut gas consumption by some 20 %, according to SARTRE. All what the project requires are navigation systems that communicate with the lead vehicle and control acceleration and steering. The projectôs lead agencies estimate that vehicles will begin testing in 2011 and say a full-scale rollout is likely within a decade. Sartre is led by Ricardo UK Ltd and comprimises a collaboration between the following additional participating companies: Idiada and Robotiker-Tecnalia of Spain, Institut for Kraftfahrwesen Aachen (IKA) of Germany, SP Technical Research Institute of Sweden, Volvo Car Corporation and Volvo Technology of Sweden.

Improving traffic flows, making faster journey times and increasing safety in road network. (co-modality).

2.7 TRAFFIC MANAGEMENT

2.7.1 Introduction

The next solutions have been selected as examples of initiatives aimed better managing traffic flows, either road, rail, air or ferry:

- Variable Road Charging in the Netherlands;
- Eurovignette;
- Distance-Based Lorry Taxes in France, Poland and Spain;
- Congestion Charges in London;
- Congestion Charges in Stockholm;
- Navigation Systems to Optimise Road Transport;
- Dynamic Speed Limits in French Motorways to Enhance Traffic Flow;
- European Railway Traffic Management System (ERTMS);
- ITS for Smarter Railways;
- Rail Interoperability on the Iberian Peninsula;
- FRAM Free Route Airspace Maastricht;
- European Airport Movement Management by A-SMGCS (EMMA);
- Singapore Electronic Road Pricing / Urban Traffic Management;
- Congestion Free Hessenòand Hard Shoulder Running on Motorways;
- HOT- HOV Lanes (Managed lanes in Texas and Utah);
- Coordinated Ramp Metering in Australia;
- NextGen - The Next Generation Air Transportation System;
- Primeline Coventry;
- Reversible BUS Lane in Madrid.

2.7.2 Variable Road Charging in the Netherlands

The scheme will use satellite technology to track every vehicle in the country and charge them per-mile-driven according to a flexible rate schedule. Initially the program will cover just commercial trucks, expanding over time to all vehicles by 2018.

According to the government proposal, the road pricing will be ñdifferentiated by time, place and environmental characteristics while proportionally eliminating fixed charges.ò Itõs worth unpacking this a bit: Fees will vary according to time and location, so that the program can specifically target congested areas. This is similar to the congestion pricing scheme that has been successful in London, on a much larger scale. A similar scheme was recently rejected in New York City, and is now under consideration in San Francisco; Fees will vary according to the fuel efficiency of the vehicle, to encourage drivers to switch to cars with a lighter footprint; the entire program will be revenue neutral. As the program ramps up, the Netherlands will phase out its stiff motor vehicle tax. Such a system is inherently fairer: people who drive infrequently will actually pay less under the new system. Heavy drivers will pay more.

Optimising traffic fluency, reducing congestion, and diminishing pollution with management systems using variable charges during the day (co-modality).

2.7.3 Eurovignette

In September 2011, the Eurovignette directive was adopted (PE-CONS 24/11 + statements in 13134/11 ADD 1). Member states will have two years following the publication of the directive in the EU's Official Journal to transpose it into their national legislation. The new European framework law, which is a revision of the "Eurovignette" directive of 1999, aims at reducing pollution from road freight transport and making traffic flow smoother by levying tolls that factor in the cost of air and noise pollution due to traffic (so called external costs) and help avoid road congestion. To this end, member states may apply an "external cost charge" on trucks, complementing the already existing infrastructure charge designed to recover the costs of construction, operation, maintenance and development of road infrastructure. They may also modulate the infrastructure charge to take account of road congestion, with a maximum variation rate of 175 % during peak periods limited to five hours per day. The level of tolls will vary depending on the emissions of the vehicle, the distance travelled, and the location and the time of road use. Such differentiated charging is intended to encourage the move to transport patterns which are more respectful of the environment. Whereas under the current directive application of tolls has basically been limited to the trans-European road network, it may now be extended to cover all motorways.

Optimising traffic fluency, improving the capacity of management of the network and internalising costs (co-modality).

2.7.4 Distance-Based Lorry Taxes in France, Poland and Spain

The French government has confirmed it will introduce a distance-based tax on lorries at the beginning of 2013. The confirmation follows a legal challenge to the government's decision to award the contract for collecting the tolls to an Italian company. The tax will apply to all lorries using national roads and some local roads.

Poland also introduced a distance-based lorry charge on parts of its national road network earlier this month. The system requires all vehicles over 3.5 tonnes using a network of 1,560 kilometres of national roads, express roads and motorways to be equipped with a tracking device. Some 350,000 on-board units have been distributed. The level of the toll varies according to vehicle weight and emissions class.

Spain is also developing a plan to introduce a distance-based charge for lorries, to come into effect by 2016 for all heavy vehicles. T&E says the move indicates that the need for stricter economic measures is driving a new wave of environmentally beneficial policies. The news comes as the European Parliament's transport committee reached agreement on a revision of the Eurovignette directive that will allow EU member states to charge for air and noise pollution in road tolls.

Increasing the ability of traffic managing through pricing, using on-vehicle devices (co-modality). This initiative can be transferred to passenger road transport, multiplying the possibilities of road flow management through pricing (different fees depending on the type of road, type of vehicle, trip length or time of the day).

2.7.5 Congestion Charges in London

A charge is levied for entering the central London area by car between 7:00 and 18:00 Mondays to Fridays. The standard charge is £ 10 per day, decreased to £ 9 for subscribers to automated payment, and increased to £ 12, if only paid on the following day. Payment is possible online, by SMS, by phone, by automated phone service, at a shop and by post.

Congestion Charging was introduced into central London in February 2003. In July 2005 the basic charge was raised from £5 to £8 per day. In February 2007 the original central London congestion charging zone was extended westwards, creating a single enlarged congestion charging zone.

Traffic patterns in and around the charging zone even before the crisis was about 21 % lower than in 2002 (prior to implementation), creating opportunities over this period for re-use of a proportion of the road space made available. The scheme generated net revenues of £123 million in 2006/2007, being spent on transport improvements across London, in particular on improved bus services. Public transport successfully accommodates displaced car users, bus services continuing to benefit from the reduced congestion and ongoing investment of scheme revenues.

A cost-benefit analysis of the central London scheme suggests that the identified benefits exceeded the costs of operating the scheme by a ratio of around 1.5 with an £ 5 charge, and by a ratio of 1.7 with an £ 8 charge.

Charging for car use when alternative more environmentally friendly and efficient modes are available will encourage their use, allowing for improved traffic for those who donʼt have any alternative (co-modality). The experience of congestion charges at local level can be transferred to long distance transport as a traffic managing tool (e.g. charging only during day time may move freight traffic towards night time, allowing for more passenger capacity during day time).

2.7.6 Congestion Charges in Stockholm

Congestion tax is charged for Swedish-registered vehicles that are driven into and out of central Stockholm, Mondays to Fridays between 06.30 and 18.29. The tax is not charged on weekends or public holidays, on a day preceding a public holiday or during the month of July. Some vehicles are exempt from congestion tax. Vehicles are automatically registered at 'control points' during the periods when congestion tax is charged. Each passage into or out of central Stockholm costs SEK 10, 15 or 20, depending on the time of day. The maximum amount per day and vehicle is SEK 60.

Whilst London charges one fee for the entire day, Stockholmʼs daily charges add up every time you enter or leave the charging zone. Rather than installing hundreds of cameras throughout its city centre, Stockholm opted to install cameras at 18 entrance points to the city – a system only possible due to the fact that central Stockholm is essentially an island with just a few possible points of entry.

Stockholmʼs congestion tax resulted initially in 4.5% increase in ridership of public transport, traffic was down by 18%, and waiting time to enter the city centre during peak hours was been reduced by 50%. Carbon emissions dropped by 14-18%, ownership of tax-exempt environmentally sustainable vehicles almost tripled, and retailers saw a 6% increase in business.

However, according to a recent study carried out by the Swedish Transport Administration (Trafikverket) on behalf of the Dagens Nyheter (DN) newspaper, it now takes 60 % longer on average to get to the Swedish capital on the E4 motorway from the south of the city than it did in 2006 initially after implantation of the charges. In the light of this increase in congestion, local authorities are considering an increase of the fee which could even double current levels.

Charging for car use when alternative more environmentally friendly and efficient modes are available will encourage their use, allowing for improved traffic for those who donʼt have any alternative (co-modality). The experience of congestion charges at local level can be transferred to long distance transport as a traffic managing tool.

2.7.7 Navigation Systems to Optimise Road Transport

When drivers used a navigation system to drive through unfamiliar surroundings reduces the number of kilometres driven by 16% and the journey time by 18% compared to the use of conventional navigation methods.

Reducing the number of kilometres driven and the journey time. (co-modality).

2.7.8 Dynamic Speed Limits in French Motorways to Enhance Traffic Flow

Speed Control means the use of Variable Speed Limits (VSL) as a mean to help drivers to travel at an appropriate speed considering the prevailing traffic or weather conditions. For this purpose VSL uses Variable Message Signs (VMS) to display speed limits (advisory or mandatory), that are adapted to the prevailing road and/or traffic conditions. The common main objective of VSL is to support drivers in travelling at a safe speed or to improve traffic fluency. The Rhone Valley motorway network (A7-A9 motorways from Lyon to the Spanish border) operated by ASF is one of the Europeqs busiest interurban route. This motorway corridor is particularly busy during the summer time (summer holliday peaks) and recurring congestions are deeply lowering the level of service. ASF designed and implemented a variable speed limits system in order to increase the corridor capacity, the infrastructure safety and the customerqs satisfaction and driver comfort. Following the very positive results of the 2004 experiment, ASF decided to extend the variable speed limits service to 330 km of the A7/A9 motorway network. Among others, the system introduced reduction from 20 to 30% of accidents, reduction of about 20% of the volume of congestion, and 3 to 5% capacity increase of the corridor.

Increasing safety in road network and optimising traffic fluency (co-modality).

2.7.9 European Railway Traffic Management System (ERTMS)

The European Railway Traffic Management System (ERTMS) is a major industrial project developed by eight UNIFE members - Alstom Transport, Ansaldo STS, AZD Praha, Bombardier Transportation, Invensys Rail, Mermec, Siemens Mobility and Thales - in close cooperation with the European Union, railway stakeholders and the GSM-R industry.

The existence of more than 20 signalling systems in Europe is a major obstacle to international rail transport. Indeed, each country and/or supplier tended to develop its own signalling system in the past, which resulted in a variety of systems in Europe ï and sometimes even in one single country. Needless to say, all these systems were not interoperable. As a unique signalling system for Europe, ERTMS has been designed to be fully interoperable across the EU. This means that any train equipped with ERTMS may run on any line, as long as the trackside equipment is also fitted with ERTMS.

The Vienna-Budapest line is running with ERTMS since 2003. In June 2009, a new ERTMS (Level 2) High Speed Line was opened in Belgium between Liege and the German border, whilst the Thalys is running with ERTMS from Amsterdam (Netherlands) to Antwerp (Belgium).

Improving interoperability, optimising international rail transport; the general principle of increasing the interoperability of systems can also be applied in other transport modes (co-modality).

2.7.10 ITS for Smarter Railways

IBM is working to build smarter railways in some of the most complex transit systems in the world, partnering with Netherlands Railways, the Taiwan High Speed Rail Corporation and Guangzhou Metro in China to improve the commute of millions of travelers every day.Smarter railroads can create competitive advantages in the ecosystem of transportation infrastructure for rail companies. Smarter railroads can reduce the costs of adding new lines and rolling stock even as they increase customer service in a capacity constrained environment. And by taking on more freight and passenger traffic, smarter railroads can reduce congestion and improve safety on highwaysð which will also reduce carbon emissions.

Smarter railways provides a set of intelligent traffic management tools which help to optimize the capacity of railway infrastructure. One major asset of these technology systems is that can be transferable to others transport modes such as road traffic management. (co-modality).

2.7.11 Rail Interoperability on the Iberian Peninsula

The difference in gauges between the rail networks of the Iberian Peninsula and the rest of the European Union remains a major obstacle to the efficient operation of Europe's rail transport system. This project involves the construction of new lines (mostly on high speed) and the installation of dual-gauge sleepers, third rails or axle-gauge changeover stations on the Spanish and Portuguese rail networks in order to make them fully interoperable with the rest of the trans-European rail network. The project was conceived according to Directive 96/48/EC on interoperability, and incorporates the ERTMS. In 2000 a Spanish variable gauge system developed by CAF started to be in commercial exploitation. Trains operated by RENFE implementing those variable gauge systems (S-130 of Talgo and S-120 of CAF) are running in UIC and Iberian gauge networks over the 14 changeover facilities connecting. There are a few international services as well.

Improving interoperability, optimising international rail transport; the general principle of increasing the interoperability of systems can also be applied in other transport modes (co-modality).

2.7.12 FRAM Free Route Airspace Maastricht

Since March 2011, 142 new direct routes are available in the airspace controlled by MUAC (Maastrich Upper Area Control Centre). These new direct routes will substantially contribute to reduced flight and engine running time, fuel consumption, gas emissions and costs in high-density European airspace. This development is the first step in the implementation of the Free Route Airspace Maastricht (FRAM) programme, which aims to put in place a direct route network for 24/7 operations, saving airlines several million kilometres of flight time. The savings expected from the first phase of FRAM deployment during nights and weekends are estimated at 1.16 million km per year, resulting in economies of 3,700 t of kerosene, 12,000 t of CO_2 and 37 t of NO_X when compared to the fixed route network.

Optimising air transport through shorter more direct flights; concept could potentially also be applied for areas with busy shipping activity (co-modality).

2.7.13 European Airport Movement Management by A-SMGCS (EMMA)

The EMMA (European Airport Movement Management by A-SMGCS) project was a project of the 6th Framework program of the European Commission (EC). A-SMGCS stands for Advanced Surface Movement Guidance and Control System. In a two phase approach, the EMMA project first consolidated the surveillance and conflict alert functions, and, in the successor project of the second call, focused on advanced onboard support to pilots and planning support to controllers. The EMMA project (2002-2004), together with the subsequent EMMA2 (2006-2009), aimed to provide the most significant R&D contribution to the Vision 2020 goals in the field of A-SMGCS. This was done by maturing and validating the A-SMGCS concept as an integrated air-ground system, seamlessly embedded in the overall Air Traffic Management system. The main objective of EMMA was to enable the harmonised A-SMGCS implementation at European airports. For this reason, it was important to bring together users, service providers, research organisations and manufacturers. A main extension of the A-SMGCS concept by EMMA was the holistic, integrated air-ground approach, considering aircraft equipped with advanced systems for pilot assistance in a context where tower and apron controllers are supported by A-SMGCS ground systems. A mature technical and operational concept, as developed through EMMA, ensures consistency of traffic information given to controllers and pilots. This is the basis for a common situation awareness and safe ground operations. The associated operational concept defines the roles and tasks of the onboard and ground stakeholders, and the procedures from an overall, holistic point of view. The development of conflict detection and resolution will not only increase safety but also efficiency. Four European test sites have been used, namely Milan-Malpensa, Paris-Charles de Gaulle, Prague-Ruzyne and Toulouse-Blagnac.

Improving safety and efficiency of air transport; the general principle of increasing consistency of information for system operators and system users can also be applied in other transport modes, notably car traffic (co-modality).

2.7.14 Singapore Electronic Road Pricing / Urban Traffic Management

Electronic Road Pricing (ERP) is an electronic system of road pricing based on a pay-as-you-use principle. It is designed to be a fair system as motorists are charged when they use the road during peak hours.

The first road pricing scheme, known as the Area Licensing Scheme (ALS), was introduced in the Restricted Zone (RZ) in 1975. The scheme was subsequently extended to major expressways with the Road Pricing Scheme (RPS). In September 1998, the ERP system replaced the manual system for the RZ and expressways. In September 1999, ERP was extended to some of the key arterial roads beyond the RZ.

Since July 2008 the aim of the charging system was adapted to manage congestion and to maintain a given speed by varying the charges. Currently, the LTA reviews the traffic conditions on the expressways and roads where the ERP system is in operation on a quarterly basis and during the June and December school holidays

After the review, the ERP rates are then adjusted where necessary to minimise congestion on the roads. ERP has been effective in maintaining an optimal speed range of 45 to 65 km/h for expressways and 20 to 30 km/h for arterial roads.

Promotes best use of road space for car, could divert users to other modes with increased charges (co-modality).

2.7.15 Congestion Free Hessen" and Hard Shoulder Running on Motorways

Hard shoulders are normally only to be used for emergency stops, but in several countries they are now also open to general traffic to alleviate traffic problems at peak traffic conditions. In the case of Hessen, they are part of a general programme "Congestion free Hessen 2015" which started in 2003. The whole programme comprises 150 single measures, but the hard shoulder running is the most effective part. Hard shoulder running is in use on the motorways A3 and A5, by 2010 on a total length of 87 km and in the future on 340 km of Hessen's 2000 km of motorways. The system is controlled around the clock by the Hessian traffic control centre with a dense network of detectors and video cameras. Lane control systems control the speed and warn of dangers, and therefore accident numbers have not increased. The entire programme has reduced congestion on Hessian motorways between 2003 and 2011 from 88,000 to 20,000 vehicle hours.

Making optimal use of the existing infrastructure (co-modality).

2.7.16 HOT- HOV Lanes (Managed lanes in Texas and Utah)

In transportation engineering and transportation planning, a high-occupancy vehicle lane (also called a HOV lane or carpool lane) is a lane reserved for vehicles with a driver and one or more passengers. These lanes are also known as carpool lanes, commuter lanes, restricted lanes, diamond lanes, express lanes, and are called transit lanes in Australia and New Zealand

A number of cities are considering converting under-utilized HOV lanes to high-occupancy toll (HOT) lanes, and others intend to build new highway infrastructure. This would permit single-occupant vehicles to buy the right to use the HOV lanes for a toll, but total flow would be regulated (with automatically determined variable pricing based on demand), to ensure total speeds on the HOV lane do not drop noticeably.

In Particular, the Texas DOT in the USA is introducing HOT lanes in some congested motorways in the Dallas / Fort Worth metropolitan area. The NTE and LBJ Express motorways will implement new high occupancy tolled lanes where vehicles will be charged depending on the Existing level of demand, the time of the day, and the occupancy of the vehicle. Tolls will be conceived so that demand always allows meeting a minimum flow speed of 80km/h.

The Utah Department of Transportation is also implementing such a program for traffic along Interstate 15 from Layton in the north to Lehi in the south. The system uses RFID transmitters to monitor entry and exiting of the lane and charges drivers between 25 cents to one dollar, depending on demand. The transmitters can be turned off in the event that the driver has two or more occupants in their vehicle.

Making optimal use of the existing infrastructure (co-modality).

2.7.17 Coordinated Ramp Metering in Australia

Ramp metering systems that limit the flow into the motorway from on-ramps with traffic lights when traffic volumes on the motorway are high and traffic threatens to break down, if the traffic volume is further increased, are implemented in Germany, Italy, the Netherlands and the UK and in many countries worldwide.

However, most of these only meter individual ramps one by one. Australia has widely introduced coordinated ramp metering with the HERO and, for special cases, multi-PI ALINEA algorithms developed by the Technical University of Crete. Co-ordinated ramp metering can control a series of ramps in parallel so as to keep traffic volumes on a whole stretch of motorway down rather than only at local points, while distributing the traffic held back on the ramps so that optimal use is made of the storage capacity of all ramps together.

Optimising the distribution of flow in a network to minimise congestion (co-modality).

2.7.18 NextGen - The Next Generation Air Transportation System

NextGen is a wide ranging transformation of the entire national air transportation system ð not just certain pieces of it ð to meet future demands and avoid gridlock in the sky and in the airports. It moves away from legacy ground based technologies to a new and more dynamic satellite based technology. Technologies and activities that support this transformation are currently part of the FAAøs investment portfolio and represent a step beyond our legacy modernization programs. These new capabilities and the highly interdependent technologies that support them will change the way the system operates, reduce congestion, and improve the passenger experience. This multi-agency initiative is led by the Joint Planning and Development Office.
The nucleus of NextGen consists of:

- Automatic Dependent Surveillance-Broadcast (ADS-B) is FAA's satellite-based successor to radar. ADS-B makes use of GPS technology to determine and share precise aircraft location information, and streams additional flight information to the cockpits of properly equipped aircraft.
- NextGen Network Enabled Weather (NNEW) is part of an interagency effort to provide users of the National Airspace System with quick, easy and cost-effective access to timely, accurate weather information. Through the sharing of common weather data, NNEW will enhance safety and support collaborative decision making.
- System Wide Information Management (SWIM) is the network structure that will carry NextGen digital information. SWIM will enable cost-effective, real-time data exchange and sharing among users of the National Airspace System.
- Collaborative Air Traffic Management Technologies (CATMT) is a NextGen Transformational Program that provides enhancements to the existing Traffic Flow Management System (TFMS).
- National Airspace System Voice System (NVS) will supplant FAA's aging analogue voice communication system with state-of-the-art digital technology. NVS will standardize the voice communication infrastructure among FAA facilities, and provide greater flexibility to the air traffic control system.
- Atlantic Interoperability Initiative to Reduce Emissions (AIRE) is a cooperative agreement between the United States and the European Commission to promote and harmonize environmental initiatives and procedures in European and North American airspace.

- DataComm Data Communications will enable controllers to send digital instructions and clearances to pilots.

NextGen will improve capacity and security of the air transport management in United States and therefore strengthens co-modality of air transport (co-modality).

2.7.19 Primeline Coventry

In Coventry (UK), Primelines is a partnership project delivering high quality bus infrastructure and services to increase bus patronage across the city. It includes 5.3 km of bus lanes, plus 4.9 km of red routes, 13 new bus gates and bus bypasses to allow buses to overtake stationary traffic, 70 new bus shelters with seating and real-time information, 19 new bus stop flags with real-time information displays, and 80 new traffic signals equipped for bus priority, supported by clever marketing including personalisedjourney and travel planning.

In each of the Primelines corridors, research is undertaken as to how the bus reliability and journey times could be improved. Consideration is given as to whether any of the following measures could be introduced onto the corridor:

- Bus Lanes & Bus Bypasses;
- Bus Priority Measures (such as bus gates);
- New Bus Stops/Shelters/Boarders;
- New parking facilities and restrictions (such as red routes);
- Improved traffic signals/roundabouts;
- New landscaped areas;
- Improved cycling facilities;
- Improved pedestrian facilities;
- Provision of Real-Time Passenger;
- Information & CCTV Cameras.

Early results are impressive, showing that 47% of householders have changed their travel behaviour, 39% of householders have reduced the amount they have driven, with 24% using the bus more frequently.

Primelineõs coordinated planning improves the conditions for bus travel and makes it more competitive to the car (co-modality).

2.7.20 Reversible BUS Lane in Madrid

In 1992, Madrid introduced a 16 km flexible bus lane ôBUS VAOö on a highway connecting the suburbs to the city itself. The bus lane consists of two sections. While the first section in the suburbs is for both buses and vehicles with more than two occupants, the second part, which is 3.8 km long, is only reserved for buses and coaches. The bus lane is reversible and functions according to the bigger traffic flow demand. (Morning: Suburbs-Madrid; After 14:00: Madrid-Suburbs).

More than 15 years of operation has proven ôBUS VAOö to be an efficient service. With 21 routes, about 252 buses make use of the lane during peak hours. The share of people taking buses from the suburbs into the city centre increased from 17% in 1991 to 28% in 2007.

Bus lanes make bus travel faster and more competitive to car travel (co-modality).

2.8 ORGANISATIONAL ARRANGEMENTS

2.8.1 Introduction

The next solutions have been selected as examples of initiatives which change the formal organisation of specific transport services aiming at increasing their efficiency. These initiatives may be originated on liberalisation processes such as concessions, franchises, privatisations, de-regulations or on agreements reached between operators to provide overall better services like in the case of agreements between rail operators and taxis or car sharing providers serving rail stations:

- Brenner Corridor Platform;
- Single European Sky Initiative;
- Privatisation of UK Airports;
- Privatisation of Spanish Airports: Barajas and Barcelona;
- Local Network Franchising: Merseyrail Concession;
- Edinburgh Airport Transport Forum;
- "Mobilfaltòï Private Cars to Replace or Complement Public Buses;
- Car Insurance Discount for PT Season Ticket Holders;
- Austrian Use of Taxis for Public Transport;
- Taxis for Public Transport in Limburg.

2.8.2 Brenner Corridor Platform

The Brenner corridor has always been a heavily travelled route. More than forty-five million net tons of goods are shipped yearly over this Alpine pass. A total of seven million vehicles - of which over two million are heavy freight vehicles - travel over the Brenner pass every year. The Brenner base tunnel project (55km) is in the final planning phases. The Brenner Corridor Platform was set up in order to have an integrated approach for the Brenner Corridor, including road and rail, going beyond the mere development of the infrastructure project and putting into place a strong cooperation between all partners involved. The shift of heavy freight traffic from road to rail is particularly important here. This requires policy changes and the introduction of a uniform toll policy in the traffic corridor from Munich to Verona and over the Alpine arc. An efficient new railway with the Brenner base tunnel and its access routes will allow a shift from road to rail of heavy freight traffic. Besides the new railway, however, freight handling terminals along the line will also be needed. The corridor is conceived as a óGreen corridorô the 5 regions along the axis are producing enough renewable hydropower energy to satisfy the energy need of the railroad from local renewable production, and for the motorway, hydrogen refill stations will be set every 100km in the corridor from 2011-2012 (hydrogen will be also produced locally).

Integrated planning of a long-distance transport corridor, with especial focus on transport efficiency and environmental care, dealing simultaneously with road and rail technical solutions, and implementing a traffic managing scheme through road/rail tolling. (Co-modality.)

2.8.3 Single European Sky Initiative

European airspace is fragmented and will become more and more congested, as traffic is forecast to grow steadily over the next 15 years. Air navigation services and the systems that support them are not sufficiently integrated and are based on technologies which are already running at maximum. The SESAR (Single European Sky ATM Research) programme is the programme launched by the European Community to support the technological and operational dimension of the Single European Sky (SES) initiative to meet future capacity and air safety needs. With SESAR, we will have a European ATM network re-engineered to become more efficient, better integrated, more cost-efficient and safer. Air traffic management affects when, how far, how high, how fast, and how efficiently aircrafts fly. More efficient ATM will help save fuel consumption and CO_2 emissions, increase predictability of flight arrivals and departures, and help reduce flight times. The required changes will be supported and facilitated by accompanying regulatory measures.

Improving the functioning of the air sector; the basic idea to have more integrated traffic management architectures is also transferable to other transport modes, in particular to car traffic (co-modality).

2.8.4 Privatisation of UK Airports

Public vs. private organisational mindsets during transition and operation. Increasing air carrier and passenger expectations. Maintaining maximum flexibility within fixed boundaries. Minimise use of regulation (consider using general competition law for this purpose). If there is to be regulation should there be more focus on vertical relationships. Small airports can be commercially viable.

Increasing flexibility and efficiency in airport management; concept could be transferred to other transport infrastructure (co-modality).

2.8.5 Privatisation of Spanish Airports: Barajas and Barcelona

Secretary of State for Transport announced that the tender process for the management of the airports of Madrid and Barcelona will begin in summer 2011. AENA would undertake a process of "probing" interested stakeholders, with the desire to know the market situation and potential interest to contrast the key points of the concession model. In parallel, the process to insert private capital in AENA, the public airport manager in Spain, would begin, with a maximum participation of 49%. The new management system of hubs in Spain was intended to be a similar model to that one already in place in countries like Sweden and Finland. The privatisation process of airports in Spain was left on standby due to government change in December 2011.

Increasing flexibility and efficiency in airport management; concept could be transferred to other transport infrastructure (co-modality).

2.8.6 Local Network Franchising: Merseyrail Concession

The Merseyrail concession is unique in the UK, though it is based on a franchising model popular in Germany, Denmark, Sweden and the Netherlands where it is credited with having established a virtuous circle of new trains and station modernisation, close integration with local bus services ï and more passengers). The role of the Department for Transport in awarding rail franchises has been delegated by Parliament to the Merseyside Integrated Transport Executive Merseytravel and the concession agreement is between the operator and Merseytravel. This gives much better local control by local people of local services. Another unique feature is the length of the concession which is 25 years from 20 July 2003, with specified interim review dates. The local rail services both form part of national networks (mainly rail) and local networks (mainly bus).

Promotes integration between different local services and into the national network (intermodality).

2.8.7 Edinburgh Airport Transport Forum

The 1998 White Paper ñA New Deal for Transportò required all airports in England handling in excess of 1,000 air transport movements per annum, to set up Airport Transport Forums (ATFs). Although this requirement was not mandatory in Scotland, BAA took the view that the establishment of an ATF was good practice and should also be followed in Scotland.

The Edinburgh Airport Transport Forum was established in 1999, and meets twice a year. The membership of the ATF is comprised of representatives of all transport providers (including bus and rail companies, and taxi operators); the Airport Operators Committee (representing airlines and handling agents); neighbouring Local Authorities; the Scottish Executive; Edinburgh Chamber of Commerce; the Edinburgh Airport Consultative Committee (EACC). SEStran, the regional statutory body.

The ATF oversees the strategy to increase public transport mode share and manage vehicle movements. Through agreeing and setting challenging short and long-term targets for increasing public transport mode share the ATF seeks to influence airport access journeys and to raise awareness of public transport options. The ATF also monitors progress on an ongoing basis towards achievement of Airport Surface Access Strategy (ASAS) targets, and oversees the preparation of the new ASAS.

An organisational framework to facilitate intermodality at the Edinburgh airport.

2.8.8 "Mobilfalt" – Private Cars to Replace or Complement Public Buses

With an unconventional idea the transport authority of North Hessian (NVV) wants to change public transport in rural areas. Starting in autumn 2012 in 5 smaller towns in North Hessian the citizens themselves shall organize public transport. Private cars then will serve the bus stops to collect passengers for carrying passengers within the town and its districts for one Euro per trip. Drivers receive a compensation of 30 Cent per kilometre. The test will be running for two years, to find out, if such a system is accepted by the citizens. Services shall be offered on an hourly base and are to be booked via internet or by phone. If no holder of a private car can be found for a specific transport, a taxi service will help out.

A decreasing number of inhabitants in the area make it difficult to provide public transport at reasonable costs per trip besides serving main axis. Complementing the remaining bus lines with this new service could bring forward public transport in rural areas at reasonable costs (co-modality).

2.8.9 Car Insurance Discount for PT Season Ticket Holders

GMF Assurance offers a 10% discount on car insurance for drivers who are annual season ticket holders for public transport, initially with Veolia, now with any annual PT ticket.

The insurance discount will encourage car owners to use public transport for their daily commute (co-modality).

2.8.10 Austrian Use of Taxis for Public Transport

Austria has introduced, in various cities and towns, hail-shared taxis. In Vienna, such taxis operate on a couple of bus lines. The taxis serve the bus stations which are marked by a special sticker. The on-demand taxis mostly operate in the evening and during the night, and on some lines also during the day.

The public transport ticket in Vienna can be used and the taxi operators are paid an agreed tariff on a kilometre basis by the Vienna operator "Wiener Linien". The number of passengers using hail-shared taxis ranges from approximately 800 to 13,000 passengers annually per line, depending on the bus route. This new system allows Vienna's citizens to have direct access to collective means of transport, whilst improving cost-efficiency for operators.

In other Austrian regions there special tariffs, lower than the standard taxi fare, for the collective taxis (Anrufsammeltaxi or Bustaxi), which then in some cases also do not only run along fixed bus routes.

In Innsbruck collective taxis are available for women from 20:00 to 2:00 or in the winter from 19:00 to 2:00, and in Bludenz (Vorarlberg) for young people from 22:00 to deter them from drink driving.

The use of taxis makes public transport more efficient (co-modality).

2.8.11 Taxis for Public Transport in Limburg

In the Limburg province in the Netherlands, the multimodal contract (Veolia Transport Nederland) include urban services in Maastricht and Heerlen, trains, buses and taxis, fixed routes and on-demand services. 240 buses, 24 operator owned trains and 300 taxis, owned or chartered by the operator, carry some 53 million passengers per year. The taxi option is important and divided into three specific types: taxis on fixed routes or ñVKBò (maximum of 8 passengers), ñRegiotaxiò with door-to-door services for people who donõt have access to regular public transport (all types of customers) and ñBellbusò which offers on-demand lines from bus stop to bus stop along virtual lines and pre-planned routes.

The use of taxis for routes and times of low demand makes public transport more efficient. It also allows operating services that would otherwise be loss-making, and increases modal choice for travellers. (co-modality).

2.9 Segregation of Freight and Passenger Traffic

2.9.1 Introduction

The next solutions have been selected as examples of initiatives to segregate passenger and freight transport, or at least decreasing the volume of freight transport in infrastructures shared with general passenger transport. Freeing passenger transport networks from freight traffics can contribute to an overall increase of traffic safety and better traffic flows, especially in most congested corridors. This family of solutions mostly considers the construction of dedicated roads and railways for freight, but also considers those initiatives aimed at transporting larger quantities of goods using a reduced number of trucks, e.g. the modular truck concept or road trains in Scandinavia:

- Betuwe Route: Dedicated Freight Rail Corridor;
- Dedicated Roadways for Trucks in Boston;
- Road Trains in Scandinavia, the Netherlands, Germany and the UK;
- Modular Vehicle Combinations (MVC) in Denmark.

2.9.2 Betuwe Route: Dedicated Freight Rail Corridor

The Betuweroute is a 160 kilometre double track freight railway from the port of Rotterdam to the German border (priority project nr. 5 of TEN-T). It is a part of the PP24 (Railway axis Lyon/Genoa-Basel- Duisburg-Rotterdam/Antwerp) and of ERTMS Corridor rail freight corridor A Rotterdam-Genoa. The Betuwe line was inaugurated in June 2007. From an operational point of view, the Betuwe route is confronted with the general issue of rail competitiveness against road and, in the case of the Port of Rotterdam, against inland waterways. By mid-2011, 78% of all trains between Rotterdam and the German border took the Betuweroute, and traffic have tripled between 2008 and 2010 (from 5350 trains in 2008 to 17600 in 2010), with an average 14% quarterly traffic increase. Still, its cost ú4,700 million have brought some to argue that the socioeconomic benefit of the investment will not be able to overcome its costs.

Dedicated railways for freight can be transferable to road mode (e.g. dedicated roads for trucks). Segregating freight and passenger traffic is a concept looking forward at improving the flow efficiency of traffic and the security of transport (co-modality).

2.9.3 Dedicated Roadways for Trucks in Boston

The South Boston Haul Road (SBHR) project moved beyond the traditional definition of intermodal to include a shared infrastructure rather than movement of passengers from one mode to another. The highly successful transformation of a little used railroad corridor into a busy multimodal route was both routine and challenging. With its combination of the easy and the difficult, however, the SBHR was an extremely satisfying project to work on. The concept of the SBHR was to use an existing transportation corridor for both railroad freight and commercial highway vehicles. The positive benefits projected for various stakeholders included among others reduced truck traffic volume in motorways, significantly reduced trip times.

Reducing truck traffic volume in motorways is to improve the flow and security of passenger transport (co-modality).

2.9.4 Road Trains in Scandinavia, the Netherlands, Germany and the UK

A road train is a string of several trailers pulled by a single tractor cab. This is common practice across the Australian Outback, and itôs common to see trailers double-ganged or occasionally tripled on open stretches of highway in the western United States and Canada. Trains donôt mix well with congested traffic and windy roads. To pull trains of four or more trailers, truckers would need dedicated lanes, and big trucking companies are beginning to say theyôd be willing to pay for their construction and maintenance via tolls or special taxes. In Finland, Sweden, Germany, the Netherlands, Denmark and some selected roads in Norway, (for a period of three years commencing November 24, 2008), trucks with trailers are allowed to be 25.25 m long. Elsewhere in the European Union, the limit is 18.75 m (Norway (19.5 m). The trucks are of a cab-over-engine design, which is with a flat front, a high floor about 1.2 m above ground with the engine below. The Scandinavian countries are less densely populated than the rest of the EU countries and distances, especially in Finland and Sweden, are vast. In the United Kingdom in 2009, a two year desk study of Longer Heavier Vehicles (LHVs) including options up to 11-axle, 34-meter long, 82-tonne (81 LT; 90 ST) combinations, ruled out all road train type vehicles for the foreseeable future. Sweden is currently (2010) performing tests on log hauling trucks, weighing up to 90 tonne (89 LT; 99 ST) and measuring 30 meters and haulers for two 40 ft containers, measuring 32 meters (105 ft) in total.

Moving more freight in less space gives more room in roads and motorways for passenger traffic (co-modality).

2.9.5 Modular Vehicle Combinations (MVC) in Denmark

Modular vehicle combinations (MVC) are long road trains. Two MVCôs are able to transport the same amount of freight as three ordinary trucks. Studies on the use of modular vehicle combinations point out a number of ad-vantages in comparison with conventional trucks, for example: reduction of the number of truck transports up to 32% and less congestion, larger efficiency in the transport trade with transport costs lowered up to 23%, and decreased fuel consumption and air pollution by 15%. In February 2007 a majority of the Danish Parliament passed a change of the national Road Traffic Act, authorising the Minister for Transport to permit MVCôs in Denmark on a specifically selected road network as of March 1, 2007. Driving MVCôs means an extension of the maximum length of a road train from 18.75 metres to 25.25 metres and an increase of the maximum weight of the load allowed from 48 tonnes to 60 tonnes. The three-year trial was launched on November 24, 2008. In the latest agree-ment on future Danish traffic investments from January 2009, A Green Trans-port Policy, the national Parliament agreed to lengthen the MVC trial beyond 2011. The precise conditions concerning a lengthening will depend on the analysis and evaluation of the first three-year trial. This MVC trial is a corner-stone in the Danish governmentôs endeavour to create a coherent, sustainable society in terms of environment and traffic.

Moving more freight in less space gives more room in roads and motorways for passenger traffic (co-modality).

2.10 TICKETING SCHEMES

2.10.1 Introduction

The next solutions have been selected as examples of initiatives related to travel tickets or vouchers. The several examples are aimed at increasing the transparency and balance of transport fares across modes and territories, to allow passengers to travel on multiple means of transport using integrated tickets, or making it easier to purchase travel tickets e.g. via smartphone applications or in-vehicle sells booths.

- Integrated Rail Transport System of Wroclaw Agglomeration;
- Municipal Transport Union of the Upper Silesian Industrial District;

- Discounted Rail Tickets to and from Glasgow Prestwick Airport;
- SailRail: Train+Ferry Tickets;
- Dutchflyer: Rail and Sail to Holland;
- Bicester Taxi-Bus;
- ôRailLinkô Feeder Service;
- Intermodal Offer for Tourists in Pomerania Region;
- ñRail&Flyò a Co-operation between DB and Airlines;
- Pre-Bookable Parking at the O2 Arena.

2.10.2 Integrated Rail Transport System of Wroclaw Agglomeration

The city of Wroclaw aims at the creation of a integrated multimodal transport system for the city and and region (voivodship). The system is designed in such a way as to make use of individual cars redundant. The project includes new infrastructure investments, a new control system for tram lines, creation of interchanges between various modes, and integration of city public transport with the rail system through common interchange points and coordination of services.

Wroclaw agglomeration rail (Wrocławska Kolej Aglomeracyjna): In order to improve integration of transport between the city and the surrounding area the city will participate in the improvement of rail lines extending to key locations outside the city borders. The plan is that WKA will be independent from the main Polish rail operator PKP. Moreover the city will develop interchanges and provide buses to deliver passengers to/from rail stations. Regional buses will be integrated with rail timetables to further extend the WKA range into areas where rail lines do not exist. The main goals are: 1) connection to the national and international rail network, 2) provision of a regional service within viovodship, 3) achieving much higher frequency on key routes: Wrocław ï Legnica, Wrocław ï Wałbrzych, Wrocław ï Kłodzko, 4) new internal agglomeration services connecting Wroclaw with Oleśnica, Jelcz, Oława, Wołów and Żmigrod, 5) upgrade of internal city services airport ï Wrocław Main Station and Leśnica - Wrocław Świebodzki.

Tram Plus programme: Tram Plus is a new and modern tram system prioritising the connection of external suburbs with the city centre and main rail and regional bus stations. The system will utilise the newest equipment and advanced traffic control technologies.

Traditional tram: Modification of existing tram lines ï replacing bus routes with trams, integration with the Tram Plus system at key interchanges.

Buses: Integration of existing bus services with both tram systems and rail stations. Introduction of new ITS technologies to bus services.

Coordination with railways and buses in relations city-region and city ï airport (intermodality).

2.10.3 Municipal Transport Union of the Upper Silesian Industrial District

KZK GOP is a municipal transport union of the Upper Silesia region which encompasses 25 municipalities. Transport is provided for an area of more than 1,400 sq km inhabited by more than 2 million people. Daily services are used by 1.2 million passengers which represents 57% of total transport activities in the area. Furthermore, KZK GOP services extend to locations outside the 25 municipalities providing comprehensive public transport for the Upper Silesia.

Efficiency, coordination and integration: Due to the different population characteristic in different municipalities, the efficiency of public transport organised by the Union necessitates a precise definition of the different service requirements by the different municipalities so that services can be allocated in line with user demand in order to make the transport offer more attractive and adjusted to the user needs. An efficient execution of the Union role requires transport to be integrated, both within the framework of KZK GOP (bus and tram), and with other organisers of transport, including railways.

Ticketing and pricing: Implementation of the income function through prices; as it is to influence the demand for transport services, it requires focusing the attention on the efficiency of tariffs applied, as well as efficiency of distribution systems and service promotion;

Introduction of ITS solutions: ICT systems are being introduced in the area serviced. The development of technology in the field of IT and electronics enabled the appearance of solutions supporting the management of mass transport, and opened the possibilities of offering passengers a completely new, enhanced level of services (electronic ticket, dynamic/active information for passengers, monitoring in vehicles and at stops, vehicle tracking, etc.).

New infrastructure: Rebuilding of roads and tram lines, creation of new access routes (especially to/from airport), improving interchange points.

Promotion of all available options of public city transport over long and short distances (routes could range from just a few to more than 100 km) utilising all modes: tram, bus, trolley-bus (co-modality). With further actions integrating this system with railways (intermodality) and servicing traffic to/from airport (intermodality).

2.10.4 Discounted Rail Tickets to and from Glasgow Prestwick Airport

All passengers travelling to/from the airport receive 50% discount from/to anywhere in Scotland on the standard fare. Passengers joining the train at Prestwick Airport have to show their official flight confirmation and photo id to the train conductor when buying their ticket, as there is no ticketing office at Prestwick Airport. Passengers joining the train at a station with a ticketing office should purchase their tickets before boarding the train. The 50% discount offer is prominently advertised along the covered walkway between terminal and train station.

For the first 6 months of any new route all passengers are entitled to FREE rail travel to/from Glasgow Prestwick Airport. To get the free travel tickets, passengers have to produce their original flight confirmation (booking confirmation with the airline logo) at a First ScotRail Booking Office or the airport's Service desk where they will be issued with a free travel voucher to anywhere in Scotland. The free rail vouchers are not available on train.

Infratil could negotiate this deal with First Scotrail, because Infratil owns the airport rail station.

The rail fare discount promotes combined air and rail travel (intermodality).

2.10.5 SailRail: Train+Ferry Tickets

The SailRail service by rail and ferry provides city to city travel for passengers wishing to travel between Britain and Ireland. It is an integrated rail and ferry ticket. It covers all UK rail stations and a wide range of Irish destinations. The ferries run between Stranraer and Belfast, Holyhead and Dublin, and Fishguard and Rosslare. The website also includes a journey planner.

The integrated rail and ferry ticket promotes intermodal travel. (intermodality).

2.10.6 Dutchflyer: Rail and Sail to Holland

Stena Line's dutchflyer service by rail and ferry provides city-to-city travel for passengers wishing to travel from Britain to Holland. It is an integrated rail and ferry ticket. It covers all Dutch rail stations and in the UK departure points are London Liverpool Street, Ipswich, Colchester, Norwich and Cambridge. The ferry runs between Harwich International and Hook of Holland.

The integrated rail and ferry ticket promotes intermodal travel. (intermodality).

2.10.7 Bicester Taxi-Bus

Chiltern Railways (in partnership with a local taxi operator, Union cars) provide a weekday ŏTaxiBusô service in Bicester, which operates on three routes around the town and links with peak hour commuter trains to and from London Marylebone.

Promotes bus/taxi/rail integration at the local level. (intermodality).

2.10.8 'RailLink' Feeder Service

A partnership between bus and rail operators to provide a feeder service with branded buses for the Petersfield to Waterlooville service.

Promotes bus-rail integration, and extends the reach of long distance rail. (intermodality)

2.10.9 Intermodal Offer for Tourists in Pomerania Region

The offer was open at the summer season 2010 and continued in 2011. Itŏs a connection of two cities (Malbork and Krynica Morska) attractive for tourists coming there by road or rail. Partners in the cooperation are four operators representing three transport modes: Pomeranian Railway Society in cooperation with the rail operator ARRIVA (railways), Bus operator Tolko (buses) and Shipowner (maritime).

Tourists coming to visit Malbork (the biggest Teutonic castle) are encouraged to visit some additional interesting tourist destinations and use a nice scenic narrow-gauge railway link and a ship to Krynica Morska at the lagoon. This offer is interesting for tourists individuals and tourist groups. Also for tourists coming to Krynica for the seaside itŏs interesting experience to have a one-day trip by ship, bus and nice railway to the castle. Timetable is integrated and integrated ticket is available for the whole trip.

Intermodal solution connecting Malbork with Krynica Morska, both attractive tourist destinations connected by road or railway network with the national and international network. (intermodality).

2.10.10 "Rail&Fly": a Co-operation between DB and Airlines

ŕRail&Flyò is a product offered by DB in co-operation with around seventy domestic and international tour operators and eighty airlines. It entitles travellers to purchase flights or tour packages, which include rail transport to and from the airports in Germany and also Amsterdam Schiphol and Basel-Mulhouse airports for an attractive price. ŕRail&Flyò conditions and prices vary depending on the specific agreement between DB and airline/tour operators and their pricing policy. ŕRail&Flyò can be sold in combination with either a flight or a tour package. Fare is therefore integrated as travellers pay a single total price when booking their journey.

The option of booking the rail ticket to reach the airport in a one-stop-shop together with a flight or a tour package strengthens intermodality of combined rail/air-travel.

2.10.11 Pre-Bookable Parking at the O2 Arena

The O2 Arena is a major concert venue in London. The arena has their dedicated parking facilities, but at big events it runs out of capacity. The O2 website allows booking, and therefore securing, a parking space in advance.

A guaranteed parking space at the trip destination makes car travel more stress free. (co-modality).

2.11 TRAVEL PLANNERS AND USER INFORMATION

2.11.1 Introduction

The next solutions have been selected as examples of initiatives aimed at increasing the quantity and quality of information provided to travellers, allowing them to do most adequate route choices when travelling. Information may be related to a single mode (e.g. rail schedules, terminal orientation) or to multiple modes (e.g. multimodal travel planners):

- SBB Online Fahrplan;
- In-Time;
- Reiseauskunft;
- Resrobot;
- Rejseplanen;
- Ecopassenger;
- START;
- Transport Direct;
- Flyrail;
- Poznan Metropolitan Area Travel Planner;
- Edinburgh Bustracker;
- Real Time Information on Trains or Buses in the Arrival Section of Airport;
- routeRANK - a Multimodal Travel Planner;
- ÖBB Railjet ï Dynamic On-Board Passenger Information;
- Postbus ï Dynamic On-Board Passenger Information;
- The Man in Seat Sixty-One;
- VBB Fahrinfo;
- DB Navigator;
- Real Time Information on Connecting Flights within Aircrafts Approaching an Airport;
- Göttingen Hauptbahnhof Service Information;
- Birmingham International Rail Station.

2.11.2 SBB Online Fahrplan

SBB Online Fahrplan is a multi-modal travel planner for Switzerland. It covers rail, ferry, local public transport, car and walking. It also covers rail travel to large and medium-size rail stations in Europe, but does not recognise small stations, and has problems identifying connections that do not at least start or end in Switzerland. Within Switzerland it operates fully from door-to-door.

It also allows on-line ticket purchase for rail tickets and what makes it stand out from other travel planners is that it also provides the option to purchase a ñCity-Zuschlagò, a city surcharge on either or both ends of the train journey which covers a 1-day travel pass for unlimited travel on the municipal transport services network of the city in question.

The calculation of intermodal trips, in particular in conjunction with the City-Zuschlag, encourages the use of local public transport in connection with the train journey. (intermodality).

2.11.3 In-Time

In-Time is a FP7 project that has produced an interface for the exchange of traffic data. Based on this interface on-line traffic information as well as route planning advice is available for users in Vienna and the Burgenland, Florence and Tuscany, Munich and Bavaria, Brno and Moravia, Oslo and Bucharest. In-Time provides pre-trip as well as on-trip information. The platforms that are supported are iPhones, Windows Mobile and Java for a series of other mobile phones. For travel between these six regions and cities flight data is available as well as, through an associated package, a car route planner, but no rail data.

What makes In-Time stand out is the universal interface that will also allow other regions to join the network. In the new Co-Cities project Prague, Bilbao and Reading will join with Munich, Florence and Vienna; within this project it will also be possible for users to provide direct feed-back to the operators. The other remarkable feature is the real-time information that will change the suggested route in case of road congestion or delayed public transport.

As other travel planners, the information on door-to-door public transport will encourage modal chains (intermodality)

2.11.4 Reiseauskunft

Reiseauskunft is a German multimodal route planner that covers rail, ferries, local public transport and walking. It also calculates an alternative travel time by car, but does not provide any route planning. Furthermore is does a so-called environmental mobility check and calculates and compares the emissions from rail with those from car or air travel. It also allows purchase of rail tickets and seat reservations, although it does not have information on local public transport prices.

One thing that makes it particularly remarkable is that, together with the Austrian planner Scotty (http://www.oebb.at/), it is the only travel planner in Europe that provides connections to any rail station in Western Europe and Central Europe as well as major Easter European ones, and also finds alternative rail connections even if origin and destination are outside Germany. For instance for a connection from Vienna to Helsinki it offers one connection via Frankfurt and Stockholm and ferry to Turku and another via Warsaw and St.Petersburg.

The second thing that makes it particularly remarkable is that it is also real-time. For connections in the near future it will give warnings that connections may be missed, because a train is delayed. And it does not only provide the length of the expected delay, but where possible also the reason, e.g. "Fire-fighters' operations close to the tracks: Between Minden (Westf) and Bad Oeynhausen delays occur at present" for a delay of a train by 5 minutes.

The calculation of different public transport mode options encourages the use of modal chains (intermodality). The calculation of alternative public transport options as well as the car option allows choosing either the fastest option or the one with the lowest emissions, depending on the user's priorities (co-modality).

2.11.5 Resrobot

Resrobot is a multimodal Swedish travel planner. It covers air, rail, ferry, local public transport, car and walking. It operates door-to-door in Sweden and also shows connections to rail stations in Norway, Denmark and Northern Germany. It always calculates a range of public transport options (typically 8 to 10, unless access to public transport at origin and/or destination is very limited) and also a full detailed route by car. Although the site owner, Samtrafiken, offers fully integrated tickets for all intermodal chains within Sweden, they are not available for purchase on the Resrobot website.

What makes Resrobot stand out from other multimodal planners is the excellent visual presentation of each of each calculated trip chain, which shows the travel time on each mode of transport and the transfer time at each interchange point.

The calculation of different public transport mode options encourages the use of modal chains (intermodality). The calculation of alternative public transport options, in particular also including air travel as an alternative to the rail options offered, which are only offered by most other planners, as well as the car option allows choosing either the fastest option or the one with the lowest emissions, depending on the userôs priorities (co-modality). The graphs showing travel times and interchange times also help choosing between the different transport modes on offer (co-modality).

2.11.6 Rejseplanen

Rejseplanen is a multi-modal route planner for Denmark. It covers rail, ferry, local public transport, as well as car, cycle and walk.

There are three things that make Rejseplanen stand out. First of all it is one of only three sites listed on the EU website, which calculates for every connection found also the CO2 emissions and compares them with those from car travel (the other two are the German Reiseauskunft and the UK Transport Direct). Second, it allows purchasing train tickets, and since the train operator DSB also operates a wide range of bus routes in Denmark, this means that for many connections fully integrated bus and train tickets are available. Third it is one of only two listed sites that also has at least some door-to-door information for other countries, in this case for Sweden and parts of Germany (the other one is the Mobilitéitszentral from Luxemburg, which also has this for Denmark, Sweden and parts of Germany http://mobiliteitszentral.hafas.de/hafas/query.exe/fn). Through diverting onto the international version of the German Reiseplaner (see there), it is also able provide connections to any rail station in Europe.

The calculation of different public transport mode options and the possibility to buy integrated bus and rail tickets for many connections on-line encourages the use of modal chains (intermodality).
The calculation of alternative public transport options as well as the car option allows choosing either the fastest option or the one with the lowest emissions, depending on the userôs priorities (co-modality).

2.11.7 Ecopassenger

Ecopassenger is a town-to-town travel planner for Europe excluding the UK. For every O/D pair it calculates a train journey, a car journey and where distances are big enough a flight. For train travel it gives a detailed timetable for the whole journey, for car travel a full detailed route, but for flight only departure and arrival airport and number of flight changes.

What distinguishes Ecopassenger from other travel planners is the detailed emission calculation, not only for CO2, but also for energy consumption, particulates, nitrogen oxides and nonmethane hydrocarbons. For flights it breaks emissions down to access, flight and egress, and the user can choose access and egress mode. For car use it allows specification of three car classes, petrol or diesel, and the number of car passengers.

The comparison between rail, air and car travel times and emissions, which allows to define the number of car passengers and other car characteristics allows an informed choice of the mode to travel with (co-modality).

2.11.8 START

Poznan Metropolitan Area Travel Planner is internet platform allowing for travel planning within metropolitan area. Poznan and nearby smaller gminas (NUTS 5 level territorial unit) have signed agreement on common (metropolitan) transport. There are 14 lines extending from city into metropolitan area. Public transport in the city of PoznaŒand lines extending to the metropolitan area is organized by ZarzŃd Transportu Miejskiego (ZTM) - Urban Transport Authority. Metropolitan lines connect outside locations to the city internal network. Modes used are: bus and tram. Public transport connects also to airport and rail stations. The planner allows for designing optimal route for passenger. Passenger defines hour of departure, origin and destination. Than system provides 3 alternative routes with detailed description of hours, means of transport, distances, interchanges, prices and plots it on the attached map.

Intermodal (bus-tram) and co-modal (bus-bus) solution within metropolitan and city public network Connection with the airport and rail station through physical infrastructure is provided but travel planner does not include rail/air option in its queries (intermodality) (co-modality).

2.11.9 Transport Direct

Transportdirect is a multi-modal travel planner for mainland Britain and the Western Isles. It is not quite door-to-door by house number, but it goes down to postcode level, which in the UK usually means only a very short stretch of road. It covers ferry, rail and local public transport, car and walking as well as flights, but these only within Scotland. It tries for each connection to find all available public transport options and combinations from and to the nearest bus or tram stop and estimates the walking distance to it. The users can also define their own walking speed. It always also calculates the travel time for car travel. It is also possible to buy train tickets directly from the site.

What makes it stand out from other travel planners is the detailed estimate of emissions for each mode combination found and the possibility to compare this against having made the entire journey by car only, rail only, bus or coach only (depending on the travel distance), and for longer journeys also by flight only. For the comparison with cars, the calculation is made for a small and a large car and the user can say how many people would be travelling in it. Furthermore, for the car option calculated in the first place alongside the public transport options, the user can define what size the car is and whether it is a petrol or diesel car, and he can also type in the specific fuel consumption of his/her car in miles/gallon or litres/100km.

The calculation of different public transport mode options encourages the use of modal chains (intermodality). The calculation of alternative public transport options as well as the car option allows choosing either the fastest option or the one with the lowest emissions, depending on the userôs priorities (co-modality).

2.11.10 Flyrail

Flyrail is a multimodal travel planner, collaboration between SAS airlines and SJ (Swedish national rail operator), where users can check timetables and book tickets combining travel by plane, train and bus. Users can check and book connections all the way from the departure point to the final destination in Sweden and abroad. Flyrail gives users more freedom of choice when it comes to taking the train or plane on certain routes, using "get you there" guarantee. As a frequent traveller, users will find combined annual pass for selected domestic destinations gives users more freedom of choice than they have today. It gives users access to a wider combined range of travel alternatives, which means more flexible travel.

The calculation of different public transport mode options encourages the use of modal chains (intermodality). The calculation of alternative public transport options, in particular also including air travel as an alternative to the rail options offered, allows choosing the fastest option.(co-modality).

2.11.11 Poznan Metropolitan Area Travel Planner

Poznan Metropolitan Area Travel Planner is internet platform allowing for travel planning within metropolitan area. Poznan and nearby smaller gminas (NUTS 5 level territorial unit) have signed agreement on common (metropolitan) transport. There are 14 lines extending from city into metropolitan area. Public transport in the city of PoznaŒand lines extending to the metropolitan area is organized by ZarzŃd Transportu Miejskiego (ZTM) - Urban Transport Authority. Metropolitan lines connect outside locations to the city internal network. Modes used are: bus and tram. Public transport connects also to airport and rail stations. The planner allows for designing optimal route for passenger. Passenger defines hour of departure, origin and destination. Than system provides 3 alternative routes with detailed description of hours, means of transport, distances, interchanges, prices and plots it on the attached map.

Intermodal (bus-tram) and co-modal (bus-bus) solution within metropolitan and city public network Connection with the airport and rail station through physical infrastructure is provided but travel planner does not include rail/air option in its queries (intermodality) (co-modality).

2.11.12 Edinburgh Bustracker

The bustracker is a website that allows to display an extract of the Edinburgh map based on entering a postcode. (The site also shows the possibility to enter a street name, but that did not function at the time of testing.) The map extract shows icons for every bus stop in the area. When clicking the icon, a list with all lines serving this stop comes up. From there it is possible either to get the real time until the next two departures from this stop for every line, or a pdf file that shows the full route, the full timetable and the ticket price for each line.

There is also a mobile website: mobile.mybustracker.co.uk, where a passenger at a stop can input the 8 digit bus stop code found on the timetable, click ôDisplay Departuresô and receives the real time bus information for that stop. Favourite stops can be bookmarked.

Furthermore, there are apps for the iphone and for android phones.

Knowledge about the next bus departures and the scheduled travel time will encourage the use of public transport either for a single bus trip or for a connection to the train station or the airport. (inter- and co-modality).

2.11.13 Real Time Information on Trains or Buses in the Arrival Section of an Airport

Monitors for real time information on trains serving the airportôs railway station or on busses from its terminal directly in the arrival area (and not just at the railway station or bus terminal) exist in a number of airports. We have identified the following solutions.

- Stuttgart: In the arrival hall of the airport at the stairs to the station for commuting trains, a second monitor for trains departing at the main station of Stuttgart
- Hamburg: In the baggage claim areas of terminals 1 and 2 for commuting trains
- Zurich: In the baggage claim area for train departures
- Berlin-Schönefeld: in the arrival hall for buses
- Nuremberg: in the arrival hall for buses and metro
- London City Airport: in the baggage claim area for Docklands light rail
- Rønne: in the arrival hall at the exit door for buses
- Mailan-Malpensa: In the baggage claim area for train departures
- Cologne: In the arrival halls of terminal 1 and terminal 2 for trains
- Birmingham: In the baggage claim area separate monitors for buses and rail
- Hanover: In the arrival hall for commuting trains (real time info disabled for the time being)
- Leipzig: In the arrival hall for trains
- Saarbrücken: At the exit of the arrival hall display for regional bus services
- Vienna: In the arrival hall for the CAT (City airport train)

Providing information on connecting transport modes directly on arrival enables smooth connectivity at airports and therefore strengthens intermodality of air and public transport. (intermodality).

2.11.14 routeRANK - a Multimodal Travel Planner

routeRANK provides a software solution for travel planning. Unlike other solutions that consider only one means of transport at a time, routeRANK addresses the entire travel route by integrating rail, road and air connections from city to city. In a single search, routeRANK's patent-pending technology finds and ranks the best possible travel routes, allowing users to sort them according to their priorities such as price, travel time and CO2 emissions. Custom developed versions of the proprietary software are offered to corporate customers and organisations, for their internal use or use on their own website, in both travel and logistics. The customised version can also include door-to-door planning. Alternatively, it is easy to sign up for the Standard Professional version, which offers additional features to the public version.

Another version illustrating the software is also publicly available on routeRANK's website. Although here the focus is on European travel, airports and flight connections worldwide and road connections in North America are also integrated. Website owners benefit from the routeRANK's widget.

The multimodal travel-planner allows to compare travel-times, costs, and CO2 emissions of different alternatives (car, train, air travel) for a trip.

2.11.15 ÖBB Railjet – Dynamic On-Board Passenger Information

ÖBB is the state owned Austrian rail company. Since 2008 Railjet is the premium product of the ÖBB concerning long-distance high speed passenger transport. Each coach is equipped with a visual dynamic passenger information system. The screens show the actual travel speed, the travel route on a map, the actual position and distance to the next stops. Connections which can be easily reached are marked in green.

Real time information about actual arrival times and connections decreases uncertainty and improves the comfort for passengers on intermodal trips.

2.11.16 Postbus – Dynamic On-Board Passenger Information

Postbus is the largest Austrian bus operator which runs the majority of the regional and long-distance bus services in Austria. Since 2003 Postbus is part of the national railway operator ÖBB. Postbus has extensive experience with dynamic passenger information systems at stations. To date a visual dynamic on board passenger information system for long-distance busses is under development.

Real time information about actual arrival times and connections decreases uncertainty and improves the comfort for passengers on intermodal trips.

2.11.17 The Man in Seat Sixty-One

The website aims first to help people who already know they want to travel by train or ferry, but who can't find out about it through normal commercial websites or travel agencies. These days, many people want to cut their carbon footprint or are simply fed up with the hassle of flying. Many people prefer train travel, and a significant number of people are afraid of flying or medically restricted from doing so. However, information on alternatives to flying can often be difficult if not impossible to find. Second, the site aims to inspire people to do something more rewarding with their lives and their travel opportunities than going to an airport, getting on a soulless globalised airliner and missing all the world has to offer. There's more to travel than the destination. The website has won many prices in the last years, e.g. Guardian & Observer Travel Awards 2008, Wanderlust Travel Awards 2010, 2009, 2008 & 2007, Responsible Tourism Awards 2010, 2009 & 2006, Virgin Responsible Travel Awards 2010, Nigel's Green Web Awards Winner 2009.

Furthermore a TV series about "The Man in Seat Sixty-One" is planned. See the taster pilot at http://www.guerilla-films.com/man-in-seat-61.html

Information is given for long-distance trips throughout Europe (and other continents from Australia to Zimbabwe) and also for train riding (links to schedules, booking website, information about trains and services etc.) in specific countries. So The Man in Seat Sixty-One strengthens the co-modal aspect of train travel, as an alternative to air travel on long-distance trips.

2.11.18 VBB Fahrinfo

VBB Fahrinfo is an international door-to-door travel planner, developed within the EU-SPIRIT project with partners from other parts of Germany, Sweden, Denmark and Poland. For national travel it offers door-to-door information for the entirety of Germany. For international travel it offers door-to-door information, including where relevant both rail and air connections, for all of Sweden and Denmark, the wider Berlin region, Northern Germany, Southwest Germany and Warsaw as well as connections to any international airport.

International door-to-door information will encourage the use of public transport and intermodal chains (Co- and intermodality).

2.11.19 DB Navigator

The DB navigator is an app for smart phones. It is free to download either directly from the DB website or from a number of app stores. It offers door-to-door information for trains, buses, trams, S-Bahn and metro within Germany including guidance for the first and final walk. The user can chose whether he/she wants timetable information or guidance that takes account of real-time information about delays. Therefore, if a delay occurs during a journey, the information is updated and makes sure that the next really available connection is shown. The navigator also has information about travel to and from all train stations in Europe, and also shows ferry connections where a port is connected to rail. Furthermore, it also allows the purchase of rail tickets.

The navigator encourages the use of public transport by showing not only time-tabled but real-time public transport connections (intermodality).

2.11.20 Real Time Information on Connecting Flights within Aircrafts Approaching an Airport

Numerous airlines provide information on connecting flights within an aircraft approaching an airport. Either on request of specific passengers, announcements by the staff of an aircraft or display information on the monitors of the (personal) IFE (in flight entertainment) systems, available in long-haul aircraft. Examples known for IFE solutions are Lufthansa (see picture), Emirates when approaching their hub Dubai, Singapore Airlines, Austrian Airlines, Qatar Airways, Air France, Air New Zealand, Japan Airlines, Air Canada.

Providing information on connecting flights enables smooth connectivity at airports and therefore strengthens co-modality of air transport.

2.11.21 Göttingen Hauptbahnhof Service Information

On the main concourse of Göttingen Hauptbahnhof there are two large notice boards with real-time departures: visible for passenger coming into the station from the street for departing trains as in most train stations, but also above the exit for arriving passengers real-time departures for the local public transport.

Clearly visible information on local public transport will encourage travellers to use this rather than simply getting into the next taxi (intermodality).

2.11.22 Birmingham International Rail Station

Birmingham International is the rail station for Birmingham International airport. Station and airport are connected by a free ñAir-Rail Linkò monorail system.

Between the rail station and the exit to the bus station is a poster board with onward travel information (see photo below). It contains one map which shows the location of buses and taxis and another map for the wider local area. Furthermore, it lists all destinations that can be reached by bus from Birmingham International with the number of the bus route and the code for the bus stop.

Next to the exit for the bus station there is a large board which displays the time until the departure of the next bus (see photo below). The board is double sided and has one display facing the train station and one facing the entrance from the airport. Integrated into the display are two touch screens, again one from each side, with the travel planner transportdirect.info, which allows identifying a public transport route to any address in the UK.

Also attached to the display are holders for various leaflets with bus routes and related information.

The journey planner, combined with the real-time bus departure display, facilitates and encourages intermodal travel (intermodality).

2.12 Enhanced Security and Fee Collecting Procedures

2.12.1 Introduction

The next solutions have been selected as examples of initiatives aimed at preventing the generation of cues in bottlenecks of the transport network generated by the need to undertake specific formalities such as security checks or transport fare payment. Most of the examples are aimed at making faster the security and check-in procedures at airports, the road toll payment, or the purchasing of public transport tickets:

- Automated Border Control at Airports;
- IATA Checkpoint of the Future;
- Self-service Bag Drop the Future of Baggage Processing;
- Common Use Passenger Processing System (CUPPS);
- Automatic Free-Flow Tolling Schemes in Czech Republic;
- LKW-MAUT Electronic Toll Collection System for Heavy Goods Germany;
- SMS Ticket for Public Transport in Wroclaw;
- On-Board Ticket Vending Machines in Wroclaw;
- DB Tickets on Mobile Phones;
- Lufthansa Application for Smart Phones;
- Door-to-Door Luggage Service for Rail Travel;
- Oyster Card;
- m-Ticket;
- Walrus Card;

2.12.2 Automated Border Control at Airports

Increased adoption of e-Passports and biometric-based security solutions have led to a sharp rise in the number of e-Gates that have been deployed at border entry points around the world. While the implementation of e-Gates allows for the expedited processing of passengers and a more tactical deployment of border control agents, questions have inevitably been raised surrounding the related security issues. A total of 55 facial recognition e-Gates are currently being tested at 13 terminals throughout the UK, while they will soon be deployed in Heathrow Terminal 3 and Gatwick Airportǿs South Terminal. Australia is one of the pioneers of the e-Gate, having introduced the SmartGate, which utilises the e-Passport alongside facial recognition biometrics, back in 2007.

Reducing queues and intrusive searches at airports through to facilitate airports proceedings for the passengers; speeding up border controls can be relevant for all transport modes (co-modality).

2.12.3 IATA Checkpoint of the Future

The Checkpoint of the Future ends the one-size-fits-all concept for security. Passengers approaching the checkpoint will be directed to one of three lanes: "known traveler", "normal", and "enhanced security". The determination will be based on a biometric identifier in the passport or other travel document that triggers the results of a risk assessment conducted by government before the passenger arrives at the airport.

The three security lanes will have technology to check passengers according to risk. "Known travelers" who have registered and completed background checks with government authorities will have expedited access. "Normal screening" would be for the majority of travelers. And those passengers for whom less information is available, who are randomly selected or who are deemed to be an "Elevated risk" would have an additional level of screening.

Screening technology is being developed that will allow passengers to walk through the checkpoint without having to remove clothes or unpack their belongings. Moreover, it is envisioned that the security process could be combined with outbound customs and immigration procedures, further streamlining the passenger experience.

Reducing queues and intrusive searches at airports through to facilitate airports proceedings for the passengers. (co-modality).

2.12.4 Self-service Bag Drop the Future of Baggage Processing

As demand for self-service throughout the travel process continues to increase, innovative self-service bag drop and self-tagging solutions have been developed to further empower the passenger. Amsterdam Airport Schiphol was one of the pioneers of the bag drop process, initially adopting it in 2008 and since then, following a successful trial period alongside KLM and BagDrop, self-service baggage drop off has been adopted on a permanent basis. In fact, on August 15, six of the latest-generation BagDrop units entered operation and by February 2012, a total of 12 new units will be installed in Terminal 2 for KLM and SkyTeam partners.

Other carriers, such as Jetstar Airways, are also implementing self-service check-in, self-tagging and fast bag drop, contributing in the case of Jetstar to receiving its highest-ever self-service survey results for check-in products. In fact, self-service check-in has increased passenger throughput by 75% at asset-constrained airports, while within the first six months of its implementation, 55% of passengers made use of the self-service facility.

Facilitates airport proceedings for the passengers; increasing internet usage for sales and increasing self-service options is relevant for all transport modes. (co-modality).

2.12.5 Common Use Passenger Processing System (CUPPS)

IATA's Recommended Practice 1797, Common Use Passenger Processing Systems, was adopted by the Joint Passenger Services Conference (IATA and ATA) in 2008 and became the first ACI Recommended Practice 500A07. The primary benefit of CUPPS is to allow airlines to have a single CUPPS application that will work on CUPPS-certified platforms implemented by any common use supplier. Following a series of successful pilots, CUPPS is now in the implementation phase and offers airlines and airports, for the first time, a comprehensive technical standard to ensure simplification of implementation and consistency of service delivery.

CUPPS will also be able to support all of the new technology and processes coming out of the various passenger experience groups, such as near field communications (NFC) in the check-in and boarding process, self-boarding and self-tagging.

John Wayne Airport in Orange County, California, has selected a CUPPS solution, and others are also in the tender process. Las Vegas McCarran Airport is upgrading to CUPPS, with the current provider expecting to have the CUPPS system in place by mid-summer 2011.

Facilitates airport proceedings for the passengers; the application of common standards that support the implementation of new technologies is relevant in all transport modes (co-modality).

2.12.6 Automatic Free-Flow Tolling Schemes in Czech Republic

On 1st January 2007 the Czech Republicǿs nationwide electronic toll collection system ǲMYTO CZǳ started commercial operation. Since then Kapsch operates and continues to develop the system. The contract was signed for 10 years. The Czech toll network is an open system, which enables tolling of moving vehicles in unimpeded driving conditions. This multi-lane free-flow system uses microwave antennas mounted on gantries above the highway which communicate with OBUs installed on the windscreen of passing trucks. The tolling process is fully automatic and requires no intervention on the part of the driver. Behind the scenes, a major IT facility deals with transactional, financial and billing data. It is supported by an extensive communications infrastructure.

Optimising traffic fluency and minimising travel time (co-modality).

2.12.7 LKW-MAUT Electronic Toll Collection System for Heavy Goods Vehicles, Germany

In January 2005 a new toll system was introduced on the 12000km of German autobahn for all trucks with a maximum weight of 12t and above. The new toll system, called LKW-MAUT, is a governmental tax for trucks based on the distance driven in kilometres, number of axles and the emission category of the truck. The tax is levied for all trucks using German autobahns, whether they are full or empty, foreign or domestic.

Global Positioning Systems (GPS or Galileo) enable the MAUT sort of road pricing system. The pricing can be differentiated in a way that the highest prices are in the peak hours and on certain sections of high congestion risk. It could be free of charge to travel by night and thus spread out the use of the roads over 24 hours

The toll system was constructed and is administered by a company called Toll Collect. The system is a major undertaking that now affects over 1.5 million lorry drivers in Germany and the rest of Europe. The tolls collected, which amount to some ú2.4bn per year, are being used by the government on road improvements and new road construction.

The investment into the system by Toll Collect is believed to have been in the order of ú700m. The system can monitor between 1.3 and 1.5 million trucks, which travel an estimated 23 billion km/year

Optimising traffic fluency, reducing congestion, and diminishing pollution.(co-modality).

2.12.8 SMS Ticket for Public Transport in Wroclaw

The system was launched in early September 2010. A ticket bought by a mobile phone is an additional form of sales especially for outside long-distance travellers. To buy a ticket, one must first download the application SkyCash. It is a virtual account from which the person can buy not only tickets for MPK Wroclaw, but also can pay for services and purchases at other locations in the country. A PIN number secures the purchase.

There is a choice between time tickets for 72 hours and single tickets, reduced and normal for the same price as traditional tickets. The ticket is validated at the time of purchase. The controllers are equipped with laser readers, which will check the validity of tickets purchased by mobile phone.

The simple ticket purchase with a mobile phone encourages in particular visitors to use public transport also on their arrival in Wroclaw (intermodality).

2.12.9 On-Board Ticket Vending Machines in Wroclaw

Since November 2010, residents of Wroclaw, can buy tickets for public transport in vehicles. Wroclaw and the Mint of Poland (Mennica Polska, http://www.mennica.com.pl/en/main-page.html) launched a pilot program in the first mobile ticket vending machines on trams. Since February 2011 the ticket machines work in all vehicles of MPK Wroclaw.

In these machines, one can buy single tickets, period-ticket and upload to the Wroclaw URBANCARD season tickets purchased over the Internet. Machines accept credit cards (do not accept coins and banknotes). This managed to reduce the size of devices, and simplify their operation. They do not require the emptying and the supply of cash and coins.

Machines accept contact and contactless cards; use does not require a PIN, but to ensure the safety of passengers the purchase price is limited to 50 PLN. This is an innovative solution, which so far has not been applied in any Polish city. The technology used in Wroclaw was developed in cooperation with companies VISA and Mastercard. What is important for passengers is that the card payment does not incur any commission from the buyer.

The simple on-board ticket purchase encourages in particular visitors to use public transport also on their arrival in Wroclaw (intermodality).

2.12.10 DB Tickets on Mobile Phones

The core online services of Deutsche Bahn AG (journey planner, ticketing, real time arrival departure information, real time information on punctuality of a distinct train, find the next railway station) are also available via mobile phone. Especially ticket less booking of rail trips can be done in a breeze, after registering once.

Booking rail trips on the spot, without using ticket offices, travel agencies or a computer, makes travelling by rail more easy and flexible and there improves co-modality of rail transport.

2.12.11 Lufthansa Application for Smart Phones

The Lufthansa application for smart phones (iPhone and many BlackBerry devices) enables the customer to inform about flight schedules (timetable and real-time), to (re) book flights and to check-in for them (including boarding pass sent to the mobile phone), on all issues of the loyalty program and also allows baggage tracing. Furthermore information on airports served by Lufthansa is available concerning Airport buses, Airport shuttles, the products Rail&Fly and AIRail, the fleet, seating plans and communication opportunities on long-haul flights.

The application enables travellers to seamless travel including transportation to/from by providing all necessary information / booking procedures via his/her smart phone.

2.12.12 Door-to-Door Luggage Service for Rail Travel

Deutsche Bahn cooperates with the courier service HERMES to offer a door-to-door luggage service. For a charge of ú 16.80 for a standard suitcase, HERMES picks the luggage up two days before travel on the mainland and three days for travel to islands or six of the German airports. For airport travel, in contrast to the SBB arrangements (see 2.15), passengers need to pick up the luggage at the airport and then check it in there themselves. The service operates within Germany, Austria and a part of northern Italy (South Tirol), although the on-line booking form only accepts German addresses.

The luggage service makes rail travel more convenient and hence increases its competitiveness with other modes (co-modality).

2.12.13 Oyster Card

Oyster is a plastic smartcard that can be used instead of paper tickets. They can contain Travelcards, Bus & Tram season tickets and pay as you go credit. Oyster is the cheapest way to pay for single journeys on bus, Tube, tram, DLR, London Overground and most National Rail services in London.

Oyster is a plastic smartcard that can be used instead of paper tickets. They can contain Travelcards, Bus & Tram season tickets and pay as you go credit. Oyster is the cheapest way to pay for single journeys on bus, Tube, tram, DLR, London Overground and most National Rail services in London.

2.12.14 m-ticket

CrossCountry launches óindustry firstôsales and information app. CrossCountry Trains has launched a new mobile óTrain Ticketsôapp which claims to be unique in combining barcode ticket sales/storage via mobile phones with real time journey information.

CrossCountry said the demand for mobile apps had been illustrated in a new survey of 2,000 people which highlighted that the average passenger is so worried about losing their train ticket, theyöd pat pockets and look in purses three times before every train journey.

Andy Cooper, Managing Director at CrossCountry said: "The óTrain Ticketsôapp will help to transform the process of travelling by train. Access to live departure boards and an intuitive user interface, making it quicker and easier to buy cheaper Advance fares, gives the consumer full control over their journey. The innovative approach to m-tickets taken by CrossCountry has made it possible to deliver a simple and secure mobile ticketing solution for customers that will help transform the experience of buying rail tickets.ò

The óTrain Ticketsôapp supports iPhone, Blackberry, Android and Nokia smart phones as well as most everyday handsets.

Makes it easier to purchase train tickets, enhances information and traveller experience (co-modality).

2.12.15 Walrus Card

Merseytravel launched its new óWalrusôsmartcard for public transport.

The card will be rolled out in a phased approach over two years. Holders of the annual Trio season ticket covering buses, trains and ferries can receive the card.

A trial of pay-as-you-go cards is scheduled to begin in winter 2012, with full pay-as-you-go functionality expected from summer 2013.

Merseytravel says Walrus will be the first card to offer public transport and non-transport related products. There are plans for a number of tourist attractions to join the scheme and for retailers to accept the card for items such as drinks and newspapers.

Makes it easier to purchase train tickets, enhances information and traveller experience (co-modality).

2.13 ENVIRONMENTAL MANAGEMENT

2.13.1 Introduction

The next solutions have been selected as examples of initiatives aimed making transport more environmentally friendly and less dependant on fossil fuels. Although these solutions do not have a direct impact on the travel experience, like reduced travel times or travel costs for users, they suppose a major issue for the transport system as a whole towards meeting the sustainability targets established in the EU2020 strategy (by 2020, 20% GHG emissions reduction; 20% energy consumption from RES; 20% energy efficiency increase) and in the 2011 EC Transport White Paper (60% GHG emissions reduction in 2050):

- Electrification of Road Transport;
- Electrified Motorways with Catenaries;
- Thermoelectric Generators in Cars;
- Autogas (Automotive LPG);
- Fuel Cells and Hydrogen Joint Technology Initiative;
- Clean Sky: Enhanced Airplane Technology;
- Electrical Aviation;
- REACT ï CR Project: Optimisation of Airplane Landing Procedures;
- Biofuel on Commercial Flights;
- Wind Farms to Power Railways in Belgium;
- Biofuels for Cars;
- List of all Austrian Electric Car Charging Stations;
- Better Tyres for Increased Fuel Efficiency.

2.13.2 Electrification of Road Transport

The European Green Cars Initiative is one of the three Public Private Partnerships (PPP) of the European Economic Recovery Plan announced by the President of the European Commission on the 26th of November 2008. The objective of the initiative is to support R&D on technologies and infrastructures that are essential for achieving breakthroughs in the use of renewable and non-polluting energy sources, safety and traffic fluidity. Under the Green Cars Initiative, the topics include research on trucks, internal combustion engines, bio-methane use, and logistics. However a main focus is on the electrification of mobility and road transport. Through electrification of the transport sector, the use of renewable energies can be introduced, even with specific targets for sustainable cars. Beyond providing loans through the European Investment Bank, the PPP European Green Cars Initiative is making available a total of one billion EUR for R&D through joint funding programmes of the European Commission, the industry and the Member States. These financial support measures will be supplemented by demand-side measures, involving regulatory action by Member States and the EU, such as the reduction of car registration taxes on low CO2 cars to stimulate car purchase by citizens.

Minimising energy costs and reducing noise and CO2 emissions; electrification is also possible in other modes of transport (co-modality).

2.13.3 Electrified Motorways with Catenaries

In the current context of a continuous, sustained rise in the price of fossil fuels and a battle against climate change, are there credible alternatives in the field of road transport to the internal combustion engine? Some manufacturers in the area of private transport are investing in electric vehicles ï where battery performance is improving (though this remains a niche market) ï and in hybrid engines. In goods transport, matters are a little more tricky, given the length of journeys and the power required. There too, however, according to Brieuc Bougnoux, the use of electrical vehicles could be an option for the future, by way of the electrification of the road network. Bougnoux outlines the technical features of such an option, the cost of its implementation and the ï environmental, financial and infrastructure ï advantages a country like France might derive from it. This is a route that is certainly worthy of interest, but would require coordination with European partners whose road hauliers also use the French road network.

Improving environmental performance of the road sector (co-modality).

2.13.4 Thermoelectric Generators in Cars

The reduction of automotive fuel consumption is a major challenge of automotive OEMs and suppliers. It is expected that during the next decade the majority of vehicles will still be driven by internal combustion engines (ICE). As a rule of thumb about 2/3 of the fuel energy fed to the engine is converted into heat and is used only occasionally and only partly for heating the interior. One promising technology to convert exhaust heat into usable electric energy is the thermoelectric generator (TEG).

Reducing energy costs and increasing environmental performances; thermoelectric generators could also be used in other transport modes, in particular in shipping (co-modality).

2.13.5 Autogas (Automotive LPG)

Automotive LPG, often referred to as Autogas, is the leading alternative fuel in Europe, powering more than 5 million vehicles in the EU-27 in 2008. Autogas is a liquid mix of propane and butane stored under pressure, which are a by-product of oil and natural gas extraction and the refining of crude oil. Autogas powered vehicles offer numerous advantages for European society, according to AEGPL, including: reduced pollutant, noise and CO2 emissions, enhanced security of supply, and lower running costs. One diesel vehicle emits the same quantities of NOx as over 20 LPG vehicles. Autogas-fuelled vehicles generate 14% and 10% fewer CO2 emissions than its petrol and diesel run equivalents respectively. With its diverse origins - LPG is primarily derived during the extraction of natural gas and oil, and is also produced in refineries - it provides a flexible supply chain and increasing production levels. LPG from Natural Gas fields alone could last at least 60 years at the current reserve. Composed largely of SMEs, the Autogas industry employs thousands of citizens from all across Europe in high-skill jobs. By virtue of its strong supply prospects, LPG is cheaper than conventional fuels (according to ADAC, autogas coasted on average of 60 cents a litre in Germany (2009), considerably cheaper than conventional fuels).

Minimising energy costs and reducing noise and CO2 emissions; LPG could also be used to power engines in other modes of transport (co-modality).

2.13.6 Fuel Cells and Hydrogen Joint Technology Initiative

Fuel cells, as an efficient conversion technology, and hydrogen, as a clean energy carrier, have great potential to contribute to addressing energy challenges facing Europe. They will have a significant role to play in a number of energy end-use sectors, from electric vehicles to power plants.

To accelerate the development and deployment of FCH technologies in the most efficient way, the EU has joint forces with European industry and research institutes in a public-private partnership, the Fuel Cells and Hydrogen (FCH) Joint Technology Initiative (JTI). Together, the partners will implement a programme of research, technological development and demonstration to accelerate the commercialisation of FCH technologies in a number of application areas.

Minimising energy costs and reducing noise and CO2 emissions; could be applied in several modes (co-modality).

2.13.7 Clean Sky: Enhanced Airplane Technology

Clean Sky is the most ambitious aeronautical research programme ever launched in Europe. Its mission is to develop breakthrough technologies to significantly increase the environmental performances of airplanes and air transport, resulting in less noisy and more fuel efficient aircraft, hence bringing a key contribution in achieving the Single European Sky environmental objectives.

The Clean Sky JTI (Joint Technology Initiative) was born in 2008 and represents a unique Public-Private Partnership between the European Commission and the industry. It is managed by the Clean Sky Joint Undertaking (CSJU) until 31 December 2017.

The CSJU will deliver demonstrators in all segments of civil air transport, grouped into six technological areas called 'Integrated Technology Demonstrators' (ITD): SMART Fixed wing Aircraft, Green Regional Aircraft, Green Rotorcraft, Sustainable and Green Engines, System for Green Engines, Systems for Green Operations, Eco-Design.

Increasing environmental performances of airplanes and reducing noise; the general idea of improving fuel efficiency and reducing emissions and noise impact of vehicles through improved design is applicable in all modes of transport (co-modality).

2.13.8 Electrical Aviation

The Boeing subsonic team, which includes BR&T, Boeing Commercial Airplanes, General Electric and Georgia Tech, has looked at five concepts as part of the SUGAR (Subsonic Ultra Green Aircraft Research) project. The team has found that the SUGAR Volt concept (which adds an electric battery gas turbine hybrid propulsion system) can reduce fuel burn by greater than 70 percent and total energy use by 55 percent when battery energy is included. Moreover, the fuel burn reduction and the ‘greening’ of the electrical power grid can produce large reductions in emissions of life cycle CO2 and nitrous oxide. Hybrid electric propulsion also has the potential to shorten take-off distance and reduce noise.

Minimising energy costs and reducing noise and CO2 emissions; the use of electric power is also possible in other transport modes (co-modality).

2.13.9 REACT –CR Project: Optimisation of Airplane Landing Procedures

REACT – CR stands for Reduction of Emissions using CDAs in TMA in Czech Republic. The project, led by Czech Airlines, aims to implement a Controlled Descent Approach (CDA). Conventional descent procedures use the principle of descent in steps, combining periods of descent with periods of horizontal flight, during which engine revolutions have to be increased. By using the proposed CDA procedure, aircraft can descend at a constant 3º angle throughout the entire approach, reducing fuel burnt and therefore CO2 emissions. In addition, the initial and final approach will take place at higher altitudes above the ground, thus minimising both engine output and noise. Czech airlines estimate that the full deployment of CDA procedures at RuzynD Airport could reduce CO2 emissions by 10,000 t annually, along with decreasing levels of noise from aircraft by 5dB. The project held its first trial on 13 April 2011 and trials are expected to continue until September 2011. Full implementation could take place in 2012.

Increasing efficiency of aircrafts minimising noise and CO2 emissions (co-modality).

2.13.10 Biofuel on Commercial Flights

Lufthansa plans to launch a pilot study to test how well one of its planes, an Airbus 321, flies on biofuel. Each day the airline, which is based in Germany, will have four flights powered partially by biofuel between Frankfurt and Hamburg. One of the plane’s engines will run on a 50:50 biofuel and kerosene blend. According to Lufthansa, this will reduce its carbon dioxide emissions by 1,500 tons.
Production of the bio-synthetic kerosene utilised by Lufthansa rests on the basis of pure bio-mass (Biomass to Liquid- BTL). The producer is Neste Oil, a fuel refining and marketing company from Finland. The company has years of experience in biofuel production and has cooperated with Lufthansa for many years. Certification of its biofuel is expected in March 2011.

Minimising energy costs and reducing CO2 emissions; the use of biofuel is also possible for other modes of transport (co-modality).

2.13.11 Wind Farms to Power Railways in Belgium

Given that electric power may be produced by a number of sources, some of them with a very low carbon footprint, the use of electric power increases rail’s environmental advantages. A good example of this is Infrabelôs ówind farmôto power the High Speed Line between Leuven and Liege. Apart from the environmental benefits this project generates, the wind farm will also promote more rational use of public funds. The electricity will cost around 30% less than the current market price. In addition, electrified rail transport provides a solution to the growing concern of oil dependency. Moreover, ProRail has signed an agreement with an energy company to develop Railwind, a unique concept involving wind turbines above railway tracks. Apart from the obvious and substantial environmental benefits of the project, Railwind also contributes to better and efficient use of space and existing infrastructure. It is expected that the first energy generated from this project will be available in 2012.

Minimising energy costs and reducing noise and CO2 emissions; wind power can also be used to generate electricity for other transport modes (co-modality).

2.13.12 Biofuels for Cars

The EU road transport sector accounts for more than 30% of the total energy consumption in the Community according to Biofuels in the European Union ï A vision for 2030 and beyond by European Commission. It is 98% dependent on fossil fuels with a high share of imports and thus extremely vulnerable to oil market disturbance. It is expected that 90% of the increase of CO2 emissions between 1990 and 2010 will be attributable to transport.

One of the most promising alternative fuel options for substituting oil as energy source for propulsion in transport are liquid biofuels (technically substituting oil in all transport modes, with existing power train technologies and existing re-fuelling infrastructures, but the production of biofuels being limited by the availability of land). As an alternative fuel, biodiesel is simply diesel fuel made from a variety of biomass sources. Since it can be grown domestically rather than pumped out of the ground from foreign sources, increased use of biodiesel offers significant benefits.

Europe has defined ambitious targets for the development of biofuels. The aim is to improve European domestic energy security, improve the overall CO2 balance and sustain European competitiveness. In 2030, domestic EU biomass would thus hold the technical potential to cover between 27 and 48 % of our road transport fuel needs (360 Mtoe), if all biomass would be dedicated to biofuels production.
By 2050, biofuels could provide 27% of total transport fuel (road, rail, air and shipping) and contribute in particular to the replacement of diesel, kerosene and jet fuel according to the Technology Roadmap Biofuels for Transport by the IEA. The projected use of biofuels could avoid around 2.1 gigatonnes (Gt) of CO2 emissions per year when produced sustainably.

Significant cost reductions in the production process would be needed to transform the technical potential into economic potential. Cost reduction of 20-30% seems plausible using future technology (beyond 2010). Preliminary estimates based on 2005 market prices, suggest that 25% biofuels in road transport in 2030 could cost in excess of ú 31 billion per year, equivalent to an additional 6.6 euro cent per litre of gasoline and 8.2 euro cents per litre of diesel

The best option for biomass to be used for road transport is to convert it into liquid fuels, since these have the highest substitution potential (gaseous fuels will continue to grow but will remain in the lower 10% because of logistic restrictions).

Biofuels will mostly be used in gasoline- and diesel-type internal combustion engines. However it is possible that specialised engines will be used in certain applications or in dedicated fleets. The majority of engines available in 2030 will require liquid fuels, although their molecular composition might have evolved from todayôs fuels. It will be beneficial if the new fuels are similar to, or at least compatible with, todayôs fuel types and specifications.

2.13.13 List of all Austrian Electric Car Charging Stations

The website www.elektrotankstellen.net contains a list of currently 3176 stations where electric cars can be charged up. Any new station can upload their information there directly. The site can be searched by town, by postcode, by Bundesland, by newest stations or with a map. Furthermore there are downloadable pdf lists for each Bundesland. The site also indicates that in the regions Achensee and Bad Ischl guests can recharge their cars everywhere where they stay overnight or even only consume a meal.

Knowledge of available charging stations will encourage the purchase of electric cars and therefore make car travel more sustainable. (co-modality)

2.13.14 Better Tyres for Increased Fuel Efficiency

From November 1st 2012, the 115 million tyres sold in the EU every year will have to carry a label telling customers how energy-efficient they are, how safe they are ï in rain ï and how loud they are. Over the past few months, Europeõs tyre makers have been falling over each other in announcing A-A tyres (rolling resistance and wet grip respectively). And thatõs not just for car tyres but also in the truck tyre segment. Europeõs tyre industry is spending huge resources promoting these new efficiency labels, as it can now better explain what makes the European products different from cheaper competitors, mostly imports. Previously, all tyres were just similar.

Even if this new regulation wonõt tackle climate change by itself, a move from C to A is estimated to cut fuel consumption by about 3%, according to T&E, saving some 30 megatonnes of $CO2$ yearly.

A few lessons can be pulled, according to T&E. The first, regulation was successfull to unleash the full force of business innovation; the market alone just did not do it. Once more it was underestimated the speed of adaptation. Second: it cannot be assumed that professional buyers are fully rational and know everything, an interesting lesson for all those thinking of fuel efficiency labelling and standards for trucks and aircraft. Third, if the industry is capable of moving from C to A within 18 months, it may be concluded the limits for the A-label might too modest.

Improved tyres make car travel more sustainable. (co-modality)

2.14 ENHANCED SAFETY

2.14.1 Introduction

The next solutions have been selected as examples of initiatives aimed making transport more safe. Although these solutions do not have a direct impact on the travel experience, like reduced travel times or travel costs for users, they suppose a major issue for the transport system as a whole towards meeting the safety targets established in the 2011 EC Transport White Paper (transport fatalities close to zero level by 2050):

- Assisted Car Driving Systems in the Netherlands;
- Intelligent Speed Adaptation in London;
- Pay As You Speed Research Program in Denmark;
- Vehicle to Vehicle Communication;
- Improved Connections between Pilots, Aircraft and Ground Systems ;
- Fully Accessible Barcelona Metro to People with Reduced Mobility.

2.14.2 Assisted Car Driving Systems in the Netherlands

Roads to the Future is an innovation programme from the Dutch Directorate-General for Public Works and Water Management (Rijkswaterstaat) to test how new technologies in vehicles can contribute to its road management objective. Various drivers in approximately 40 vehicles equipped with ADA systems (Advanced Driver Assistance) drove around the Netherlands. Behavioural aspects and traffic effects were analysed. Headway Monitoring and Warning (HMW), Adaptive Cruise Control (ACC), Lane Departure Warning (LDW) and Lane Keeping Assist (LKA) were used during ôThe Assisted Driverö pilot. HMW constantly indicates the distance to the vehicle ahead on a display and provides a warning the moment the distance is less than the specified limits. ACC is an advanced form of the cruise-control system currently installed in many cars, ensuring that distance with ahead car is maintained automatically; if the car gets too close to the vehicle in front, the system will brake. LDW is a system that warns the driver when the vehicle is about to leave the lane it is travelling in unintentionally. LKA actively helps the driver to ensure the car continues on the right course by correcting the steering when the car leaves the middle of the lane. The majority of participants in the pilot are satisfied with AWS. They find the system easy to use and believe that driving with both LDW and HMW is conducive to road safety. There is a preference for LDW above HMW.

Increasing safety in road network. (co-modality).

2.14.3 Intelligent Speed Adaptation in London

Intelligent Speed Adaptation (ISA) is a system that provides, within the vehicle, information on the speed limit for the road currently being travelled on. That information can be used to display the current speed limit inside the vehicle and warn the driver when he or she is speeding (i.e. Advisory ISA); it can be linked to the vehicle engine and perhaps brakes to curtail speed to the speed limit for the road while allowing the driver to override the system (i.e. Voluntary ISA); or it can be linked to engine and brakes without the possibility of an override (i.e. Mandatory or Non-Overridable ISA). Over the last few years, London has achieved considerable reductions in casualties resulting from road traffic collisions. The city is exploring new technology like ISA for low cost ways to achieve further reductions. ISA may have many benefits beyond the expected reduction in casualties. These include reduced possibility of speeding tickets, improved driver style and an associated reduction in CO_2 and fuel costs.

Increasing safety in road network, optimising traffic fluency and minimising CO2 and fuel costs (co-modality).

2.14.4 Pay As You Speed Research Program in Denmark

The purpose of the project is to examine whether equipment for Intelligent Speed Adaptation installed in driversôcars combined with insurance discounts can motivate drivers to reduce speed. The project is carried out by the Traffic Research Group at Aalborg University in cooperation with the Danish insurance company Topdanmark, the computing services companies M-tec and Webhouse and Copenhagen University. The project contains three sub projects: Development of ISA equipment e g an On Board Unit (OBU) in the cars and a web server to handle log files. Development of digital speed maps and a web application for local authorities to update the position of speed signs. A test period of three years with 300 test drivers. A precondition for participation is that the car insurance is held in the insurance company Topdanmark, which accept to offer a discount of up to 30% of the insurance rate. The three years are divided in 6 periods of 6 months. After each period the drivers are paid 30 % bonus on their insurance rate minus 7 cent for each penalty point registered in the period.

Increasing safety in road network. (co-modality).

2.14.5 Vehicle to Vehicle Communication

Ford Motor Company is rapidly expanding its commitment to intelligent vehicles that wirelessly talk to each other, warning of potential dangers to enhance safety and flag impending traffic congestion to help improve the environment. Intelligent vehicles could potentially help in 81 percent of all police-reported light-vehicle crashes involving unimpaired drivers. Experts say intelligent vehicles could be on the road in five to 10 years.

For example, drivers could be alerted if their vehicle is on path to collide with another vehicle at an intersection, when a vehicle ahead stops or slows suddenly or when a traffic pattern changes on a busy highway. The systems also could warn drivers if there is a risk of collision when changing lanes, approaching a stationary or parked vehicle, or if another driver loses control.

Improving traffic flows and increasing safety in road network. (co-modality).

2.14.6 Improved Connections between Pilots, Aircraft and Ground Systems (UPLINK)

This aim of this programme was to provide a datalink connecting pilots and controllers or aircraft and ground computer systems in order to have fewer misunderstandings and reduced workload for controllers as part of their management of airspace. This would as a consequence lead to increased safety and efficiency. The deliverables were split between air and ground aspects (EC Euro19.3 million for airborne acceleration). Although system operational validation began at the time when Vision 2020 was established in 2000, full European system deployment is envisaged by 2015. The programme is led by EUROCONTROL with a research budget of ú 576 million.

Improving safety and efficiency of air transport. (co-modality).

2.14.7 Fully Accessible Barcelona Metro to People with Reduced Mobility

The Parliament of Catalonia approved Law 20/1991 of 25 November promoting accessibility and removal of architectural barriers which aims to ensure people with reduced mobility, or any other limitation, access to and use of goods and services of society. According to the Infrastructure The main objective of these actions is adapting at least one of existing vestibules at each station in order to make possible the journey from street to platform for people with reduced mobility.

Accessibility solutions consist mainly in providing access via a lift from street level to the vestibule level and from the vestibule level to the platforms by one or two lifts depending on each case. This action is complemented by the construction of ramps where needed and the implementation of standard routings for the blind in the routes adapted. All lifts have installed dual electric service connection to function in adverse conditions. TMB continue to work to make the metro more accessible for everyone, gradually adapting its facilities, and installing voice-guided ticket vending machines throughout the network, tactile paving strips for the blind in many stations and door closure warning lights on an increasing number of trains.

The network transformation process is difficult sometimes as adaptation requires important investment effort. Nowadays, 83% of the stations of Barcelona subway network already have an elevator (115 stations), and 95% of the stations of the suburban FGC rail. Between 2001 and 2010, the Infrastructure Plan of the Barcelona Metropolitan Region has allocated almost 280 Mú to implant elevators to metro and rail stations.

Making public transport accessible to all (co-modality)

3 APPLICABILITY OF BEST PRACTICES: OVERCOMING MOST EVIDENT SYSTEM PROBLEMS AND NEEDS

3.1 APPROACH

The ORIGAMI project defined itself in its Description of Work as being "concerned with improvements in long-distance door-to-door passenger transport chains through both improved co-modality and intermodality."

For intermodal trips ORIGAMI is looking at all elements of the transport chain:

- The "first and last mile" from the interchanges to final origin and destination, which again may encompass more than one mode;
- The interchanges to, within and from the long-distance part of the trip (exempt from the ORIGAMI investigation with regard to interchanges are all airside operations at the airport); and
- The central long-distance journey that may comprise one or more legs and one or more modes.

The "first and last mile" may involve one or any combination and number of the following modes: bus / tram / metro, rail including S-Bahn, ferry, car, and cycling and walking. Furthermore, ORIGAMI also looks at the pre-trip stage where the trip is actually planned.

For the long-distance leg, there are four types:

- Journeys where the long leg only involves one mode, e.g. access trip to the airport, flight (with or without interim stop and flight change), egress from airport; this would also include trips that are made by car all the way from origin to destination and do not involve any change of mode at all;
- Journeys that involve more than one-long-distance leg, e.g. access to a rail station, rail journey to an airport 200 km away, a flight and then the egress from the airport;
- Journeys where the long leg is not continuous, but may be interrupted by local transport, e.g. access to a rail station, a rail trip to London Waterloo, the tube to Heathrow airport, a flight to Paris and then egress there; and finally
- Journeys with cars that involve trains or ferries; in certain contexts they are considered as unimodal, because the passenger uses the same car from beginning to the end of the journey; however, on the ferry or train, the passengers have to leave their vehicles and go into the lounges or coaches for safety reasons, and at that stage they do become a ferry or train passenger like any other, except that they can leave their luggage in the car. The same type applies for trains loaded on a ferry, so that in general roll-on and roll-off traffic qualifies for this type.

The applicability of solutions is reported in relation each of the trip stages above mentioned. First the problems and system needs[3] addressed are presented, and then a discussion is presented on the applicability of the ORIGAMI best practices to overcome them.

This discussion is also available at the On-line Best Practice Library (www.origami-project.eu).

3.2 PRE-TRIP STAGE

3.2.1 Problems to be Addressed: System Needs

The two key issues at the pre-trip stage are

- Multimodal travel information and
- Integrated ticketing.

Concerning the travel information, there are four main aspects:

[3] System needs have generally been derived from user needs, but in some cases also take account of the operators' needs.

- The first aspect is the capability to combine information from different modes of travel. This does include all relevant information for decision making such as travel time, travel cost, frequency, transfer time, and station/terminal information;
- The second aspect is the capability to plan a true door-to-door trip that even includes the walk to the nearest bus stop or train station;
- The third aspect is the capability to build alternative routes with alternative modes and combinations of modes for a trip;
- And the fourth one is the capability to calculate the CO2 emissions for each of the alternative trips to provide another decision criterion besides the classical transport characteristics of time, price, etc.

All of these relate to all trips involving any form of public transport mode, and the last two should also include car trips. Furthermore, the trip information should be available for trips across at least all 27 Member States plus Norway and Switzerland.

Concerning ticketing, it should be possible to book a single ticket for all public transport legs of a journey from anywhere to anywhere at least in the EU27 plus Norway and Switzerland, including flights, ferries, rail and local public transport. Furthermore, not everybody who has web access and can book a ticket also has a printer available.

Table 3-1 Pre-trip stage system needs for analysis of bottlenecks

Mode	System needs
All public transport	On-line information on prices, routes and timetables
	On-line real-time information on delays and cancellations
	On-line travel information for combined public transport modes
	On-line door-to-door travel information for public transport usage
	Fully integrated on-line public transport ticket
	Ticket not requiring a printer
All forms of transport	On-line comparative travel information with all realistic mode combinations incl. car usage and flights
	On-line comparative information on CO2 emissions for different mode combinations

3.2.2 Applicability of ORIGAMI Solutions

All public transport

On-line information on routes and timetables

For on-line information on public transport there are a number of good examples around. For information on routes and timetables for local transport there are, for instance, the Poznan Metropolitan Area Travel Planner (example 10.10 in website) and the Edinburgh Bustracker (10.11), but there are many others around, since the provision of this information is straightforward with today's technology.

However, the language barrier can constitute a problem. The Poznan planner is a positive example, since it also provides information in English, but this is not the case for every planner, and some are therefore of little use for the international traveller at the destination city. Furthermore, even where there are any language options, English is normally the only alternative to the local language, and this will constitute a problem for people less fluent in English.

On-line real-time information on delays and cancellations

Although the Edinburgh Bustracker (10.11) does contain timetable and route information, its main purpose is real-time information on the next two bus arrivals of any line at any stop in the city. The information is available both on the internet and on mobile phones. To get the information on the phone, users have to enter the unique bus stop code that is displayed at the stop, and for regular users there is also the option to store the code, so that they can also call up the information from their home or office, the pub or restaurant, or anywhere else. If the phone is equipped with a positioning tool, the application automatically scans for nearest bus stop. For internet users, the sites provides maps by postcode, which displays all stops in area, and the users simply click on the stop icon to get the next bus departures.

For rail travel DB and their website Reiseauskunft (10.3), where one can select up to 12 languages, as well as their app DB Navigator (10.18) are examples of real-time information. When information about travel options for a trip is requested, the site and app indicate the length of any delays in the expected train arrival and also flashes up, whether the connection to the onward leg of the trip may become too short. VBB Fahrinfo (10.17) also has real-time information on local public transport.

Technically, all of this is all not a problem and can be installed anywhere, where the operator has the knowledge about the whereabouts of his fleet.

On-line travel information for combined public transport modes

Flyrail (10.9) is the result of the cooperation between SAS and the Swedish public train operator SJ. It provides information for air travel between any Swedish and international airport and combines that with information on airport access, respectively onward travel, by train and bus within Sweden.

The START project (10.7) has develop a multilingual web portal www.integra-travel.eu that provides information for travel between originally nine, and now 52, cities in Scotland, England, France, Spain and Portugal. It offers several options for each origin-destination pair that may involve flights, ferries, trains and long-distance buses, and the user can choose to get the options ranked either by trip duration or number of interchanges. The icon for each leg of the journey contains a link to a relevant operator's site, e.g. an airport operator or a rail enquiry site, where precise time schedules are to be found. START, up to now, only provides city to city information and none on local public transport, although it is the project's expressed intention to provide this eventually as well.

The public version of routeRANK (10.13) provides information for travel in all of Europe by air, rail and/or private car, and it gives a large range of travel options on a city to city basis[4]. By not including ferries it is, however, not fully multimodal.

On-line door-to-door travel information for public transport usage

The complexity of an information increases dramatically, when not only information on different modes of transport needs to be combined, but actual door-to-door information is to be provided, because this does not just require the knowledge of a discrete, even if large, number of stops, but of the detailed whole underlying road network, including often the location of specific sites, such as theatres, shopping centres etc. In principal, these planners have to combine the knowledge available in the multimodal public transport planners with that of satnav[5] systems for car drivers. In spite of this complexity, there are several examples of such planners around, even if none of them covers door-to-door information from anywhere to anywhere in Europe.

Transportdirect (10.8) is a multi-modal travel planner for mainland Britain and the Western Isles. It is not quite door-to-door by house number, but it goes down to postcode level, which in the UK usually means only a very short stretch of road.

DB Reiseauskunft (10.3) and DB Navigator (10.18) and Resrobot (10.4) are door-to-door in Germany and Sweden respectively, but also offer rail information across Europe.

VBB Fahrinfo (10.17) is a multi-modal route planner for the Berlin region, partially developed within the EU-SPIRIT project. It is one of only two sites known that also has at least some door-to-door information for other countries, in this case for Sweden, Denmark and Warsaw. (The other one is the Mobiliteitszentral from Luxemburg, which also has this for Denmark, Sweden and parts of Germany http://mobiliteitszentral.hafas.de/hafas/query.exe/fn.) Rejseplanen (10.5) and Resrobot (10.4) were also part of EU-SPIRIT, but the international capability appears to be defunct now, but Alsace and Lorraine are also coming on soon.

The In-Time project (10.2) has produced an interface for the exchange of traffic data. Based on this interface on-line traffic information as well as route planning advice is available for users in Vienna and the Burgenland, Florence and Tuscany, Munich and Bavaria, Brno and Moravia, Oslo and Bucharest. In-Time provides pre-trip as well as on-trip information. The platforms that are supported are iPhones, Windows Mobile and Java for a series of other mobile phones.

4 There are commercial applications of routeRANK that also include door-to-door information

5 Satellite Navigation

So it is possible to provide international door-to-door information, but a major effort will be involved in networking all the relevant information, so a system that provides door-to-door information from anywhere to everywhere in Europe appears to be still many steps away

Fully integrated on-line public transport ticket

There are a number of sites that allow some form of integrated ticketing. SailRail (9.4) and the Dutchflyer (9.5) provide integrated rail and ferry tickets. In Pomerania there is an integrated rail, bus and ferry ticket for visits to Malbork (the largest Teutonian castle) and Krynica Morska available to tourists (9.8). The Swiss SBB offers an add-on ticket to their rail tickets for all public transport services in the destination city for the day of arrival (10.1). Deutsche Bahn, in conjunction with a number of airlines, offers Rail&Fly (9.9), an integrated plane and rail ticket as well, for a range of cities, the use of local public transport services.

The above mentioned Rejseplanen (10.5) is not only a journey planner, but also allows purchasing train tickets, and since the train operator DSB also operates a wide range of bus routes in Denmark, this means that for many connections fully integrated bus and train tickets are available.

SJ and SAS have created Flyrail.se (10.9), a new website where users can book their journeys within Sweden and through to Europe. Flyrail combines train, plane and bus travel from travellers local bus stop to all SAS' European destinations. Users can book travel by train, SAS planes and local transport companies in one and the same booking. The SJ and SAS joint travel "Get you there" guarantee means users can travel secure in the knowledge that they will reach their destination. If SJ or SAS is delayed and users then miss their connection, they will be booked onto the next departure free of charge.

Paperless Tickets

The Oyster card (11.11) is valid on the London Underground and Overground, buses, trams, the Docklands Light Railway and some National Rail services. It was first issued with a limited range of features and there is continued phased implementation of further functions. It is a form of electronic ticketing being a stored value contactless smart card which can hold single tickets, period tickets and travel permits which have to be added to the card before travel. Usage is encouraged by offering substantially cheaper fares on Oyster than payment with cash. The Walrus card (11.14) has a similar functionality as the Oyster card, but also offers discounts and offers for local attractions and shopping.

An alternative to smart cards are mobile phone apps. One example for urban public transport exists in Wroclav (11.7), where users can download an app, register, charge their SkyCash account from their bank account and then buy and display single trip or time-limit tickets. A similar app for rail is offered by Deutsche Bahn (11.9) and Crosscountry (11.13) and for air by Lufthansa (11.10), although LH does not issue any tickets at all and all the flyer needs is the booking reference.

On-line comparative travel information with all realistic mode combinations including car usage and flights

The routeRANK system (10.13) mentioned before does not only provide information on rail and air travel, but also calculates the travel time for a pure car journey or suggests car use for access from a city to an airport, and is therefore truly multimodal for the long legs of any trip in Europe.

Ecopassenger (10.6) is a town-to-town travel planner for Europe excluding the UK. For every O/D pair it calculates a train journey, a car journey and, where distances are big enough, a flight. For train travel it gives a detailed timetable for the whole journey, for car travel a full detailed route, but for flights only departure and arrival airport and number of flight changes. For flights it breaks emissions down to access, flight and egress, and the user can choose access and egress mode. Unfortunately it returns "unfortunately there was no route found" for many city combinations.

The Swedish Resrobot (10.4) and Transport Direct (10.8), also both mentioned before, are improving on routeRANK and Ecopassenger by also including the first and last mile of the trip within Sweden respectively the UK, but neither allows car use for access and egress of the main trip stage. Furthermore, Transport Direct is limited to national travel and allows flights only to the northern parts of Scotland and not otherwise within the UK.

The In-Time project (10.2), that has route planning advice for users in Vienna and the Burgenland, Florence and Tuscany, Munich and Bavaria, Brno and Moravia, Oslo and Bucharest, also provides flight data as well as, through an associated package, a car route planner for travel between these six regions and cities. Its shortcoming is that it has no rail data

So routeRANK goes furthest towards meeting the requirements for a truly multimodal long-distance European transport planner, but it would need ferry information and the additional first/last mile features of the other examples to provide a fully satisfactory solution.

On-line comparative information on CO2 emissions for different mode combinations

There are several of the aforementioned route planners that provide some information on CO2 emissions for the different mode choices.

routeRANK (10.13) simply shows the CO2 emissions for any leg of any calculated trip without indicating the basis for this calculation. Rejseplanen (10.5) calculates the CO2 emissions for each suggested public transport journey and compares that with those of a medium sized car with an unspecified passenger number.

Transport Direct (10.8) adds a comparison with coach and, for longer journeys, with flight emissions, although it does not take account of the length of the flight and the relative impact of start and landing. It also allows specifying the number of passengers in a car and shows CO2 both for a large and small passenger car.

Reiseauskunft (10.3) adds to that information on energy consumption and particulate emissions; it also allows the specification of the type of car and engine, gives the choice between average and maximum utilisation of public transport and of the feeder mode for flights. Ecopassenger (10.6) has the same options, but also provides information on emission of nitrogen oxides and nonmethane hydrocarbons.

What none of them do is take any account of the type of train or aircraft[6] that will actually be used. Whether it is a heavy old diesel train, High Speed Rail or Belgian railways powered by wind farms (12.10), the assumption made for rail emissions by any of the planners stay the same[7].

3.3 First/Last Mile

3.3.1 Problems to be Addressed: Systems Needs

The so-called first/last mile stage of any long-distance journey corresponds to the access and egress stages to the long-distance leg(s). The next table presents critical system needs.

For access by car, two issues are listed. For the purposes of this paper, the general reduction of travel time will be seen in the context of efficient connections, i.e. high-quality roads that allow quick and easy access to the interchange point, while minimising congestion will refer to effective traffic management.

A requirement for car users not listed here is the need for a parking space. Is the car used for the first leg of a journey, then the parking space is needed at the interchange, and if this interchange is an urban rail station, then parking is often a problem. The solution could either be to build more spaces or to manage the spaces through a rep-booking system that could advise the driver at the approach to the station not only where the nearest parking lot is, but the nearest available space - may be not in the nearest lot. Where the car is used for the entire journey and, again, ends up in an urban area with which the driver is often not familiar, then the possibility to book a free parking space that is as close as possible to the final destination and then to be guided towards it, would be a very valuable service.

6 The schedules do not indicate whether the aircraft is equipped with winglets, which would reduce emissions.

7 There is a lack of information about emission relevant data in the schedules

Table 3-2 First/last mile stage: critical areas in the system needs

(Source: ORIGAMI D4.2 of WP4)

Mode	System needs	Critical areas
Road (car)	•Efficient connections with the interchange point •Reducing congestion and travel time	√ √ √ √
Coaches/Bus	•Free flow traffic condition, reducing access/egress travel time, •Safety and comfortable bus/coach stops	√ √ √ √
Rail	•Information needs: rail service information to be made available via the web, including price and journey conditions •Enhancements of connections from rail stations to other modes	√ √ √ √ √
Cycling/walking	•Efficient connections with terminals : cycle paths, footpaths •Information provision (signs, etc)	√ √ √

The final requirement with regard to cars is to have one available at the destination station for the final mile. At airports this normally means car rental, but in most rail and coach stations there will only be taxis available for final legs that cannot easily be done by public transport. The availability of a car sharing station would avoid the need for taxis, reduce the costs for travel and may encourage multimodal travel in the first place.

For buses as well as trams the general requirements for reducing travel time are the same as for cars, but in addition to generally optimising traffic, buses will benefit from bus lanes, which may be segregated or just a reserved lane within the general road space. Those within the general road space may be permanent, or where bus volumes are lower, only be reserved during peak traffic. In addition, buses and trams can be speeded up through bus and tram priority at junctions. Safe and comfortable stops are specific to both buses and trams, and for metro stations there is also the issue of accessibility for those not able to use escalators or even stairs in the case of an escalator breakdown.

D4.2 was generally written with a view to user needs, but the operator perspective is also relevant. Optimising operations is a requirement that is relevant for all transport operators, and for all of them there are various means to doing so. However, in the context of buses there is one particular option to which much more attention should be given, and that relates to the fact that there are so many large buses running around with only one or two passengers in it, which makes public transport in these cases very inefficient. But there are some examples where taxis are being used on demand instead of scheduled buses at times or on routes with low demand, which hugely increases efficiency.

For rail there is the need for information listed, but this will be moved into a separate category of pre-trip information that was not used in D4.2.

Enhancement of connections to other modes is, in D4.2, meant to be specifically the building of airport rail links, but could of course also refer to ports, although for these even the provision of bus links would be an improvement to the status quo. What is equally relevant for rail stations as for metros is accessibility to the platforms, but this issue will be addressed in the context of rail stations as interchange points anyhow, and therefore does not need to be listed here as well.

Good cycle paths and footpaths are certainly needed, but they should be seen as part of the general local infrastructure and not as a potential bottleneck for long-distance journeys. Given that long-distance journeys generally involve some form of luggage, there will only be very few long-distance travellers wanting to access the main mode by bike and certainly not warrant building dedicated cycle paths for them. Similarly, information provision for pedestrians and cyclists on their way to airports, ports and railway stations, cannot be seen as a bottleneck for long-distance travel. Facilities for pedestrians and cyclists are therefore not included in any further considerations for this paper.

Something else to note is that the table does not make any reference to ferries, although they may also form a key part of the access to a long-distance means of transport, with the ferries connecting to Amsterdam Central train station and to Marco Polo airport in Venice among the most prominent examples. The key system need for these is that they are fast and frequent; this is of course also relevant for other public transport, but for ferries speed differences can be particularly stark. Furthermore, they have the same requirements as buses concerning safe and comfortable stops.

Common to all public transport modes is the need for real-time information on the current mode: is the bus/train/ferry on time? Will I reach the interchange in time for my onward connection? And related to that in addition, I would be useful if the traveller had also real-time information on the onward connection: will they depart on time? Or can I relax, because my bus is delayed, but I can see that my flight is delayed as well.

The final list of system needs for the first/last mile for chapter 3 is therefore the one shown in the table below.

Table 3-3 First/last mile system needs for analysis of bottlenecks

Mode	System needs
Car	Efficient road connections
	Effective urban traffic management
	Pre-bookable parking space
	Availability of a car for the last mile
Bus, tram, metro	Safe and comfortable stops
	Accessible metro stops
	Dedicated bus lanes
	Bus and tram priority at junctions
	Public transport links to ports
	Optimising public transport operation
Rail	Rail links to ports and airports
Ferries	Fast and frequent connections to airports and rail stations
	Safe and comfortable stops
All public transport	Real-time information on status of current vehicle
	Real-time information on status of onward main mode of travel

3.3.2 Applicability of ORIGAMI Solutions

Car

Efficient road connections

Efficient road connections refer to extra-urban roads that would lead to ports and airports (for urban roads see next section). In most cases the larger airports have direct motorway access, and a particularly good example is Frankfurt airport (1.2), which lies directly at the cross-roads of the A3 and the A5, two Germany's most important motorways. Good road access is generally a problem for many of the airports only used by low-cost airlines, like Hahn and Weeze, an hour's drive on country roads from Frankfurt and Düsseldorf airport respectively, but nevertheless referred to as Frankfurt-Hahn and Düsseldorf-Weeze by the airline Ryanair.

Where motorways do exist, congestion may still make the connection inefficient, as is for instance often the case for Glasgow airport. Therefore the second pre-condition of efficiency is that the motorways are well managed with efficient control systems. More on this aspect can be found later in the context of the main trip stage.

Effective urban management

All larger cities and smaller towns have some form of Urban Traffic Control (UTC) management at various degrees of complexity and sophistication. The key tools are traffic lights at intersections and pedestrian crossings. Many of the lights are controlled by pre-planned fixed-time programs, but there is a large variety of real-time control algorithm available; for single junctions the most notable is probably MOVA, while for urban networks some of the most prominent ones are SCOOT, SCATS, UTOPIA, BALANCE and TUC. The other main tool in larger cities is parking guidance systems that show where free parking spaces can be found. However, while they all help manage traffic better, none of them has been able to solve congestion problems in big cities and at peak times of the day.

The only other way of influencing traffic volumes in a city is road user or congestion. Singapore was the first to bring traffic volumes down to a manageable level with their Electronic Road Pricing (ERP) scheme (6.13). In Europe London (6.4) and Stockholm (6.5) have successfully implemented charging schemes in their cities, but their charging structure is much less flexible and therefore less effective in tackling congestion than Singapore's. The Netherlands has plans for introducing a much more wide-ranging nationwide charge with a flexible pricing structure like Singapore's that allow will targeting in particular congested areas (6.1) and could turn out to be equally effective.

Pre-bookable parking space

The idea for pre-bookable parking spaces with the idea to reserve a space in advance of the trip has been vented since a long time, but there are still no examples known where this is available for general city centre parking. One example where pre-booking is available for a specific car park and a specific venue is the O2 arena in London (9.10), where it is possible to secure a parking space by pre-booking on-line.

Pre-booking is also available for many airport car parks, but here the purpose is generally to secure a discount rather than guaranteeing a space, since most airport car parks have spare capacity anyhow. Just at some German railway stations pre-booking allows to reserve parking space but often this service is limited to frequent travellers joining the bonus program of Deutsche Bahn.

Availability of a car for the last mile

For arrival at airports, the desire for onward travel by car is generally not an issue, since all airports have a number of car hire companies on their grounds. Also available in many places are Park & Ride facilities for car drivers accessing public transport for the main part of the journey.

In contrast, train stations do not normally include car hire facilities but there are some examples how alternatives have been created. In Austria there is a network of 200 car sharing stations, 20 of which are located at rail stations. Moreover OBB incentivises car sharing by offering an advantage card that not only gives rail discounts, but also serves as key to car share cars (2.12).

In Bremen, there are 40 so-called Mobilpunkt stations, one of which is at a ferry and one at the main rail station (2.13). The idea of Mobilpunkt is to combine public transport use for the main journey with the use of either bicycles or a car from a car share pool for the first and/or last leg and to provide mobility related information.

In the north of Hessen in Germany there are plans for five towns for local people to organise their own "public transport" (7.7). Private cars will serve the bus stops to collect passengers for carrying passengers within the town and its districts for one Euro per trip from autumn 2012. Drivers receive a compensation of 30 Cent per kilometre. The test will be running for two years, to find out, if such a system is accepted by the citizens. Services shall be offered on an hourly base and are to be booked via internet or by phone. If no holder of a private car can be found for a specific transport, a taxi service will help out.

Bus, tram, metro

Safe and comfortable stops

User requirements for facilities at bus stops are generally rather basic: they want shelter against rain, good lighting at night time for safety and ideally somewhere to sit. Examples for stops that fulfil these basic requirements can be found all over Europe.

Accessible metro stops

There are a great number of metro stations around Europe that would not be accessible with a wheel chair and where even mothers with pushchairs will struggle, in particular, as is so often the case, when some of the escalators are not working. However, in more modern metro stops elevators can more often be found, and Barcelona is rolling out a whole programme of making metro stations more accessible (13.6). Accessibility solutions consist mainly of providing access via a lift from street level to the vestibule level and from the vestibule level to the platforms by one or two lifts depending on each case. This is complemented by the construction of ramps where needed and the implementation of standard routings and tactile paving strips for the blind as well as voice-guided ticket vending machines.

Dedicated bus lanes

There are many examples for both bus lanes that operate all day and those that are only reserved during peak hours and for those operating all day both for lanes which are taken out of the general road space and those that are segregated. In Madrid there is also one example where the bus lane operates as a tidal flow system and is open for opposite directions during the morning and afternoon hours (6.19).

Public transport links to ports

There are a great number of ports that do not have any satisfactory public transport connection to the next bigger town, because the ferry service is totally geared up for trucks, cars and coach travellers. However, there are a number of exceptions and two particularly positive examples are Helsingborg (2.19) and Piraeus (2.24).

In Helsingborg there is a new large ferry terminal complex to which local and regional buses were rerouted when it was built. In Piraeus, most travellers arriving from Athens make use of the very convenient metro. Line 1 terminates at the Port, from there it is a short walk to the Saronic Gulf ferries, hydrofoils and catamarans, or a free shuttle-bus ride to the ships sailing to Crete and the Dodecanses. Central Cyclades ferries conveniently sail from just across the metro station. Direct Airport Express buses run 24 hours between the port of Piraeus and Athens International Airport. Other public buses connect Piraeus with its outlying suburbs, the southern coastal zone and with central Athens.

Optimising public transport operation

The efficiency of public transport services depends on the load factor. Large buses driving around with only two or three passengers are highly inefficient. Apart from the obvious solution of using smaller buses for certain routes, one key option is the introduction of demand responsive services. There is a variety of options for those: they may run on fixed or semi-fixed routes where they only serve stops, if called there by a passenger, or they may roam to provide door-to-door services. Some services only run during night time, while others operate all day.

There are also now several examples around where for routes and or times of low passenger volumes, taxis are used instead of buses as part of public transport services. In Austria many towns provide collective taxi services that can be called by telephone either on fixed bus routes or for door-to-door travel at either the same fare as buses or at least at a much lower rate than a normal taxi fare; in two examples the service is dedicated for women or for young people at night time, in the latter case with the expressed aim to prevent them from drink-driving (7.9). In the Limburg region the taxi option is divided into three specific types: taxis on fixed routes (maximum of 8 passengers), "Regiotaxi" with door-to-door services for people who do not have access to regular public transport (all types of customers) and "Bellbus" which offers on-demand lines from bus stop to bus stop along virtual lines and pre-planned routes (7.10).

From the point of view of the passengers both options mean that in many case they will receive a services that would otherwise been withdrawn, because they are unaffordable for the operator. From the operators' point of view this will also mean that they can run services more efficiently that are required for social reasons.

Rail

Rail links to ports and airports

Although too many ports and airports do not have rail access, there are a quite a number that have excellent one. The ports listed in the web directory are Dagebull (1.13), Turku (1.14) and Helsingborg (2.19) and the airports listed are Schiphol (1.1), Frankfurt (1.2), Charles de Gaulle (1.3), Zurich (1.4), Copenhagen (2.5) and Hong Kong (2.19). Other examples that still constitute good practice have some shortcomings though, such as a rail station located outside the immediate airport area (Düsseldorf 1.5) or at the other end with poor access to the city centre (Shanghai Maglev 2.6) or with less direct access into the wider rail network (Lyon 1.7, Vienna 1.8, Stockholm 21, Oslo 2.2 or Krakow (2.6). Other airports will get rail links in the future, either heavy rail as in Gdansk (2.4) or HSR as in Barcelona (1.6), but there are still many for which no such plans exist.

Ferries

Fast and frequent connections to airports and rail stations

Where airports and rail stations are sitting on the edge of a body of water, ferry links are often provided. A good example for ferry links to the main rail station is Amsterdam (1.11) and in Lisbon (2.20) there are also two ferry stops at rail stations. Good ferry connections to airports exist for instance in Kansai (1.10), Venice (2.8), Hong Kong (2.9) and Boston (2.10). In Vancouver (2.10) there is a ferry, but this is not well connected to downtown Vancouver.

Safe and comfortable stops

The same considerations apply here as for bus stops, and again many examples exist at ferry terminals around Europe.

All public transport

Real-time information on current mode

Real-time information on local public transport within the vehicle becomes available increasingly often, and the Edinburgh Bustracker (10.11) is only one of many examples around Europe.

Real-time information on main mode

In contrast, real-time information within the local public transport vehicle on the next, main, leg of the journey is an exception, but one such exception can be found in Vienna on board the CAT train (1.8), which is an airport express train and where real-time information on flight departures is provided on board the train.

3.4 INTERCHANGE

3.4.1 Problems to be Addressed: Systems Needs

The next table shows the critical areas for interchanges identified in D4.2.

Table 3-4 Interchanges: critical areas in the system needs
(Source: ORIGAMI D4.2 of WP4)

Mode	System needs	Critical areas
Ports	•Rapid turnaround for short-distance ferries •Minimum comfort for waiting and connection areas •Integration with other modes, i.e. information	√ √ √ √
Airports	•Information about surface transport •Physical design of infrastructure to improve accessibility and usage for disabled people • Security and reduced waiting time at check -in •Accessibility to other modes (rail station, car parking, etc)	√ √ √ √ √ √ √
Rail stations	•Making access, interchange and egress easy and pleasant •Physical design of infrastructure to improve accessibility and usage for disabled people •Information provision on multi-modal connections (coach/air/ferry)	√ √ √ √ √

To keep the sequence for interchanges the same as for the first/last mile and the main mode, rail stations shall be discussed first. A pleasant station layout is indeed missing in many stations, and unpleasant stations will deter many travellers from using rail at all; so this can be relevant for the gaps and bottlenecks. The ease of access is most relevant, and most difficult to achieve, for mobility impaired people, so shall be listed in this context. Information on connections can be relevant in three contexts:

- If a change is to be made from one train to another, then information is needed on departure times and platforms.
- If the rail station is at a port or airport, then information on ferry and flight departures and locations is required.
- If the rail station is at the end of the long-distance leg, then information on local public transport is needed.

Each of those has different specific requirements.

A rapid ferry turnaround at ports can help enable more frequent services, but in many cases ferries will be held for a certain time period at a rail station or airport anyhow to enable a regular pattern of departure times. So overall this issue does not seem critical enough to be regarded as a serious bottleneck in long-distance travel. Comfort levels for waiting foot passengers are fairly basic in most ferry ports and car passengers are generally waiting in their cars, but this does not appear to be a factor that deters travellers from using ferries, so again does not really constitute a bottleneck. More important can be the information on onward travel from the destination port and, moreover, the fact that there will be fitting public transport connections in the first place, either in the form of rail access or at least in the form of scheduled buses as mentioned in the last section. This would be crucial in making ferry connections not only attractive to car and coach passengers.

At airports information on onward connections by rail and bus, or in the case of Venice even by ferry, is highly relevant for travellers (that there should be rail and not only bus connections has already been addressed in the previous section); that implies that these connections are all there in the first place, but with regard to rail this has already been addressed and car parking is normally available at ample amounts and, related to the distance from the airport, with a range of pricing options. Accessibility for mobility impaired users is generally less of an issue at airports than at rail stations, since once they reach a check-in desk they are normally well looked after by airport/airline staff, and airports are generally well equipped not only with escalators but also with lifts. Since most scheduled airlines allow on-line check-in as well as having self-service check-in stations and baggage drop-counters at the airport, waiting times at check-in today are only significant for charter flights and some low-cost airlines and travellers using these are generally prepared for a wait and do not consider this as a deterrent for travel. Security queues can constitute more of a problem, in particular for business travellers who are "cutting it fine" and - outside Schengen - for interconnecting flights: security procedures should be quick, but they should still guarantee total protection from terrorist acts.

For coach stations, safe and comfortable waiting areas are certainly a critical issue. Furthermore, conveniently located coach car parks for tourist coaches and facilities for the drivers while they wait for their passengers to return will encourage coach operators to lay on trips to these destinations.

However, there are more issues that are relevant for all interchanges. Ideally, there would not be any interchange at all and minimising their number in any given journey would be the first travellers would hope for. Where interchanges must exist, they should be made easy and all roll-on / roll-off services, be it in trains or ferries, are very convenient. Where passengers have to walk though an interchange, distances between the different public transport stops should be as short as possible and navigation should also be easy and intuitive. The visually impaired need special orientation guidance.

Level access to stations, specifically for metro and rail stations, was mentioned earlier, but level access to buses, trams and trains are equally relevant for wheelchair users and parents with pushchairs (only for coaches this is probably impossible to achieve without complicated lift constructions). Finally convenient luggage services that allow the traveller to carry luggage with him or her for as little for the journey as possible will be a welcome addition in particular for people with heavy or multiple suitcases.

The resulting list of needs taken forward is shown in Table 3-5.

Table 3-5 Interchange system needs for analysis of bottlenecks

Mode	System needs
Coach stations	Safe and comfortable waiting areas for passengers
	Central coach parks
	Waiting facilities for tourist coach drivers
Rail stations	Pleasant station layout
	Accessibility for mobility impaired passengers
	Real-time information on connecting trains
	Real-time information on ferry departures at ports
	Real-time information on plane departures at airports
	Real-time information about local public transport
Ports	Real-time information on onward travel
Airports	Real-time information on onward travel
	Short waiting times at security
All interchanges	Making interchange unnecessary
	Roll-on / roll-off service
	Short distances within the terminal
	Easy navigation
	Orientation guide for the visually impaired
	Level access to PT vehicles
	Convenient luggage services

3.4.2 Applicability of ORIGAMI Solutions

Coach stations

Safe and comfortable waiting areas

Coach stations are places where users may have to wait for considerable amounts of time. Requirements for comfort are therefore much higher than for ordinary bus stops, but many coach stations do not offer any more than the basics. One very positive example is Edinburgh bus station (2.27), which provides not just toilets, left luggage lockers, ticket desks, ATM machine and vending machines, but also heated and air-conditioned waiting areas with a newsagent and coffee shop, is covered by CCTV and has on site security in attendance. Scheduled bus service information is displayed on screens at the entrances, the central ticket hall and at the departure gates. Touch screen kiosks connect to journey planners, bus and train operators, Edinburgh airport and other useful web sites

Another impressive example is the Avenida de America interchange in Madrid (2.22), where long-distance coaches connect with regional and urban buses and four metro lines on four separate underground levels. The interchange also contains a shopping area and a large short-stay car park, and is generally very modern, spacious and well it.

From the point of view of the operator of tourist coaches, an important consideration is also where the coaches can park and what the driver can do while waiting for the tourists to return to the coach. Southport provides not only a central coach park, but also a waiting room with kitchen facilities and a shower for coach drivers, which has led to a huge increase of tourist coaches visiting the town (2.28).

Rail stations

Pleasant station layout

The vast majority of railway stations are rather utilitarian structures that serve their purpose, but are not particularly pleasant places to dwell in. One of the exceptions is the main railway station in Prague (2.25), an Art Nouveau structure that combines an elegant building with all state-of-the-art amenities. A very modern building is the central station in Berlin, opened in 2006 (2.16). It combines high functionality with short connecting paths between HSR, heavy rail, S-Bahn and metro with an elegant design and wide vistas. And there are some other stations in Germany where Deutsche Bahn combines transport with pleasant shopping areas such as e.g. Leipzig.

Accessibility for mobility impaired passengers

Accessibility for mobility impaired passengers is often a problem in smaller stations where the only connection between the station and the platform for one direction on the one side and the platform for the other direction on the other is a footbridge with steps. In bigger stations, however, it is the standard that lifts are available for access to all platforms.

Real-time information on connecting trains

Display boards or screen that show expected departure and arrival times for trains are today very much the standard even in smaller railway stations.

Real-time information on ferry departures at port stations

No concrete examples could be identified, but ORIGAMI does not assume that this constitutes a real bottleneck in seamless travel.

Real-time information on plane departures at airport stations

The railway station in Frankfurt airport (1.2) is one example for a station that has real-time information on flight departures within the railway station, but even where this is not the case, the walking distance from the platform to the next display boards or screen within the airport is normally so short that their absence in the railway station is only a very minor shortcoming.

Real-time information about local public transport

No example of a railway station where real-time information about local buses or metros is available on the station concourse could initially be identified through literature or web searches, and this would be more of a shortcoming than the lack of information on ferries and planes. The main reason is that in ports and airports passengers know where they are heading for when they leave the train, while identifying the right bus or metro to use is much more difficult. Moreover, the choice of the fastest means of transport to the final destination will in many cases also depend on the departure times of the next bus or metro, since there are often multiple options for reaching that destination, and a map with all public transport routes together with the next departure times for each line shown in a prominent position on the station concourse would prevent many travellers from simply jumping into the next taxi.

However, the project team then learnt through word of mouth that there are at least two stations, namely Berlin-Sudkreuz and Göttingen, which have notice boards on the concourse. In the case of Göttingen, there is the board for train departures as usual visible for passengers walking into the station from the street and another one above the exit doors for local public transport departures for passengers who have just arrived by train (10.20). Furthermore, it was then found that Birmingham International rail station also have big display boards with real-time information within the station before the exit to the bus station (10.21). Furthermore, in that case there is right next to it a touch screen with the travel planner www.transportdirect.info, which allows the easy identification of a public transport connection to any address within the UK.

The Birmingham configuration is ideal, but at least a display board with a city map and all bus and metro or tram lines on it, and another display with the next two real-time departures from the train station for each of them plus a ticket machine next to it, should be somewhere prominent on the main station concourse. This should be general practice in all medium-size and large railway stations.

Ports

Real-time information on onward travel

Again no example could be identified, and in principle the same considerations apply as for railway stations. The one big difference is that in many ports there are very few, if any, options for onward travel by public transport. Furthermore, in contrast to train conductors who stop at many stations, staff on board the ferry are normally able to explain to travellers what the options are.

Airports

Real-time information on onward travel

Real-time information in the arrival hall of airports about onward bus, tram, metro or rail connections is not available at the majority of airports, but at many it is, as for instance in the good practice examples given in 10.2. Certainly there are no technical or logistical problems in providing this information, and there is no real reason why it should not be available as a standard everywhere, where real-time information on the location of buses etc is available to the operator.

Short waiting times at security

Short waiting times at security are not just important for passengers arriving at the airport at the last minute, but even more so for passengers on connecting flights with short connection times. Automated controls using e-gates dramatically reduce queues at border checks (11.1); they were first introduced in Australia, but are now starting to be deployed in Europe as well. The Common Use Passenger Processing Systems CUPPS (11.4) supports self-boarding and self-tagging.

The concept for "Checkpoints of the Future" (11.2) categorises travellers as 'known traveller', 'normal', and 'enhanced security'. The determination will be based on a biometric identifier in the passport or other travel document that triggers the results of a risk assessment conducted by government before the passenger arrives at the airport. The three security lanes will have technology to check passengers according to risk. "Known travellers" who have registered and completed background checks with government authorities will have expedited access. "Normal screening" would be for the majority of travellers. And those passengers for whom less information is available, who are randomly selected or who are deemed to be an "Elevated risk" would have an additional level of screening. Screening technology is being developed that will allow passengers to walk through the checkpoint without having to remove clothes or unpack their belongings. Moreover, it is envisaged that the security process could be combined with outbound customs and immigration procedures, further streamlining the passenger experience.

All interchanges

Making interchange unnecessary

The ideal solution for seamless travel is making interchange altogether unnecessary. The first place where this was made possible was Karlsruhe in Germany, where the first TramTrain was installed (4.6). The same vehicle runs on a rail track within the city and on a heavy rail track outside and bridges the difference by being able to switch between different voltages. TramTrains or TrainTrams, depending on the primary application, have since been introduced in a number of places

A newer solution is the bus-train developed by Toyota (4.5) where a bus was equipped with steel rails, so that it can move between road and rail. Since it requires less infrastructure than the TramTrain, it is a solution that could be widely applicable, although its effectiveness is constrained by the low capacity of 25 passenger per bus.

A new idea are vertiports (5.3), which are designed to overcome the problem that space and noise constraints mean that airports are normally located well outside the city centres and necessitate a sometimes rather lengthy transfer between city and airport. Vertiports are airports for VTOL (Vertical take of and landing) aircrafts. This classification includes fixed-wing aircraft that can hover, take off and land vertically as well as helicopters and other aircraft with powered rotors, such as tiltrotors. The capability to land vertically makes it possible to install a vertiport even on a large roof space in the middle of a city, although the vertiport shown in 10.2, with its six gates, mini-taxiways and large associated building, has the size of a large urban park.

Roll-on / roll-off service

The most common form of roll-on/roll-off service is provided by car ferries, and there are hundreds of connections all over Europe where this service is provided, some just for river crossing, but others also for long distances.

Cars transported on trains (4.1) is a solution that had been, with 163 connections served, most widespread in the 1970s, but since then the number of offers strongly declined and there are now only 50 stations left in Europe where cars can be loaded for long-distance transport (plus various for short-distance tunnels). This is a true co-modal solution where the best use is made of the two forms of transport at each stage of the journey, but the more widespread use of hire cars meant there is an alternative option that is more attractive many travellers.

The third form of service is the train ferry, and there are a number of examples for those, such as the Puttgarden-Rodby ferry in the Baltic Sea (4.2) and various in Italy (4.3) and China (4.4). This solution nearly fits under the heading of making interchange unnecessary altogether, except for the fact that the train passengers normally have to leave the train for the crossing, but at least they do not have to take their luggage with them.

Short distances within the terminal

Many airports are notorious for the long walking distances in the terminal between the gates and the platforms or stops for onward travel, and some of the rail stations are not much better, with Roma Termini being on particularly bad example. There, not only are the distances between the train platforms and the two metro stations extremely long, but the connection is also poorly signposted, levels change all the time and for many of the level changes there are not escalators. In contrast, one example where the split-level station design has ensured that distances between connections are as short as possible is Berlin Central rail station (2.16).

For large airports it is more difficult to achieve this and given the choice between finger based access to airplanes in long terminal corridors and being bussed to the aircraft, most passengers will prefer the former, as long as moving walkways are provided wherever possible.

Easy navigation

In large terminals, especially in airports, orientation and navigation can be difficult. Good signposting is the first requirement and most terminals make a good effort to provide that. But navigation is even made easier by the new generation of indoor navigations systems that allow downloading floor plans of train stations or airports.

Orientation guide for the visually impaired

Only one European example is known for any specific help for the visually impaired in any type of terminal, although there are plenty of examples in China and Hong Kong. In Berlin Central Station (2.16) there is a tactile guidance system for the visually impaired which is available through wide parts of the station. There are knobbed guidance strips in the floor that can be followed with the guiding stick for the blind. Knobbed attention plates on the interim floors and rippled metal plates on the platforms alert passengers to stairs, lifts, junctions and changes of direction. In front of the six main lifts are columns that, when touched, provide information on their location, which platforms are served by the lift and any services provided on the interim floors. The banisters of the stairs included in the guidance system have information on the location of platforms in one direction and information on exits and connecting public transportation the other. In airports, once impaired passengers reach the check-in desk at an airport, staff will normally look well after them, but for reaching the check-in desk in the first place and for making their way from the exit gate to any form of onward transport they normally depend on the help of fellow travellers. In railway stations and ports there is often no staff available to help at all, so again they are up to now in most cases fully depend on fellow travellers. In the future, the solutions most likely to help, rather than physically equipping all interchanges with orientation guides, are mobile apps which provide travellers with timetables, information on delays as well as information on the physical layout of interchanges.

Level access to PT vehicles

Level access is today the norm for trains and metros, but many buses and trams still require stepping up to.

Convenient luggage services

For air travel, in the vast majority of cases, flight luggage has to be checked in at the check-in desk at the airport. Deutsche Bahn and Lufthansa had a service for a while where passengers could check-in their luggage in Cologne rail station for flights from Frankfurt airport, but this service was discontinued due to security considerations. Now it is only possible to check the luggage in at arrival in Frankfurt within the train station, so that at least passengers do not have to carry it with them on the way from the station to the airport departure area (1.2).

In Vienna, one step further has been taken, since it is at least possible to check the luggage in at the railway station Wien-Mitte before boarding the airport express train (1.8).

However, in Switzerland it is still possible to check their luggage in at 56 rail stations on the day before departure and receive their boarding pass at the same time (2.15). On return, luggage checked in at any airport worldwide will be transported from Zurich or Geneva airport to any train station in Switzerland.

In Germany Deutsche Bahn (DB) offers a door-to-door luggage service that operates nationwide as well as to Austria and the German speaking part of Northern Italy (11.11). The service can be booked on the DB website, but DB cooperates with a courier service for the actual luggage transport.

3.5 Main Trip Stage

3.5.1 Problems to be Addressed: Systems Needs

The next table lists the areas considered as critical for the main trip stage in D4.2.

Table 3-6 Main trip stage: critical areas in the system needs
(Source: ORIGAMI D4.2 of WP4)

Mode	System needs	Critical areas
Rail	•Passenger information during the trip, dynamic information on delays , etc •Comfort, travel comfort, train temperature, seat comfort •Development of international standards for integrated ticketing (implementation of the EC TAP-TSI Directive	√ √ √ √ √
Air	•Availability of a convenient booking/information interface (schedules, prices, alternatives) with other transport modes •On-time departure and arrival	√ √ √ √
Coach/bus	•Software architecture to connect existing travel information systems •Quality of trips (journey time, vehicle occupancy, waiting time at stops, cleanliness of vehicles, driver attitudes and comfort	√ √ √

Most needs related to passenger information and ticketing will be addresses in the context of pre-trip information. This leaves only a small number of issues from the above table open.

Comfort issues are listed for both rail and coaches, including aspects of temperature, seat quality and cleanliness. Vehicle occupancy is only listed in the context of coaches, although they will, at least in Europe, not normally carry more passengers than they have seats - train overcrowding can be a much more substantial problem.

It is not entirely clear what waiting time at stops refers to for coaches: at the departure point the waiting time will entirely depend on the arrival time of the access means of transport; at intermediate stops the main delays will occur when a coach travelled faster than expected and has to wait in order to catch up with his schedule; and in the rare event where a traveller changes from one long-distance coach to another the number of travellers concerned do probably not warrant a coordination of coach schedules. So in either case, this does not look like an issue to be carried forward into the bottlenecks analysis.

Another issue listed for coaches is the journey time. This is certainly relevant, but since coaches are nearly always mixed with normal traffic, and have a speed limit for safety reasons, the main problem here occurs when they get stuck in congestion. Here, as already stated in the context of the first/last mile, they will benefit from effective traffic management as private cars, in this case only in particular from effective motorway control instead of urban traffic control. However, even though not listed for rail, high speed is here an even bigger issue and the building of HSR connections is a key requirement, if the train is to compete effectively with either the private car or with air traffic for longer distances.

For air traffic on-time departure and arrival are listed as critical areas and apart from delays due to bad weather, which are largely outside human control, the two main problems to be addressed are overcrowded airspace and inefficient air traffic control procedures, which will both be included in the analysis of bottlenecks although the ongoing 'single sky' project already focuses on this matter. But delays are not only an issue for air travel, but also for rail, and there on-time departures and arrivals are also going to be listed.

Car travel is not listed in Table 4-1, but it was already said above that effective motorway management is an important requirement for them. Furthermore, the text in D4.2 that accompanies Table 4-1 discusses the fact that although cars are not listed in the table, in the context of co-modality, long-distance car travel does need to be included, and apart from safety and comfort, real-time information for car drivers is one key need to be addressed here. Traditionally this involved Variable Message Signs (VMS) but increasingly often in-car navigation systems that do not only have maps for static guidance, but also Traffic Message Channel (TMC) receivers that feed any information about congestion and delays directly in the routing algorithm. Since ORIGAMI is looking at horizons of 2030 and 2050 it seems safe to assume that by then they will ubiquitous and actual motorway control will be redefined again to its original function, i.e. controlling flows and speeds on motorways, rather installing large and expensive VMS to advise drivers of travel conditions. The other issue to be mentioned for car travel is the need for road safety - relevant in principle for all modes, but for car travel a much bigger problem.

Passenger information during the trip is also an issue on board a coach, train or plane, and would be desirable for most passengers, in particular in the case of delays. On a coach this could be achieved by showing the navigation system display not only to the driver, but displaying it throughout the bus, so that passengers can follow the expected arrival times. Ideally this would be accompanied by the expected real-time departure times from the next stop of two, so that travellers have time to prepare themselves, if they see connection times become very short and make a dash for it, or relax because they see their onward connection is delayed as well, or if they missed their connection altogether, interrogate their smart phone about the next possible coaches. On a train the negation system display would be replaced by some other display showing the expected delays, but the principle of showing the status of the own train and the onward connections at the next one or two stations could be equally applied. Only once real-time public transport information is available on smart phones any time anywhere, the in-coach or in-train equipment would be no longer needed. Air travellers are until now [8]not allowed to use any phones on board, but they could be helped as well, if the on-board entertainment system also includes the departure boards and possibly even the potential connections of surface modes at the destination airport.

What has not been mentioned so far at all are long-distance ferries. They usually offer all creature comforts, though at which level depends on the price people are prepared to pay for their cabins. They are generally safe, and whether they are an hour fast or slower does not matter too much to most passengers, since most are leisure travellers (the exception are the few truck drivers, but this report is about passengers transport). All required information on onward travel can usual is acquired from staff at the service desk. Therefore, there do not appear to be any particular issues with ferry crossings that could constitute major bottlenecks.

One issue that has not been mentioned for either road or rail, although it is important for both, is the need for direct connections. Where natural obstacles like water or mountains are in the way, there is often the need for bridges and tunnels to cut out millions of kilometres of detours that are added to travel today.

Finally, relevant for all vehicles in all modes is the need for clean engines

The resulting list of main trip stage system needs to be taken forward into the analysis of gaps and bottlenecks is shown in next Table.

8 Experiments are ongoing and already some airlines offer internet services on their airplanes.

Table 3-7 Main trip stage system needs for analysis of bottlenecks

Mode	System needs
Car	Effective motorway management
	Safety
	Real-time in-car navigation
Coach	Comfortable vehicles
	Real-time information on trip status and connections
Rail	Construction of High Speed Rail systems
	Departures and arrivals on time
	Minimisation of overcrowding
	Comfortable carriages
	Real-time information on train status and connections
Road and rail	Direct connections
Air	Efficient air traffic management to keep departures and landings on time
	Efficient use of air space
	Real-time information on connecting flights
All modes	Clean engines

3.5.2 Applicability of ORIGAMI Solutions

Car

Effective motorway management

There are four main groups of existing control systems that aim at ensuring that best use is made of the existing road infrastructure.

The first one, ramp metering, limits the flow of cars onto the motorway in peak periods, thereby keeping traffic volumes on the motorway at a level at which traffic can still flow without breakdown and resulting congestion. Nearly all of the existing installations in Europe and elsewhere are operating on a ramp by ramp basis, but Australia has implemented coordinated ramp metering on a large scale (6.16). Coordinated metering significantly improves its effectiveness by controlling a whole stretch of motorway rather than single points, and spreading the vehicles waiting to get onto the motorway over a series of ramps.

The second group is lane control systems (6.7), which control traffic on the motorway by either telling drivers that certain lanes are out of use or, more crucially by indicating a variable speed limit in accordance with current traffic volumes and conditions. These speed limits will smooth traffic flow, thereby increasing motorway capacity and reducing the risk of congestion.

Hard shoulder running (6.14) adds capacity to the motorway by temporarily allowing the use of the hard shoulders, which are normally reserved for emergency stops, by normal traffic. Hard shoulders will normally need to be strengthened to cope with the heavier loads, which together with the necessary control infrastructure, does not make these systems cheap, but it is still a way of adding a lane to the motorway without increasing its footprint in the countryside.

Finally, High Occupancy Vehicles (HOV) lanes (6.15) do not directly add capacity to the motorway, but they are an incentive for car pooling, since vehicles with more then one person on board get access to less or non-congested lanes and will reach their destination much faster than cars in the main stream. In some cases, the lanes are also being converted to High Occupancy Tool (HOT) lanes, where single drivers can pay to be allowed to use these lanes as well, but this really defeats the original purpose.

All of these systems will help to increase capacity on the motorway and reduce accidents and congestion, but one of their limitations lies in the availability of up-date traffic information in the control centre, and therefore the accuracy and timeliness of control actions. In the future, this should be increasingly overcome with Vehicle-to-Infrastructure (T2I) communications, which will allow the control centres to collect information on current traffic conditions directly from the cars in their network. simTD (5.8) is one of the projects working into that direction. Better information will allow the control centres to take smarter control actions, and the direct communication means that information about control decisions does not need to be relayed via (costly) Variable Message Signs, but directly from the control centre back into the car.

The other limitation of current control system is the maximum density of the traffic, which in turn depends on the minimum safe distance between cars. SARTRE (8.3) is one of the most current ones in a series of projects that aim at building "road trains" through Vehicle-to-Vehicle (V2V) communication. The on-board computers take over the control of each car in the train from the driver and communicate directly with each other. This makes reaction to any change in speed or direction of the car in front instant and allows much closer head-distances, leading to much higher traffic density and dramatically increased motorway capacity. SARTRE is the only motorway control system classed as "fulfils needs in key aspects" in the Table *Needs and solutions*, since once a sufficient number of cars are equipped with the necessary sensors and intelligence, their exploitation does not depend on any local infrastructure, but they can, at least in theory, be used anywhere in the European motorway network. The first big caveat lies in the "once a sufficient number of cars are equipped", since a great many drivers must invest in this before they will be able to find a significant number of other cars to connect to on the road and draw any benefit from their investment. The second big caveat is the complex legal and regulatory framework required to ensure the safety of these systems outside a secure test environment.

The final potential future tool for motorway management is the flexible road charging systems envisaged for The Netherlands (6.1) that has already been mentioned in the context of the first/last mile. Motorway charges today are generally levied to pay for the cost of infrastructure and are not intended to serve as a means of controlling the traffic on the motorway. In the Dutch scheme fees will vary according to time and location, so that the programme can specifically target congested areas

Safety

Although many efforts have been made over the years to make cars safer, such as for instance the introduction of seat belts or airbags, none of these have been listed as good practice examples in the web directory, since they are ubiquitous. What most of these have in common is that they alleviate the impact of accidents rather than preventing them in the first place. One exception is ABS (Anti-Blocking Systems) which, depending on the situation, can either reduce the speed at impact or avoid impact altogether.

New systems are now aimed at recognising potentially dangerous situations and avoiding accidents to happen in the first place. Assisted driving systems include Headway Monitoring and Warning, Adaptive Cruise Control, Lane Departure Warning, Lane Keeping Assist and Side Assist (13.1). All of these, although still quite expensive, are now being increasingly introduced into commercial cars and will certainly reduce the number of accidents in the coming years.

Another more recent development is intelligent speed adaptation, where the car's computer knows the speed limit and either advises the driver, if he is about to break it or slows down the car directly, which then can be either overridden by the driver or not. Trials have been held in four Swedish cities and the system is now also in use in London. In Denmark a trial is underway, where the system is combined with an incentive scheme in which drivers get a rebate on their car insurance, if they stick to the speed limit. However, all of this will reduce the accident risk or the consequences of accidents, but cannot directly prevent accidents.

Vehicle to vehicle (V2V) communication (5.8 and 13.4) will allow vehicles not just to react to their surroundings, but to exchange information between each other and be therefore more pro-active in preventing accidents. However, although various trials have been carried out and are still underway, it will be a long way into the future until a sufficient number of cars equipped with V2V are travelling in the road network to make it likely that two cars meet in a critical situation that are both equipped. The fact that the first hundreds of thousands of driver would need to purchase cars with the expensive equipment knowing that it may be years until they reap the benefits makes it questionable whether V2V will ever penetrate the market.

Real-time in-car navigation

Since the first satnav systems (6.6) came onto the market in the 1980s, they have become increasingly sophisticated. One of the latest developments is that many of them are equipped with TMC (Traffic Message Channel) receivers, which obtain real-time traffic information silently on the main broadcasting channel without interrupting the main broadcast. Not only do they flag up delays on the intended route, but depending on the length of the expected delay they will also recalculate the route to bypass congestion where possible. TMC is now available in most European countries

Coach

Comfortable vehicles

The standard of coaches varies hugely, but there are plenty of examples of high-quality and comfortable coaches, including some with built-in entertainment systems.

Real-time information on trip status and connections

No existing examples for real-time information in coaches could be identified, although the Austrian Postbus is apparently planning to introduce it.

Rail

Construction of High Speed Rail Systems

Rail is a much more sustainable form of transport than car travel, and the main way to make it more competitive for longer distances is the introduction of High Speed Rail (HSR) systems. In parts of Western Europe the existing network already shows good network coverage (5.7), but further extensions are planned in several countries. Particularly notable are the ambitious plans for Spain, where it was intended that by 2020 90% of the population would live within 50km of an HSR station, and that all province capitals would have an HSR station and would link with Madrid in four hours or less. But unfortunately the EURO crises and the latest poor economic evaluations of the Sevilla-Madrid route forced the government to stop the infrastructure plan.

An extreme form of high speed rail, with speeds up to 581 km/h, is the magnetic levitation train, Maglev, which has its first long-distance connection between Tokyo and Osaka (5.1). But the construction cost of this system is unfortunately likely to be an obstacle to a more widespread introduction.

Punctuality of services

Modern ITS systems like the one listed in 6.9 will certainly increase the efficiency of train operations, and therefore also help to increase the punctuality. ERTMS can make some contribution, albeit a much smaller one.

Limited overcrowding in public transport systems

The above mentioned ITS systems (6.9) are mainly designed to increase the capacity of the rail network and to assign carriages to the trains with the highest passenger demand. This will, at least initially, also reduce overcrowding, although it is possible that the additional capacity will eventually be filled again with additional passengers.

Comfortable carriages

The standard of the carriages for long-distance trains is generally reasonably high in Europe, not only in first class but also in second class compartments, although there are of course differences between different train operators.

Real-time information on train status and connections

The Austrian rail operator OBB introduced in 2008 a new service on their high speed trains (10.14), which provides in each carriage a visual dynamic passenger information system. The screens show the actual travel speed, the travel route on a map, the actual position and distance to the next stops. Connections which can be easily reached are highlighted. An alternative to fixed in-train displays are in the era of smart phones new apps that provide this information. The DB Navigator (10.18) can be used for trip planning, but is equally useful during a trip, when a train is delayed, to check which onward connections are still possible.

Road and rail

Direct connections

Water and mountains are natural obstacles to direct road and rail connections, but bridges and tunnels can overcome this, even if at substantial investment costs. Existing examples are the bridges over the 0resund (3.1) and the Great Danish Belt (3.2) and the Channel tunnel (3.3). Other examples under construction or under consideration are the tunnels under Saint Gotthard (3.4), the Brenner (3.5), from Fehmarn to Lolland (3.6), the Alps between Lyon and Turin (3.7), the Pyrenees (3.8) and the Gibraltar Strait (3.9) and the bridge from Gedser to Rostock (3.10).

Air

Efficient air traffic management to keep departures and landings on time

One way of trying to increase the efficiency of airport operation is to privatise them as happened in the UK (7.3) and is planned for Spain (7.4). However, although this provides a financial incentive for efficiency, it does not increase it automatically by itself.

An attempt to increase efficiency more directly was made by the EMMA project (6.12), which developed advanced onboard support to pilots and planning support to controllers to ensure consistency of traffic information given to controllers and pilots. The SESAR programme is another attempt to increase the efficiency of air traffic management (7.2). NextGen (6.17) is a similar US initiative. Finally the UPLINK programme, led by EUROCONTROL, was to provide a data link connecting pilots and controllers or aircraft and ground computer systems in order to have fewer misunderstandings and reduced workload for controllers as part of their management of airspace (13.5). This would as a consequence lead to increased safety and efficiency. Full European system deployment is envisaged by 2015.

Efficient use of air space

In many locations around Europe air space is getting increasingly tight, but in 2011 EUROCONTROL introduced a new system in the Maastricht area, which optimises the use of air space. This system allowed the introduction of new direct routes, which already in the first phase save more than 1 million air kilometres per year.

Real-time information on connecting flights

Numerous airlines provide information on connecting flights within an aircraft approaching an airport, either on request of specific passengers, announcements by the staff of an aircraft or display information on the monitors of the (personal) IFE (in flight entertainment) systems, available in long-haul aircraft (10.19). Among those providing information via IFEs are Lufthansa, Emirates, Singapore Airlines, Austrian Airlines, Qatar Airways, Air France, Air New Zealand, Japan Airlines and Air Canada

All modes

Clean engines

The oldest alternative to petrol or diesel engines is Autogas or LPG (12.4). Becoming more widely available now are biofuels (12.11), which are a good replacement of oil based fuels as long as they are a by-product, and do not stem from crops that are planted instead of food and, even more so, from plantations for which rain forests have been cleared.

A better alternative are electric cars, in particular if the electricity comes from renewable sources, and the European Green Cars Initiative supports their introduction (12.1). Key to the wider acceptance of electric cars is a readily available network of charging stations. For Austria a list of charging stations exists and is constantly updated (12.12). The list currently contains over 3000 stations and also points out that in two Austrian regions guests can recharge their cars at any hotel they stay or restaurant they dine in.

For the future there are two main types of technologies in sight. The first one reduces the wasted energy by converting exhaust heat into usable electric energy through a thermoelectric generator (12.3). This would make petrol engines much more efficient than today, since, as a rule of thumb, about 2/3 of the fuel energy fed to the engine is converted into heat and used only occasionally and partly for heating the car interior. The second technology, short FCH, is more revolutionary and involves fuel cells, as an efficient conversion technology, and hydrogen, as a clean energy carrier (12.5). The EU has joint forces with industry to accelerate the development of FCH technologies.

Also trains can be powered from renewable electricity. In Belgium a wind farm powers the rail line between Leuven and Liege (12.10), and it should be investigated where this good practice example can be followed as sustainable solution in other regions and countries.

The use of electric power is also being piloted for aeroplanes, but here only as hybrid with conventional fuel (12.7). A mix of kerosene and biofuel has been trialled by Lufthansa (12.9) and other airlines, although, at least for the time being, the use of biofuel has been stopped or slowed down because of excessive costs. The REACT-CR project used conventional planes, but tried to reduce fuel consumption and emissions through a new approach to landing procedures (12.8). The most comprehensive attempt to enhance the environmental performance of aircraft is underway in the Clean Sky Initiative, a joint venture of EU and industry (12.6). It is managed by the Clean Sky Joint Undertaking (CSJU) and runs until 31 December 2017. The CSJU will deliver demonstrators in all segments of civil air transport, grouped into six technological areas called 'Integrated Technology Demonstrators' (ITD): SMART Fixed wing Aircraft, Green Regional Aircraft, Green Rotorcraft, Sustainable and Green Engines, Systems for Green Engines, Systems for Green Operations, Eco-Design.

3.6 ALL TRIP STAGES

3.6.1 Problems to be Addressed: Systems Needs

One pre-condition for seamless travel is that not only the operators for the different transport modes cooperate with each other during the transport planning process, but that they work together with local, regional and, where applicable, with national authorities in one integrated planning process.

Another issue that relates to all trip stages and all public transport modes is the need for well trained staff who is able to assist the passenger politely in all aspects of the journey.

Table 3-8 System needs for all stages for analysis of bottlenecks

(Source: ORIGAMI D4.2 of WP4)

Mode	System needs
All public transport modes	Integrated planning
	Well trained staff

3.6.2 Applicability of ORIGAMI Solutions

All public transport modes

Integrated planning

One key issue for co- and intermodality is integrated planning and there are quite a number of positive examples around, both in the freight and the passenger sector. One such example is the Merseyside Integrated Transport Executive Merseytravel, which coordinates bus and rail travel in the region (7.5). It is based on a franchising model used already in Germany, Denmark, Sweden and The Netherlands. A similar example is the city of Wroclaw, which aims at the creation of an integrated multimodal transport system for the city and region (9.1). In Coventry, the Primeline partnership improves bus services (6.18). Wroclaw agglomeration rail (Wroctawska Kolej Aglomeracyjna) has been set up in order to improve integration of transport between the city and the surrounding area (9.1).

Another form of partnership is the Edinburgh Airport Transport Forum (ATF) which comprises representatives of all transport providers (including bus and rail companies, and taxi operators); the Airport Operators Committee (representing airlines and handling agents); neighbouring local authorities; the Scottish Executive; Edinburgh Chamber of Commerce; the Edinburgh Airport Consultative Committee (EACC) and SESTRAN, the regional statutory body (7.6). The ATF oversees the strategy to increase public transport mode share and manage vehicle movements, and seeks to influence airport access journeys and to raise awareness of public transport options.

Well trained staff

Well trained staff, who are not only polite and welcoming, but also knowledgeable about the current trip as well as possibilities for onward travel, are an important form of assistance for travellers. One example where staff training is been given particular emphasis by providing any new member of staff five weeks of training before they start service as on-board train attendants (2.1).

3.7 Overall Matching Between Existing Needs and Available Solutions

The previous section listed a long series of solutions that address the various system needs, which are mainly based on user needs (see ORIGAMI deliverable D4.1 for further references) and in a few cases consider operator needs. However, the coverage is rather uneven, with some needs being well addressed and others much less so.

The few identified gaps found concern real-time information: real-time information at rail stations in ports on ferry departures, real-time information on onward travel at ports, and real-time information on trip status and connections for coaches. However, for the latter the Austrian Postbus operator is aiming to install such a system in the near future, and the two former may even already exist somewhere unbeknown to the project team, and in any case can be easily realised with technology already in use for other existing real-time information.

On the other end of the spectrum, there are just a few needs for which, at least in principle, there are universal solutions available. These are:

- Hire cars at airports for the last mile;
- Park & Ride facilities for the first mile;
- Demand responsive public transport services;
- Cars with assisted driving facilities to make cars safer; and
- Electric vehicles to make cars cleaner, even though facilities to reload batteries are in some countries still very rare.

The closest candidates for availability for all of Europe are the routeRANK travel planner, although this does not contain information on local public transport in the publicly available version, and the German Reiseauskunft and DB navigator, which both provide rail information for all of Europe, though door-to-door information only for Germany.

All other solutions identified are only available for certain countries, regions or even cities, although a roll-out to other sites is in most cases technically perfectly feasible. The main obstacle to further developing and implementing solutions that reach across borders is the lack of common standards for data bases and data exchange. Here is a role for the European Commission to help further the development of these standards and providing a central point, for instance through EUROSTAT, where key data could be stored and be made available to all.

Overall, it was somewhat unexpected that there were so few of the system needs identified by ORIGAMI in the first place for which no solution has been found that is already available or at least under development somewhere in Europe. Engineers in Europe and worldwide have addressed the needs of long-distance travellers in a multitude of ways, all that is needed is that these solutions are rolled out throughout Europe.

The following table synthesises the applicability of ORIGAMI's identified best practices in Europe to address problems and system needs.

Table 3-9 Applicability of ORIGAMI solutions to address system problems and needs

Mode	System needs	Best practice example			Suggested solution		
		Fulfils need in key aspects	Meets need in parts of the world	Meets need partially	Fulfils need in key aspects	Meets need in parts of the world	Meets need partially
Pre-trip stage							
All public transpo	On-line information on routes and timetables		10.10 Poznan planner 10.11 Edinburgh Bustracker				

Mode	System needs	Best practice example: Fulfils need in key aspects	Best practice example: Meets need in parts of the world	Best practice example: Meets need partially	Suggested solution: Fulfils need in key aspects	Suggested solution: Meets need in parts of the world	Suggested solution: Meets need partially
	On-line real-time information on delays and cancellations		10.3 Reiseauskunft 10.11 Edinburgh Bustracker 10.17 VBB Fahrinfo 10.18 DB Navigator				
	On-line travel information for combined public transport modes		10.7 START 10.9 Flyrail	10.13 routeRANK			
	On-line door-to-door travel information for public transport usage		10.2 In-time 10.3 Reiseauskunft 10.4 Resrobot 10.8 Transport Direct 10.17 VBB Fahrinfo 10.18 DB Navigator			10.7 START	
	Fully integrated on-line public transport ticket		10.5 Rejseplanen 10.9 Flyrail[9]	9.4 SailRail 9.5 Dutchflyer 9.8 Pomerania for tourists 9.9 Rail&Fly 10.1 SBB City-Zuschlag			
	Ticket not requiring a printer		11.7 SMS ticket in Wroclaw 11.9 DB mobile ticket 11.10 Lufthansa app 11.11 Oystercard 11.13 m-ticket 11.14 Walrus card				
All transport modes	On-line comparative travel information with all realistic mode combinations including. car usage and flights		10.4 Resrobot 10.8 Transport Direct	10.2 In-time 10.6 Ecopassenger 10.13 routeRANK			
	On-line comparative information on CO2 emissions for different mode combinations			10.3 Reiseauskunft 10.5 Rejseplanen 10.6 Ecopassenger 10.8 Transport Direct 10.13 routeRANK			
First/last mile							
Car	Efficient road connections		1.2 Frankfurt airport Motorway control systems as for the main trip stage.				

[9] Not listed under ticketing.

Mode	System needs	Best practice example			Suggested solution		
		Fulfils need in key aspects	Meets need in parts of the world	Meets need partially	Fulfils need in key aspects	Meets need in parts of the world	Meets need partially
	Effective urban traffic management		6.13 Singapore ERP	Many UTC systems exist. 6.4 London congestion charge 6.5 Stockholm congestion charge		6.1 NL flexible road charging	
	Pre-bookable parking space		O2 Arena				
	Availability of a car for the last mile	Hire cars are available at all airports. Park & Ride facilities exist in many locations	2.12 ÖBB Vorteilscard 2.13 Mobilpunkt Bremen			7.7 Mobilfalt	
Bus, tram, metro	Safe and comfortable stops		Many examples exist.				
	Accessible metro stops		Many examples exist in the newer stations.			13.6 Barcelona	
	Public transport links to ports		2.19 Helsingborg 2.24 Piraeus				
	Dedicated bus lanes		There are many examples of fixed bus lanes, both segregated and within general road space. There are also many examples of reserved during peak hours 6.19 Reversible bus lane Madrid				
	Bus and tram priority at junctions		All UTC programs contain bus priority options, and there is also a series of smaller individual control algorithms				
	Public transport links to ports		2.19 Helsingborg 2.24 Piraeus				
	Optimising public transport operation	Demand responsive services exist in many variations in many parts of Europe	7.9 Use of taxis in Austria 7.10 Use of taxis in Limburg				
Rail	Rail links to ports and airports		1.1 Schiphol 1.2 Frankfurt airport 1.3 Charles de Gaulle 1.4 Zürich Airport 1.13 Port of Dagebüll 1.14 Port of Turku 2.5 Copenhagen airport 2.9 Hong Kong airport 2.19 Port of Helsingborg	1.5 Düsseldorf airport 1.7 Lyon airport 1.8 Vienna airport 1.12 Port of Ancona 2.1 Stockholm Arlanda 2.2 Oslo Gardermoen 2.3 Shangai Maglev 2.6 Cracow airport		1.6 Barcelona airport 2.4 Gdansk airport links	

Mode	System needs	Best practice example: Fulfils need in key aspects	Best practice example: Meets need in parts of the world	Best practice example: Meets need partially	Suggested solution: Fulfils need in key aspects	Suggested solution: Meets need in parts of the world	Suggested solution: Meets need partially
Ferries	Fast and frequent connections to airports and rail stations		1.10 Kansai Kobe ferry 1.11 Amsterdam 2.8 Marco Polo airport 2.9 Hong Kong airport 2.10 Logan airport Boston	2.11 Vancouver airport 2.20 Lisbon rail stations			
	Safe and comfortable stops		Many examples exist				
All public transport	Real-time information on current mode		10.11 Edinburgh Bustracker				
	Real-time information on main mode		1.8 Vienna CAT				
Interchange							
Coach stations	Safe and comfortable waiting areas		2.27 Edinburgh 2.22 Madrid				
	Central coach parks		2.28 Southport coach park				
	Waiting facilities		2.28 Southport coach park				
Rail stations	Pleasant station layout		2.25 Prague 2.16 Berlin				
	Accessibility for mobility impaired passengers		This is the general standard in larger bigger railway stations				
	Real-time information on connecting trains		This is the general standard.				
	Real-time information on ferry departures at port stations						
	Real-time information on plane departures at airport stations		1.2 Frankfurt airport				
	Real-time information about local public transport		10.20 Göttingen main station 10.21 Birmingham International rail station				
Ports	Real-time information on onward travel						
Airports	Real-time information on onward travel		Various examples, see 10.12 Real Time information on trains or buses in the arrival section of an airport				
	Short waiting times at security		11.1 Automated controls 11.4 CUPSS		11.2 Checkpoints of the future		
All inter-chan	Making interchange unnecessary		4.5 Toyota bus-train 4.6 TramTrain		5.3 Vertiports		

Mode	System needs	Best practice example: Fulfils need in key aspects	Best practice example: Meets need in parts of the world	Best practice example: Meets need partially	Suggested solution: Fulfils need in key aspects	Suggested solution: Meets need in parts of the world	Suggested solution: Meets need partially
	Roll-on / roll-off service		Many examples for car ferries exist. 4.1 Cars on trains 4.2 Puttgarden - Rodby train ferry 4.3 Train ferries in Italy 4.4 Train ferries in China				
	Short distances within the terminal		2.16 Berlin Central Rail Station				
	Easy navigation	There are now several indoor navigation systems that allow downloading floor plans for a large interchange where finding the way may be difficult					
	Orientation guide for the visually impaired		2.16 Berlin Central Station				
	Level access to PT vehicles		Many examples exist.				
	Convenient luggage services		1.2 Frankfurt airport[10] 1.8 Vienna airport 2.15 SBB 11.11 Door-to-door luggage service				
Main trip stage							
Car	Effective motorway management		6.14 Hard shoulder running 6.15 HOV lanes 6.07 Lane control 6.15 Coordinated ramp metering	6.07 Lane control (French dynamic speed limits)	8.3 SARTRE	5.8 simTD 6.1 NL flexible road charging	
	Safety	13.1 Assisted driving				5.8 simTD 13.4 V2V communication	13.2 Intelligent speed adaptation 13.3 Pay as you speed
	Real-time in-car navigation		6.6 Satnavs				
Coach	Comfortable vehicles		Many examples exist.				
	Real-time information on trip status and connections					10.15 Postbus	
Rail	Construction of High Speed Rail systems		5.1 Maglev Tokyo-Osaka 5.7 HSR in Europe			5.2 HSR network Spain	
	Departures and arrivals on time		6.9 ITS for Smarter Railways	6.8 ERTMS			

[10] The entry in the web directory does not mention that arriving train passenger can check their luggage in straight in the train station.

Mode	System needs	Best practice example			Suggested solution		
		Fulfils need in key aspects	Meets need in parts of the world	Meets need partially	Fulfils need in key aspects	Meets need in parts of the world	Meets need partially
	Minimisation of overcrowding		6.9 ITS for Smarter Railways				
	Comfortable carriages		Many examples available.				
	Real-time information on train status and connections		10.14 ÖBB Railjet 10.18 DB Navigator				
Road and Rail	Direct connections		3.1 Øresund bridge 3.2 Great Belt 3.3 Channel tunnel			3.4 Saint Gotthard tunnel 3.5 Brenner Base tunnel 3.6 Fehmarn Belt 3.7 Lyon – Turin tunnel 3.8 Pyrenees tunnel 3.9 Gibraltar Strait tunnel 3.10 Gedser-Rostock bridge	
Air	Efficient air traffic management to keep departures and landings on time			7.3 Privatisation of UK airports		6.12 EMMA 6.17 NextGEN 7.2 SESAR 13.5 UPLINK	7.4 Privatisation of Spanish airports
	Efficient use of air space		6.11 FRAM				
	Real-time information on connecting flights		IFE use				
All modes	Clean engines	12.1 Electrification of Road Transport	12.10 Wind power for trains 12.12 List of Austrian electric charging stations	12.4 Autogas 12.11 Biofuel	12.5 Fuel cells and hydrogen		12.3 TEGs in cars 12.6 Clean sky 12.7 Electrical aviation 12.8 REACT-CR 12.9 Biofuels on commercial flights
All trip stages							
All public transport modes	Integrated planning		6.18 Primeline Coventry 7.5 Merseyrail 9.1 Integrated rail in Wroclaw 7.6 Edinburgh Airport Transport Forum				
	Well trained staff		2.1 Arlanda Express				

4 TRANSFERABILITY OF SOLUTIONS

4.1 APPROACH

This chapter discusses the potential of solutions to be transferred onto other contexts different than those where they were originally conceived for; in other words, the possibility of certain solutions to be generalised onto different geographic contexts or even different modes.

The selected criteria to assess transferability of solutions are based on the INTERCONNECT 7FP evaluation framework (Bonsall et al. 2011) and on the evaluation criteria proposed by the European Bank of Investment in the Railway Project Appraisal Guidelines (*RailPAG*, EIB 2005) synthesised by the stakeholder-effects matrices (SE) shown in the next table.

Table 4-1 Stakeholder-effects (SE) matrix proposed by the EIB in the RailPAG

(Source: RailPAG, European Bank of Investment 2005)

CELL CLASSIFICATION			STAKEHOLDERS																						
SE MATRIX			USERS				TRANSPORT SERVICE OPERATORS					CONTRACTORS & SUPPLIERS				INFRASTRUCTURE MANAGERS				NON USERS (external)		GOVERNMENT			
			RAIL LINES		ALTERNA-TIVE MODES		RAIL									RAIL									
EFFECTS			Pax	Freight	Pax	Freight	Rail Operator 1	Rail Operator 2	...	Other modes	INSURANCE COMPANIES	Infrastructure	Superstructure	Rolling stock	Electrification & signaling	Rail manager 1	Rail manager 2	...	Other modes	LOCAL	REGIONAL	LOCAL	REGIONAL	NATIONAL	EU
USER SERVICE		Fares	●	●	●	●	●			●	●													●	
		Travel time	●	●	●	●																			
		Reliability of service	●	●	●	●																			
		Comfort	●																						
		Convenience	●	●																					
		Safety / accidents (economic / financial)	●		●						●														
		Consumer surplus (new traffic)	●	●	●																				
OPERATION	DIRECT	Fees					●									●								●	
		Vehicle operating costs					●			●															
		Operating personnel					●			●															
		Facilities operations					●																		
	INDIRECT	Overhead management -HQ					●																		
		Subsidies					●									●								●	
		Taxes					●			●														●	
ASSETS	INVESTMENT	Land value										●				●				●		●		●	
		Infrastructure					●						●			●								●	
		Superstructure					●									●									
		Stations & terminals					●									●									
		Garage & repair facilities					●							●		●									
		Rolling stock (vehicles)					●							●									●		
		Residual value					●									●									
		Taxes					●					●										●			
	MAINTAIN-ANCE (ROUTINE)	Infrastructure & Superstructure														●									
		Rolling stock					●																		
EXTERNAL EFFECTS		NETWORK EFFECTS (not included above)	●	●			●									●								●	●
	ENVIRONMENTAL	Noise & vibrations																		●					
		Air pollution																		●	●				
		Climate change																			●			●	
		Use of space																		●					
		TERRITORIAL DEVELOPMENT																		●	●				

In ORIGAMI, a solution is considered to have a high generalisation and transferability potential when it may have a manifested interest for a wide range of stakeholders (users, operators, government), and when conditions are such that there are no feasibility barriers to its transferability.

The transferability evaluation of each solution is done based on six complementary criteria reflecting six (not always conciliated) dimensions in the transport market:

- The user dimension (traveller);
- The operator dimension;
- The government dimension;
- The regulator dimension;
- The technological dimension;
- The external dimension or the vision of non-users.

Each of these dimensions responds to different specific issues, reflecting the variety of interests of involved stakeholders, but the set of criteria includes in any case the aim for seamless travel, efficient transport systems, social profitability of investments, respect for the legality in force, the possible need for ad hoc approaches, and the minimisation of externalities of transport.

As pointed in the RailPAG, ***users*** tend to obtain the benefits of a transport project not included in the cash flows: travel time savings, safety and comfort improvements, reliability. Users being usually poorly organised, they tend to have a very modest influence in decision-making, their interests being mostly defended by the public administrations, local governments, trade unions, and neighbourhood associations. However, foreseeing a substantial benefit from the user point of view will help administrations justifying required expenditure for a project.

Competing ***operators*** will try to obtain the best deal from any new investment. Operators may have interest in implementing a new solution when it tends to reduce the costs of transport (i.e. optimise the transport system) or when it creates new business opportunities (e.g. increased flows in an airport terminal brought in by a HSR connection, increasing the value of retailer spaces), and will expect new solutions not to bring in additional organisational difficulties (e.g. necessity to reconcile a large number of stakeholders or interests).

The tendency of ***governments*** to look at their own financial interests should not detract from their ultimate goal, which is to promote the interests of society at large. The ultimate goal should be to obtain a maximum level of social benefit for a minimum level of investment. The distribution of costs and income among different governments and infrastructure owners is politically sensitive and an essential component of the decision-making process. At the same time, any major transport investment should have an impact on the distribution of traffic flows and therefore on the performance of other transport modes, bringing in some cases threatened operators to try to influence the decision-making process.

The ***regulator*** is a most important player in the transport system as it is an enabler of a solution being implemented in a certain context or not. A different regulatory framework might make a solution extremely difficult or too expensive to be implemented in a different context (e.g. the Karlsruhe tram-train has proved to be more difficult to export abroad than expected due to different regulatory frameworks[11]).

The ***technological dimension*** is another crucial issue for generalisation of a certain solution. Ad hoc solutions are hard to transfer onto contexts different than those where originally planned, losing interest with each new specificity that makes them unique, regardless of their technical virtuosity. Even when some solutions are of easy application onto diverse geographic contexts, they might still prove to be specifically mode-based. Most interest lies on those solutions which can be generalised onto other geographic contexts and be transferable onto other modes.

[11] See A.Kühn (2005) *Tram-trains: Euphoria or depression?* Tramways & Urban Transit, Light Rail Transit Association.

Non-users are essentially affected by externalities, notably environmental and social. These are not easy to quantify but can have an important weight in decision-making. Concerns about the external impacts of projects leading to opposition of non-users can make a project unfeasible. Although Environmental Impact Assessment (EIA) procedures should provide enough headway for finding adequate solutions for these impacts in the definition of a project, quite often there are interest groups (in favour or against the project) that will place their position regarding the project firmly in the political arena.

The table below synthesises the stated criteria, specifying the dimension / stakeholder each criterion refers to, and some indications on elements to be considered to assess each criterion.

Table 4-2 Criteria for transferability (standarisation, generalisation)

	Stakeholder	Criterion	Elements to consider *(indicative)*
INTEREST	USERS *(Fast, cheap and comfortable travel)*	Is the solution interesting enough to be useful for other users in a different context?	*What is the overall magnitude of benefits to users? (e.g. decreased travel times and travel costs, increased reliability, comfort, convenience...)*
INTEREST	OPERATORS *(Commercial profit)*	Is the solution attractive enough for other operators to consider?	*To what extent benefits to operators outweigh difficulties to implement? (e.g. decrease operating costs, increase profit opportunities for operator...)? Is it simple enough in terms of organisation?*
INTEREST	GOVERNMENT *(social profitability)*	Is the solution strategic enough for other governments to consider?	*How large is the set of benefited users in relation to the cost of the solution? Cost-Benefit ratios*
FEASIBILITY	REGULATOR *(legal framework)*	Is the regulatory framework simple enough to allow straightforward implementation of solution in other countries?	*What are the legal constraints constraining the solution? Are there any barriers likely to be insurmountable in a different country, region?*
FEASIBILITY	TECHNOLOGY *(ad hoc approach)*	To what extent can the solution be implemented in other geographic contexts or in other modes?	*Is it an ad hoc solution for a specific problem, transport mode or transport technology?*
FEASIBILITY	NON-USERS *(externalities)*	Are there any externalitites or/and side effects linked to the solution affecting third parties other than users?	*Is the solution environmentally acceptable? What are the impacts at local or regional scale for not users? (increased noise, pollution, congestion, visual intrussion...)*

4.2 Transferability of Solutions, by Families

Each of the transferability criteria is rated with a value from 0 to 10, with low scores indicating low transferability potential, and high scores pointing towards high transferability rates. The average value of the six proposed criteria allows obtaining an indicative value of the global transferability potential of a specific solution.

The scoring for each solution family has been determined qualitatively based on the outputs of ORIGAMI Stakeholder Seminars and consultations, involving the transport industry, the research community, transport consultants, and civil servants, and complemented by literature review, analysis of specific cases and expert judgment of the ORIGAMI FP7 consortium.

ORIGAMI Stakeholder Seminars were organised with the aim to discuss innovative transport solutions and their likely impact on future transport scenarios. A first seminar was held in Barcelona in May 2012, and a second one via internet during November and December 2012. Previously, in November 2011 ORIGAMI had a first expert eConsultation. The main outcomes of the ORIGAMI expert workshops are synthesised as annexes to this Deliverable and are fully documented at the ORIGAMI website (http://www.origami-project.eu/).

The next table provides the overall scoring of the 13 ORIGAMI solution families.

Table 4-3 Transferability of solutions by families (standardisation, generalisation)

SOLUTION FAMILY	CRITERIA FOR TRANSFERABILITY (STANDARDISATION, GENERALISATION)					
Criterion	**What is the overall magnitude of benefits to users?**	**To what extent benefits to operators outweigh difficulties to implement?**	**How large is the set of benefited users in relation to the cost of the solution?**	**Is the regulatory framework simple enough to allow straightforward implementation of solution in other countries?**	**To what extent can the solution be implemented in other geographic contexts or in other modes?**	**Are there any externalitites or/and side effects linked to the solution affecting third parties other than users?**
Score Range	(1 min - 10 max)	(1 min - 10 max)	(1 small - 10 large)	(1 complex - 10 easy)	(1 purely place-based - 10 general)	(1 negative externalities - 10 positive externalities)
Target Stakeholder	TRAVELLERS	OPERATOR	GOVERNMENT	REGULATOR	TECHNOLOGY	NON-USERS
Issue addressed	Fast, cheap and comfortable travel	Commercial profit	Social profitability	Legal framework	Ad hoc approach	(-) Barrier effect, noise... // (+) friendlier urbanisation
Travel planners and user information (e.g. better information on departures, delays..., in stations or smartphones, route planners...)	6	7	9	10	9	6
Traffic management (e.g. Airspace control optimisation, ERTMS....)	8	7	7	7	7	9
Local interconnections (e.g. Better local public transport in Rail terminals or Airports)	8	6	6	9	6	9
Enhanced vehicle performance (e.g. Faster trains, more intelligent cars...)	8	7	7	8	6	8
Enhanced safety (e.g. Safer vehicles)	7	7	7	8	7	8
Security & fee collecting procedures (e.g. Faster check-in procedures at airports, enhanced toll collecting in motorways...)	7	7	7	6	9	6
Environmental management (e.g. Cleaner vehicles)	6	6	7	9	7	7
Ticketing schemes (e.g. air-rail joint tickets, integrated ticketing in PT, ticket sales in smartphones ...)	8	5	7	7	7	7
Long-distance interconnections (e.g. High Speed Rail links into airports)	8	7	5	8	6	7
Organisational arrangements (e.g. Privatisation of airports or rail operators...)	6	8	7	3	5	7
Segregation of freight & pax traffic (e.g. Dedicated freight rail lines aimed at pulling trucks out of motorways)	6	6	6	6	7	5
Dual mode solutions (e.g. Tram-train, bus-train, rail-ferries..)	7	6	5	5	5	7
Missing links: megaprojects (e.g. Gibraltar tunnel, Eurotunnel, Oresund...)	6	5	3	5	2	4

A discussion is provided below for each of the solution families, based on the Transferability Criteria presented in Table 4-2.

Travel Planners and User Information

Solution Interest. Solutions allowing for multi-modal trip planning and ticket purchasing in Europe can have an important role in optimising passenger routes in the future. Providing real-time trip information in smart phones or car navigating systems that will change the suggested route in case of road congestion or delayed public transport allows increasingly accurate decision making in transport. As users are better informed about alternative route choices, they can optimise their trip itineraries saving time and money. Transport operators also benefit from this solution as they are able to easily sell tickets and facilitate user information using less human resources (employees), and can also make a profit from publicity appearing in the travel planner applications. The market is already spontaneously promoting these solutions without regulation or public support required. The social benefit of such solutions at EU level may seem rather marginal, but as costs are also low, the social profitability of these initiatives is likely to be positive.

Feasibility. New ITS protocols for trip planning (like EU-spirit) allow for the distributed computation of alternative journeys. Different networks of existing local and regional journey planners are used for computing segments of the journey corresponding to specific regions or modes. This makes the technical side of this solution simpler to implement. Additionally, the inclusion of environmental indicators such as CO2 emissions in travel planners, like in routeRank, might promote more responsible behaviour by travellers, decreasing the level of externalities of transport. This technology can be applied for different modes and different regions of Europe, or for all modes and all Europe simultaneously in an integrated approach.

Final scoring. Considering relatively high interest for travellers, operators and public authorities, and being easy to implement, Travel Planers and Passenger Information have the highest level of transferability.

Traffic management

Solution Interest. There are many positive impacts of this solution. For users, proper management of transport infrastructure allows for increased average travel speeds, increased travel reliability, increased safety. For operators, solutions aimed at improving management allow for increasing capacity of existing infrastructure with relatively low investments. For instance, implementing a system of managed lanes in a motorway such as London's and Birmingham's in the UK, including variable speed limits and hard shoulder management, allows better driving conditions with investments being about one third of the cost of enlarging motorways with one additional lane. However, investments required for the implementation of systems allowing for better management of transport infrastructure are not to be underestimated (e.g. ICTs in motorways or ERTMS).

Feasibility. Despite the fact that some adjustments in the legal framework might be necessary for the implementation of certain management solutions (e.g. hard shoulder driving, variable speed limits), these legal adjustments should not be insurmountable. Although ICT technologies applied to traffic management are relatively mode-based, making it difficult to transfer them across modes, they can be exported relatively easily from one region to another, all across Europe. Implementation of such solutions is only expected to be cost efficient in areas with important traffic congestion, like in metropolitan motorways and railways, European airport hubs and a very limited number of long-distance rail lines across Europe. Externalities are likely to decrease with improved management. For the road mode, decreased congestion results in decreased accidents, emissions and noise, with particularly positive impacts for communities living close to large transport corridors, like metropolitan motorways. Improved management strategies for the air space, like point to point routing (FRAM) and optimisation of airplane landing procedures (REACT) has shown that fuel savings are also possible through management in the air mode.

Final scoring. Traffic management solutions have the second highest level of transferability. Spontaneous implementation by transport operators is relatively likely according to experts. There are already several examples of such practice in Europe.

Access and egress to long-distance transport networks (local Interconnections)

Solution Interest. Enhancing the public transport access and egress conditions to airports, rail and ferry terminals has an obvious positive impact on users in terms of travel time savings and increased comfort. When using a car, solutions aimed at increasing traffic flow in congested areas (via management or new infrastructure solutions) result in travel time savings and reduced fuel consumption. On the other side, public administrations responsible for financing investments and service subsidies face very important economic costs and are forced to establish priorities among different transport alternatives, whenever possible with clear and transparent cost-benefit methodologies. Solutions exclusively dedicated to serve long-distance transport terminals, like high speed shuttles to airports, are likely to incur high, sometimes unsustainable, financial costs, while making best use of already existing infrastructure provides much higher social profitability (e.g. using suburban trains or buses to reach airports). The interest of transport operators to manage such services is usually high as minimum economic profitability for service exploitation is granted through public subsidies.
Feasibility. Local interconnections may not raise relevant legal issues but, as they often need to be built in heavily populated and urbanised areas, they often have a high level of organisational complexity, especially when agreements among multiple stakeholders are needed (city halls, transport operators, user associations). The design of the Barcelona airport interconnections, for instance, was long discussed over the 1990s and 2000s, with a dozen project alternatives proposed and no overall final agreement ever reached. On the other hand, solutions are technically relatively easy to be transferred from one area of Europe to another, but they always have specificities which need to be closely taken into account to obtain a good project. Access and egress public transport to long-distance terminals can also be used by other users than merely long-distance travellers, like metropolitan commuters, increasing the scope and the interest of these solutions.
Final scoring. Local interconnections have a high level of transferability.

Enhanced vehicle performance

Solution Interest. With clear benefits for users (shorter travel times, increased comfort, convenience and safety), not all solutions may be equally interesting to transport operators or public administrations. Investments in some cases may be very considerable (e.g. high speed programmes).
Feasibility. No major feasibility issues are to be expected for these kinds of solutions. When the approach is on a vehicle basis like for car multiple driving assistants or automatic subways, transferability across Europe is very easy, even if technologies may be often mode specific. If the approach is infrastructure intensive, like the high speed rail programs, difficulties may be much higher. Standardisation of technologies is a basic precondition for transferability.
Final scoring. Transferability is to be expected high for those solutions with a market interest and providing high traveller benefits. These solutions will mostly be developed by the private sector.

Enhanced vehicle safety

Solution Interest. Not all solutions may be equally interesting to transport operators despite benefits for users. However, public administrations are likely to be very in the case of safety applications. Increasing transport safety is one of the goals of the 2011 transport White Paper, and initiatives helping to attain the zero fatalities target by 2050 will be most likely supported by the EC, both economically and in terms of back-up regulation.
Feasibility. No major feasibility issues are to be expected for these kinds of solutions. Transferability across Europe is more likely to be easy when the approach is on a vehicle basis (e.g. car driving assistants) than on infrastructure (vehicle to infrastructure communications). Some solutions might

require higher organisational requirements than others, like the eCall platform, but are likely to be directly supported by the EC. Standardisation of technologies is a basic precondition for transferability.
Final scoring. Transferability is to be expected higher for those solutions with a strong institutional interest and providing more safety benefits. These solutions will mostly be developed by the private sector, sometimes promoted by the public initiative.

Enhanced security & fee collecting procedures

Solution Interest. For users, these solutions tend to improve service quality, provide travel time savings, increase transport comfort, and transport reliability. Most of the times, operators aim at keeping the system working efficiently to attract more users and save operating costs: for instance, increasingly automatic motorway tolls to prevent congestion and increase road demand; reducing delays caused by formalities at airports can make medium distance flights more competitive against rail. In other occasions, it may be the interest of the operator to keep passengers as long as possible within the transport system, e.g. to increase the profit of retailing spaces at airports or to increase revenues from car parking. Public administrations are likely to seek transport solutions that are as efficient as possible.
Feasibility. Solutions considered can easily be implemented all over Europe, and may also be easy to be transferred across different modes: security procedures from the air mode are starting to be applied to access high speed services at rail stations, and queue management at road tolls is comparatively similar to airport queue management at security controls, or queue management at urban traffic lights. However, there may be legal obstacles in relation to privacy issues depending on the technologies used, like in the case of cell phone tracking via blue tooth IDs.
Feasibility. Transferability is estimated medium-high for these kinds of solutions.

Environmental management

Solution Interest. Environmental solutions, such as in-situ energy generation to power transport infrastructures such as rail or the electrification of motorways are most attractive for public administrations concerned with energy dependency and environmental conservation. Some initiatives developed by the public sector are only aimed at generating the initial necessary conditions (seeds) for the private sector to take over later on. However, there are many alternatives available and some of these are of higher value than others. Some solutions might not prove to be sufficiently cost-effective.
Feasibility. Technologies are easy to be transferred across Europe and across modes. Environmental returns may be positive. No major legal obstacles may be expected. Intensive land occupation and visual intrusion may be some determinant drawbacks.
Final scoring. Because of not having major technical obstacles or insurmountable social barriers to wide-spread application, and having a relatively high public sector interest, transferability is determined medium-high. However, scores may differ widely from one solution to another.

Ticketing schemes

Solution Interest. Initiatives aimed at providing more comprehensive fare structures for transport are expected to provide highly positive impacts on users. However, solutions like integrated ticketing may have substantial organisational complexity, proportional to the number of different operators involved. Complexity is likely to come from the system used to distribute costs and revenues of integrated systems. The cost of integrated ticketing can be considerable high for the public

administrations.

Feasibility. General orientations to integrated ticketing schemes and operations may be relatively easy to transfer across modes and territories, but specificities for each case are likely to be very important. Legal frameworks may be complex and may require adjustment. Overall success of such systems will depend on the capacity to overcome such specificities.

Final scoring. Ticketing solutions are granted a medium level of transferability.

Interconnections between long-distance transport networks

Solution Interest. Similarly to local interconnections, enhanced long-distance interconnections have obvious positive impacts on long-distance travellers. In some cases, a proper interconnection may save large amounts of time to passengers on transit, especially when saving users the trip to the closest city to transfer to another long-distance transport network. However, with investments typically large (e.g. 225 million euro for Frankfurt airport's ICE terminal without considering cost of access railway infrastructure; 180 million euro for Dusseldorf Skytrain people mover) and demand for long-distance transits relative low compared to typical urban public transport ridership figures, these solutions are only cost effective in very specific cases. Analysis of alternative technologies to provide such interconnection becomes necessary, and in some cases simpler solutions such as shuttle buses may prove to be just as good as more complex solutions.

Feasibility. A majority of transport stakeholderswho participated in the ORIGAMI workshops have declared the need for ad-hoc approaches to long-distance transport network interconnections, mostly in relation to transits, already available infrastructure and possible territorial constraints; a solution which has proved to be efficient in one case may not work in another context (e.g. ICE connections in Frankfurt compared to TGV connections in Lyon or many AVE connections in Spain). Interconnections may not raise relevant legal issues but may have considerable organisational complexity due to a large number of stakeholders typically involved (e.g. central public administration, various municipalities, at least two infrastructure managers, transport operators, user associations). Finally, improving air/rail interconnections may tend to increase the modal share of the air mode[12], and consequently, GHG emissions and noise (increased externalities)

Final scoring. Long-distance interconnections have low level of transferability. According to experts involved in ORIGAMI workshops, a market niche will develop spontaneously in the future for such solutions though it may not be expected to be a very big.

Organisational arrangements

Solution Interest. The impact on the efficiency of the transport system of public-private partnerships (PPPs), privatisations or liberalisation is uncertain according to most experts who have participated in the ORIGAMI workshops. Some claim that PPPs should drop prices for the consumers, bring additional funding resources for transport investment and put less pressure on the public sector. Others claim that PPPs are just a mechanism to postpone the payment of the infrastructure by the public sector with much greater cost in the end, and that it transfers profits to the private sector while keeping risks for the public bodies.

Feasibility. Time is required to acquire enough evidence to draw sensible conclusions on the impact of liberalisation. It is necessary to contrast and compare approaches taken in various EU countries and various initiatives. However, it is clear that no single formula exists to be applied across modes and territories in Europe. A good regulatory framework to transport sector liberalisation is necessary.

Final scoring. For all these reasons, Organisational Arrangements are given a medium low

12 See Deliverable D5.2 and D5.3 of INTERCONNECT 7FP. Ulied A, Biosca O, Català R, Franco N, Larrea E, Rodrigo R, "Metamodels for the analysis of interconnectivity" Deliverable D5.2 of INTERCONNECT, Co-funded by FP7. TRI, Edinburgh Napier University, Edinburgh, May 2011

transferability potential.

Segregation of freight and passenger traffic

Solution Interest. The large investments required for providing dedicated freight motorways or railways, like the ú5,000 million of the Betuwe line, can only be socially profitable when freight volumes to be transported are very important and need to go through very congested transport infrastructure (e.g. to connect European busiest ports with leading economic regions throughout major metropolitan areas). Social benefits of dedicated freight infrastructure are more likely to come from alleviated congestion in the passenger network (few minutes saved by millions of vehicles or passengers) rather than direct benefits for freight transport. Some argue there might be traffic management systems that provide better use of existing infrastructure, e.g. using spare road capacity during night times,which may be just as good as dedicated infrastructure at a much lower costs.

Feasibility. The very specific nature of these solutions makes their transferability very difficult. Even when legal obstacles may not be especially relevant, and when externalities of such projects may not be relevant either, still the place based approach of these many solutions (e.g. inland connections for busiest European ports, or largest heavy industries and mines), makes them difficult to be generalised for other modes or areas of Europe.

Final scoring. The transferability level for segregated freight infrastructure is low compared to other solutions.

Dual-mode transport solutions

Solution Interest. Dual mode transport solutions may only be socially cost efficient when required investments are relatively low, like in the Karlsruhe tramtrain case but unlike many other tramtrain experiences in Europe. Train ferries face increasing financial problems and services are cut back as passengers move to other modes such the airplane, like train ferries to Sardinia, or ferry connections are substituted by fixed links, like the Helsingor-Helsingborg or Korsor-Nyborg train ferries. Train ferries tend to survive for freight transport mostly. Similarly, car train services are increasingly withdrawn.

Feasibility. The very specific nature of dual mode transport solutions makes their transferability difficult. Even when legal obstacles or externalities may not be especially relevant, the place based approach required by these solutions makes them difficult to be generalised across Europe.

Final scoring. The transferability level for dual-mode transport solutions is low compared to other solutions.

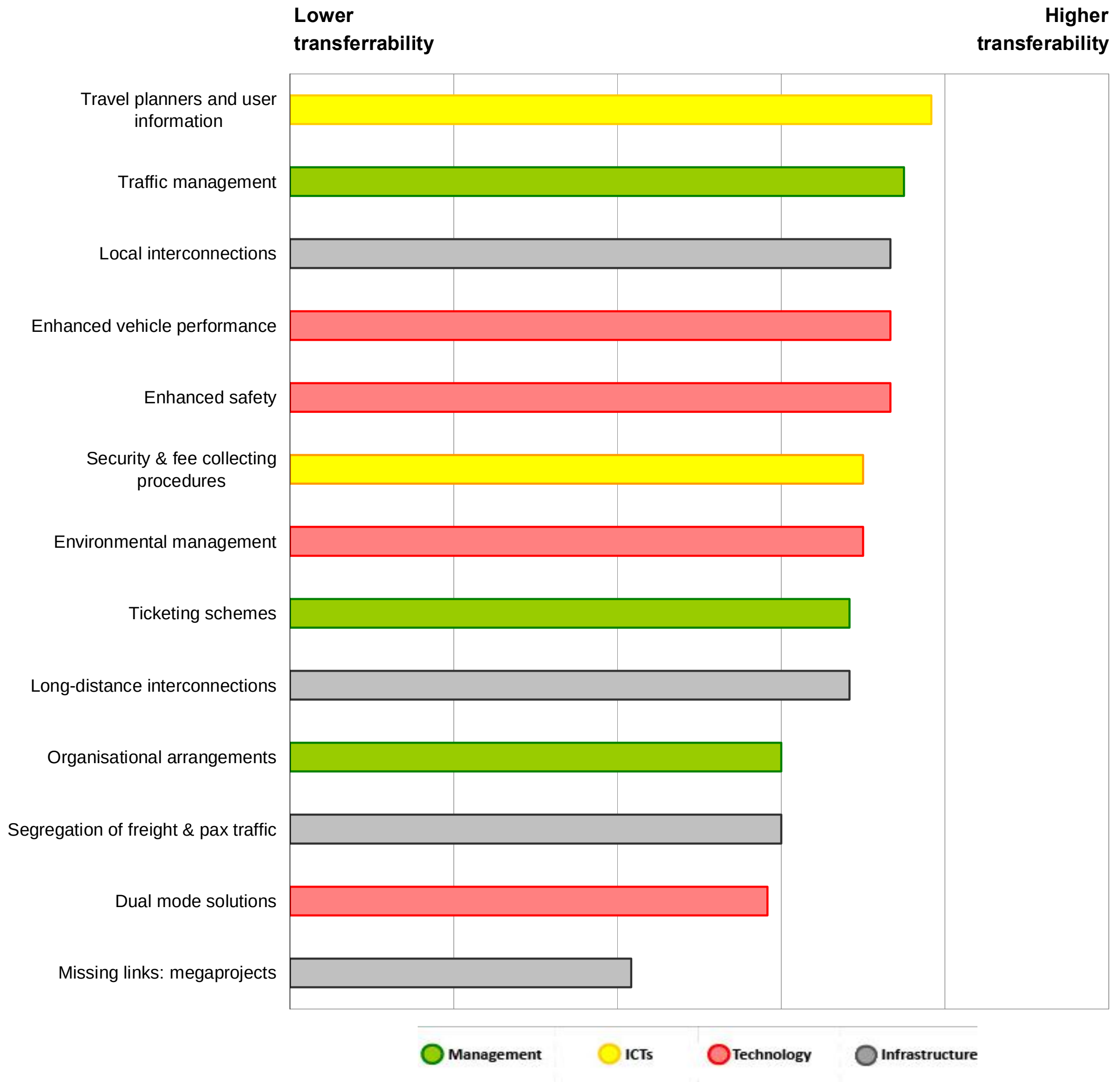
New transport links: mega-projects

Solution Interest. While the impact on users is likely to be important in most of the cases, with large travel time savings and increased comfort and convenience, costs are also likely to be extremely high for a relatively limited number of benefiting users. With these hypotheses, social cost benefit ratios are often very low or even negative. Large investments required for mega-projects for instance, often way above 5 or 10 billion euros, make them only possible when strong political will is able to compensate for all other poor financial performances (e.g. Channel Tunnel, Öresund bridge-tunnel or Gibraltar tunnel).

Feasibility. The very specific nature of mega-projects makes their transferability very difficult. Even when legal obstacles or externalities may not be especially relevant, the place based approach required by these solutions makes them difficult to be generalised across Europe. Mega-projects are to be tailored for each case, both in terms of design and technical solutions.

Final scoring. The transferability level is lowest for mega-projects.

Table 4-4 Overall Transferability of Solutions by Families



4.3 TRANSFERABILITY OF SOLUTIONS, BY SPECIFIC APPLICATIONS

Starting from the transferability discussion at a family level in the previous section, particular scores have been given to each solution based on the relative differences between solutions in each family, and on the specific analyses and discussions by the stakeholder community (along in participatory activities, and comments at the Solutions Library webpage), literature review and expert judgement by ORIGAMI 7FP consortium partners.

Each of the next solutions would merit some discussion on transferability but it is out of the scope of this report to provide such level of detail.

The next table is the resulting synthesis assessment for each solution.

Table 4-5 Synthesis of transferability of solutions

Name	CRITERIA FOR TRANSFERABILITY (STANDARISATION, GENERALISATION)					
Criterion	**What is the overall magnitude of benefits to users?**	**To what extent benefits to operators outweigh difficulties to implement?**	**How large is the set of benefited users in relation to the cost of the solution?**	**Is the regulatory framework simple enough to allow straightforward implementation of solution in other countries?**	**To what extent can the solution be implemented in other geographic contexts or in other modes?**	**Are there any externalities or/and side effects linked to the solution affecting third parties other than users?**
Score Range	**(1 min – 10 max)**	**(1 min – 10 max)**	**(1 small – 10 large)**	**(1 complex – 10 easy)**	**(1 purely place-based - 10 general)**	**(1 negative externalities – 10 positive externalities)**
Stakeholder	**TRAVELLERS**	**OPERATOR**	**GOVERNMENT**	**REGULATOR**	**TECHNOLOGY**	**NON-USERS**
Issue	**Fast, cheap and comfortable travel**	**Commercial profit**	**Social profitability**	**Legal framework**	**Ad hoc approach**	**(-) Barrier effect, noise... // (+) friendlier urbanisation**
TRAVEL PLANNERS AND USER INFORMATION						
10.13. routeRANK - a multimodal travel planner	8.3	10.0	8.5	10.0	8.9	7.4
10.17. VBB Fahrinfo	7.4	8.1	8.5	10.0	8.9	5.8
10.08. Transport Direct	7.5	7.1	7.9	10.0	8.9	6.6
10.03. Reiseauskunft	7.5	7.1	7.9	10.0	8.9	5.8
10.04. Resrobot	7.5	7.1	7.9	10.0	8.9	5.8
10.05. Rejseplanen	7.5	7.1	7.9	10.0	8.9	5.8
10.07. START project	7.5	7.1	7.9	10.0	8.9	5.8
10.06. Ecopassenger	5.3	7.1	7.9	10.0	8.9	7.4
10.01. SBB Online Fahrplan	6.4	7.1	7.9	10.0	8.9	5.8
10.02. In-Time	6.4	7.1	7.9	10.0	8.9	5.8
10.09. Flyrail	6.4	7.1	7.9	10.0	8.9	5.8
10.10. Poznan Metropolitan Area Travel Planner	6.4	7.1	7.9	10.0	8.9	5.8
10.14. ÖBB Railjet ï Dynamic on board passenger information	6.4	6.1	6.0	10.0	10.0	5.8
10.15. Postbus ï Dynamic on board passenger information	6.4	6.1	6.0	10.0	10.0	5.8
10.11. Edinburgh Bustracker	6.4	6.1	6.0	10.0	8.9	5.8
10.12. Real Time information on trains or buses in the arrival section of an airport	5.3	6.1	6.0	10.0	10.0	5.8
10.16. The Man in Seat Sixty-One...	5.3	6.1	8.5	10.0	6.7	5.8
TRAFFIC MANAGEMENT						
06.06. Navigation Systems to Optimise Road Transport	8.0	6.8	8.0	9.0	9.5	9.0
06.14.ñCongestion Free Hessenòand Hard Shoulder Running on Motorways	9.4	7.2	9.3	5.5	8.0	8.7
06.01. Variable Road Charging in the Netherlands	7.0	8.0	9.0	7.0	9.0	8.0
06.05. Congestion Charges in Stockholm	7.5	9.0	8.0	7.0	7.5	8.7
06.04. Congestion Charges in London	7.5	8.5	8.0	7.0	7.5	8.7
06.07. Lane Control Systems in French Motorways	8.2	7.2	8.3	6.5	7.7	8.7
06.02. Eurovignette	7.5	7.7	8.7	6.5	8.0	8.0
06.13. Singapore Electronic Road Pricing / Urban Traffic Management	7.5	8.5	8.3	7.0	7.5	7.4
06.15. HOT- HOV lanes (Managed lanes in Texas and Utah)	7.5	7.5	7.2	7.0	7.0	8.7
06.03. Distance-based Lorry Taxes	6.3	7.7	7.0	6.0	7.7	9.9
06.09. ITS for Smarter Railways	7.5	7.2	6.7	7.5	6.1	8.7
06.16. Coordinated Ramp Metering in Australia	7.0	6.8	7.5	7.0	7.0	7.8
06.11. FRAM Free Route Airspace Maastricht	8.0	5.0	6.5	5.0	7.7	9.9
06.12. European Airport Movement Management by A-SMGCS (EMMA)	6.5	7.7	6.5	7.0	7.0	6.0

Name	CRITERIA FOR TRANSFERABILITY (STANDARISATION, GENERALISATION)					
Criterion	**What is the overall magnitude of benefits to users?**	**To what extent benefits to operators outweigh difficulties to implement?**	**How large is the set of benefited users in relation to the cost of the solution?**	**Is the regulatory framework simple enough to allow straightforward implementation of solution in other countries?**	**To what extent can the solution be implemented in other geographic contexts or in other modes?**	**Are there any externalities or/and side effects linked to the solution affecting third parties other than users?**
Score Range	**(1 min – 10 max)**	**(1 min – 10 max)**	**(1 small – 10 large)**	**(1 complex – 10 easy)**	**(1 purely place-based - 10 general)**	**(1 negative externalities – 10 positive externalities)**
Stakeholder	**TRAVELLERS**	**OPERATOR**	**GOVERNMENT**	**REGULATOR**	**TECHNOLOGY**	**NON-USERS**
Issue	**Fast, cheap and comfortable travel**	**Commercial profit**	**Social profitability**	**Legal framework**	**Ad hoc approach**	**(-) Barrier effect, noise... // (+) friendlier urbanisation**
06.08. European Railway Traffic Management System (ERTMS)	6.5	5.8	5.2	7.0	4.4	9.9
06.10. High Speed Rail Interoperability on the Iberian Peninsula	5.5	4.0	5.0	7.0	4.0	9.9
LOCAL INTERCONNECTIONS						
02.22. Avenida de América Bus and Metro Interchange Station in Madrid	9.3	7.9	8.2	9.3	7.4	9.0
02.07. Gothenburg City Airport Bus Link	8.2	9.2	8.2	9.3	7.4	8.0
02.13. Integrated Public Transport Facility in Bremen	8.2	9.2	8.2	9.3	7.4	7.8
02.23. Layout of multimodal transfer points	8.2	7.9	8.2	8.7	6.8	10.0
02.12. Combined Rail and Car Sharing Service with ÖBB VORTEILScard	9.3	5.9	6.4	8.7	7.9	10.0
02.15. Zürich Central Rail Station	9.3	5.9	6.4	8.7	7.9	8.0
02.27. Edinburgh Bus Station	7.6	7.9	8.2	8.7	6.8	6.5
02.16. Berlin Central Station	8.2	5.3	5.8	9.3	7.4	8.5
02.05. Copenhagen Airport	8.2	5.3	5.8	9.3	7.4	8.0
02.14. Dresden Transport Hub	8.2	5.3	5.8	9.3	7.4	8.0
02.26. Railway Connection between the Airport and the City of Cracow	8.2	5.3	5.8	9.3	7.4	7.5
02.04. Rail Link Connection Gdansk Airport & Railway and Bus Stations	8.2	5.3	5.8	9.3	7.4	7.0
02.01. Stockholm Arlanda Express Shuttle to Downtown	8.2	5.3	4.7	9.3	7.4	7.0
02.18. Linz Central Station	5.8	5.3	5.8	9.3	7.4	8.0
02.17. Liège-Guillemins Station	5.8	5.3	5.8	9.3	7.4	7.8
02.02. Oslo Gardermoen Airport Flytoget Express Shuttle to Downtown	8.2	5.3	4.7	9.3	5.3	8.6
02.06. Cracowï Fast Tram System Better Access City-Main Train Station	8.2	5.3	4.7	9.3	6.3	7.5
02.21. "Haller Willem"- Revitalisation of a Regional Railroad Line.	7.0	6.6	4.7	9.3	4.2	9.0
02.24. Metro and buses to the Port of Piraeus	8.2	6.6	5.8	8.0	4.2	7.9
02.19. Helsingborg Ferry and Rail Connections	8.2	5.3	5.8	8.0	5.3	7.0
02.20. Lisbon Ferry and Rail Connections	8.2	4.0	5.8	9.3	4.2	8.0
02.09. Hong Kong International Airport Ferry Services to Mainland China	8.2	6.6	5.8	6.7	4.2	7.8
02.11. Vancouver airport to the Vancouver Island ferry terminal	8.2	5.3	7.0	9.3	2.1	7.0
02.03. Shanghai Pudong Airport ï Air/Maglev interface	8.2	5.3	3.5	9.3	5.3	6.5
02.25. Prague Main Railway Station	7.0	5.3	3.5	8.0	6.3	7.5
02.08. Ferries at Marco Polo Airport in Venice	8.2	5.3	5.8	9.3	2.1	6.5
02.10. Logan Airport to Boston CBD water shuttle services	8.2	5.3	5.8	9.3	2.1	6.5
ENHANCED VEHICLE PERFORMANCE						
05.08. simTD - Safe and Intelligent Mobility Test Field	7.0	6.0	8.5	6.0	8.5	7.5
05.07. High Speed Rail (HSR) in Europe	8.5	6.5	6.4	9.0	7.0	6.0

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Score Range	**(1 min – 10 max)**	**(1 min – 10 max)**	**(1 small – 10 large)**	**(1 complex – 10 easy)**	**(1 purely place-based - 10 general)**	**(1 negative externalities – 10 positive externalities)**
Stakeholder	**TRAVELLERS**	**OPERATOR**	**GOVERNMENT**	**REGULATOR**	**TECHNOLOGY**	**NON-USERS**
Issue	**Fast, cheap and comfortable travel**	**Commercial profit**	**Social profitability**	**Legal framework**	**Ad hoc approach**	**(-) Barrier effect, noise... // (+) friendlier urbanisation**
05.02. High Speed Rail network in Spain	8.5	6.5	5.8	9.0	7.0	6.0
05.06. Automated Metro	4.0	7.0	8.1	8.0	7.0	8.0
05.01. Japan Maglev Train between Tokyo and Osaka	8.5	6.0	5.8	8.0	7.0	6.0
05.03. Vertiports	7.0	5.6	6.5	7.0	8.5	6.0
05.04. Water-Trams in the Tri-City	6.5	6.0	6.9	8.0	5.0	7.0
05.05. Gothenburg-Kiel Ferry	5.0	6.5	6.9	7.0	5.0	6.0
ENHANCED SAFETY						
13.01. Assisted Car Driving Systems	7.2	7.4	6.9	7.7	10.0	10.0
13.04. Vehicle to Vehicle Communication	8.2	5.9	7.4	9.5	6.7	7.4
13.06. Fully accessible Barcelona metro to people with reduced mobility	7.2	5.9	6.5	8.3	8.0	7.4
13.02. Intelligent Speed Adaptation (ISA)	7.2	7.9	8.3	7.1	5.3	7.4
13.05. Improved Connect. btn. Pilots,Aircraft & Ground Systems(UPLINK)	5.1	6.9	5.5	8.3	8.0	7.4
13.03. Pay as you speed research program in Denmark	7.2	7.9	7.4	7.1	4.0	7.4
SECURITY & FEE COLLECTING PROCEDURES						
11.12. Oyster card	9.1	7.8	9.2	8.8	6.5	8.8
11.14. Walrus card	9.1	7.8	9.2	8.8	6.5	8.8
11.07. SkyCash Ticket in Wroclaw	9.1	6.8	8.1	8.8	6.5	9.7
11.09. DB tickets on mobile phones	8.0	7.8	4.6	8.8	7.5	9.7
11.10. Lufthansa application for smart phones	8.0	7.8	4.6	8.8	7.5	9.7
11.13. m-ticket	8.0	7.8	4.6	8.8	6.5	9.7
11.02. IATA Checkpoint of the Future	9.1	6.8	8.1	7.1	6.5	6.8
11.01. Automated Border Control at Airports	9.1	5.8	8.1	6.2	6.5	6.8
11.06. LKW-MAUT Electronic Toll Collection System for Heavy Vehicles	8.0	7.8	9.2	7.1	4.7	5.8
11.04. Common Use Passenger Processing System (CUPPS)	5.7	7.8	8.1	7.1	4.7	8.8
11.11. Door-to-door luggage service for rail travel	8.0	4.9	5.8	8.8	4.7	9.7
11.05. Automatic Free-Flow Tolling Schemes in Czech Republic	8.0	6.8	8.1	7.1	4.7	5.8
11.03. Self-service Bag Drop the Future of Baggage Processing	6.9	6.8	5.8	7.1	6.5	6.8
11.08. On-Board Ticket Vending Machines in Wroclaw	5.7	5.8	4.6	8.8	4.7	4.9
TICKETING SCHEMES						
09.02. Municipal Transport Union of the Upper Silesian Industrial District	8.0	6.0	5.0	7.0	7.7	7.1
09.04. SailRail Train+Ferry Tickets	8.0	6.0	5.0	7.0	7.7	7.1
09.01. Integrated Rail Transport System of Wroclaw Agglomeration	8.0	6.0	5.0	7.0	7.7	7.1
09.03. Discounted Rail Tickets to and from Glasgow Prestwick Airport	8.0	6.0	5.0	7.0	7.7	7.1
09.07. RailLink Feeder Service	7.1	6.0	5.0	7.0	7.7	7.1

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Stakeholder	**TRAVELLERS**	**OPERATOR**	**GOVERNMENT**	**REGULATOR**	**TECHNOLOGY**	**NON-USERS**
Issue	**Fast, cheap and comfortable travel**	**Commercial profit**	**Social profitability**	**Legal framework**	**Ad hoc approach**	**(-) Barrier effect, noise... // (+) friendlier urbanisation**
09.08. Intermodal Offer for Tourists in Pomerania Region	7.1	6.0	5.0	7.0	7.7	7.1
09.06. Bicester Taxibus Rail link service	8.0	6.0	5.0	7.0	6.7	7.1
09.09. ŕRail&Flyŕ a co-operation between DB and airlines	7.1	6.0	5.0	7.0	6.3	6.2
09.05. Dutchflyer Rail and Sail to Holland	8.1	6.0	5.0	7.0	3.8	7.1
ENVIRONMENTAL MANAGEMENT						
12.05. Fuel Cells and Hydrogen Joint Technology Initiative	5.5	6.3	7.4	9.3	8.1	8.4
12.01. Electrification of Road Transport	4.6	6.3	7.4	9.3	8.1	7.6
12.10. Wind Farms to Power Railways in Belgium	4.6	6.3	7.4	9.3	6.9	8.4
12.06. Clean Sky: Enhanced Airplane Technology	4.6	6.3	7.4	9.3	8.1	6.7
12.11. Biofuels for cars	4.6	5.8	7.4	9.3	8.1	6.7
12.09. Biofuel on Commercial Flights	4.6	6.3	7.4	8.0	8.1	6.7
12.03. Thermoelectric Generators in Cars	7.4	6.3	7.4	9.3	4.6	5.9
12.02. Electrified motorways with catenaries	5.5	4.5	6.3	8.0	8.1	8.4
12.08. REACTï CR Project: Optimisation of Airplane Landing Procedures	4.6	6.3	7.4	9.3	5.8	6.7
12.07. Electrical Aviation	4.6	6.3	6.3	8.0	6.9	6.7
12.04. Autogas (Automotive LPG)	5.5	6.3	6.3	9.3	4.6	5.9
12.12. List of all Austrian electric car charging stations	5.0	5.4	7.0	9.3	6.9	5.9
LONG-DISTANCE INTERCONNECTIONS						
01.08. Vienna Airport Rail and Bus Services	8.0	7.0	6.7	9.0	8.0	7.0
01.11. Amsterdam ferry & rail connections at Amsterdam Central Station	8.7	7.2	5.6	8.6	6.5	6.0
01.09. Frankfurt Hahn Airport Long-Distance Bus Connections	7.0	7.0	6.3	8.0	7.5	7.0
01.05. Düsseldorf Airport Rail Connections with SkyTrain People Mover	7.5	7.0	7.5	8.0	7.0	5.5
01.02. Air-rail integration at Frankfurt am Main airport	7.9	7.5	6.7	7.2	6.1	7.0
01.04. Zürich Airport rail connections	9.1	7.5	4.4	7.2	7.1	7.0
01.01. Amsterdam Schiphol Airport regional and local rail connections	7.9	7.0	5.0	8.6	6.6	7.0
01.03. Paris - Charles de Gaulle TGV and public transport connections	7.9	6.3	5.0	8.6	6.6	7.0
01.06. Barcelona Airport HSR, commuter and metro connections	7.5	6.0	5.6	8.0	6.8	7.0
01.10. Kansai International Airport ï Kobe Airport High Speed Ferry	7.9	7.5	6.7	7.2	5.0	6.5
01.12. Port of Ancona Ferry and Rail connection	7.9	7.1	4.4	7.2	5.0	6.5
01.13. Port of Dagebüll Ferry and Rail connection	7.9	7.1	4.4	7.2	5.0	6.5
01.14. Port of Turku Ferry and Rail connection	7.9	7.1	4.4	7.2	5.0	6.5

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Issue	**Fast, cheap and comfortable travel**	**Commercial profit**	**Social profitability**	**Legal framework**	**Ad hoc approach**	**(-) Barrier effect, noise... // (+) friendlier urbanisation**
01.07. Lyon Saint-Exupéry Airport TGV Connection	5.7	5.0	2.5	8.0	6.1	7.0
ORGANISATIONAL ARRANGEMENTS						
07.07. "Mobilfaltòï Privat cars to replace or complement public buses	7.0	7.6	5.0	7.0	5.5	8.4
07.05. Local Network Franchising: Merseyrail Concession	7.5	9.0	6.0	6.0	5.0	6.0
07.04. Privatisation of Spanish Airports: Barajas and Barcelona	6.5	7.6	7.1	6.0	4.0	5.6
07.02. Single European Sky Initiative	7.3	7.6	7.0	5.0	4.0	5.6
07.03. Privatisation of UK airports	6.0	7.6	7.1	6.0	4.0	5.6
07.06. Edinburgh Airport Transport Forum	5.5	7.0	5.0	5.0	6.5	6.0
07.01. Brenner Corridor Platform	5.5	7.0	5.0	5.0	5.0	7.0
SEGREGATION OF FREIGHT & PAX TRAFFIC						
08.03. SARTRE Project: Automatically Driven Car Trains	9.0	7.0	7.0	5.0	8.5	6.5
08.04. Road Trains in Scandinavia, the Netherlands, Germany and the UK	7.0	8.5	6.9	4.0	8.0	7.0
08.05. Modular Vehicle Combinations (MVC) in Denmark	5.9	8.5	6.9	4.0	8.0	7.0
08.02. Dedicated Roadways for Trucks in Boston	6.5	7.5	8.0	6.0	6.5	4.0
08.01. Betuwe Route: Dedicated Freight Rail Corridor	6.5	6.5	4.0	6.0	4.6	5.0
DUAL MODE SOLUTIONS						
04.01. Long Distance Car Transport on Board of Trains	5.3	5.5	5.8	8.0	8.0	8.1
04.06. The Karlsruhe Tram Train (Karlsruhe Model)	7.5	6.4	6.0	4.0	3.0	9.5
04.02. Puttgarden - Rodby Train Ferry	6.0	7.0	5.1	6.0	5.0	5.4
04.03. Train Ferries in Italy	6.0	7.0	5.1	6.0	5.0	5.4
04.04. Train Ferry in China ï Yuehai Railway	6.0	7.0	5.1	6.0	5.0	5.4
04.05. The Toyota Bus - Train	6.0	6.0	4.3	3.0	7.0	6.0
MISSING LINKS: MEGAPROJECTS						
03.02. Great Belt in Denmark	7.5	7.5	4.5	6.5	2.9	4.0
03.04. Saint Gotthard Base Tunnel	7.0	7.0	3.0	6.5	4.0	5.0
03.01. Øresund Bridge	7.5	7.3	4.5	5.5	2.9	4.1
03.05. Brenner Base Tunnel	7.0	7.0	3.0	6.5	4.0	5.0
03.07. Transalpine Lyon - Turin	6.0	6.5	2.5	4.9	4.0	5.0
03.06. Fehmarn Belt Fixed Link	7.0	6.5	3.0	4.9	2.9	4.1
03.03. English Channel Tunnel	7.5	6.5	4.5	4.9	0.0	4.1
03.11. Messina Strait Bridge	6.0	5.0	4.5	6.5	1.0	4.5
03.08. Pyrenees Central Base Tunnel	6.0	3.5	1.5	4.9	4.0	4.5
03.10. Gedser-Rostock Fixed Link	6.5	5.5	1.5	3.2	1.0	4.1
03.09. Tunnel under Gibraltar Strait	6.0	3.0	1.0	1.6	0.0	4.0

5 CONCLUSIONS

- A total of 162 solutions were identified under ORIGAMI as having a potential to improve long-distance transport for passengers. Solutions were fully documented in an on-line public web directory, in a systematic structure (www.origami-project.eu). Solutions were classified according to 13 different solution families, each of them acting in a specific segment of the transport chain to improve overall efficiency of the European transport system.
  - 14 solutions have been selected as examples of initiatives aimed at improving interconnections between different long-distance transport networks (e.g. rail services to airports, connections between railways and ferry lines).
  - 28 solutions have been selected as examples of initiatives aimed at improving access and egress to long-distance transport terminals from cities and metropolitan regions.
  - 9 solutions have been selected as examples of initiatives aimed at addressing missing links relevant at a European scale. Most solutions discussed are mega-projects: tunnels or bridges overcoming major natural obstacles usually worth over ú5 billion.
  - 5 solutions have been selected as examples of initiatives aimed at designing hybrid vehicles that can use the classic infrastructure of different transport modes without requiring travellers to tranship from one mode to another.
  - 9 solutions have been selected as examples of initiatives aimed at enhancing the performance of vehicles, for instance by increasing their speed or making them more reliable.
  - 19 solutions have been selected as examples of initiatives aimed at better managing traffic flows, either for road, rail, or air.
  - 10 solutions have been selected as examples of initiatives which change the formal organisation of specific transport services aiming at increasing their efficiency: liberalisation processes such as concessions, franchises, privatisations, de-regulations, or agreements reached between operators to provide coordinated services.
  - 4 solutions have been selected as examples of initiatives to segregate passenger and freight transport, or at least decreasing the volume of freight transport in infrastructures shared with general passenger transport.
  - 10 solutions have been selected as examples of initiatives related to travel tickets with the aim to increase the transparency and balance of transport fares across modes and territories in Europe, to allow passengers to travel on multiple means of transport using integrated tickets, or to make it easier to purchase travel tickets.
  - 21 solutions have been selected as examples of initiatives aimed at increasing the quantity and quality of information provided to travellers allowing them to make better route choices when travelling.
  - 14 solutions have been selected as examples of initiatives aimed at preventing the generation of queues in bottlenecks through the need to undertake specific formalities such as security checks or transport fare payment.
  - 13 solutions have been selected as examples of initiatives aimed at making transport more environmentally friendly and less dependant on fossil fuels.
  - 6 solutions have been selected as examples of initiatives aimed at making transport safer.
- ORIGAMI solutions have been discussed in a series of participatory activities with transport stakeholders (transport industry, research community, policy makers and public servants, and transport consultants). Two Stakeholder seminars were developed to allow knowledge transference between stakeholders developing transport solutions and stakeholders with specific transport needs. A first seminar was held in Barcelona in May 2012, and a second one was held electronically during November and December 2012. An expert consultations on transport trends had been previously developed in November 2011.
- Few of the system needs identified by ORIGAMI in WP4 have no solution already available or at least under development somewhere in Europe. The few identified gaps found concern real-time

information: real-time information at rail stations in ports on ferry departures, real-time information on onward travel at ports, and real-time information on trip status and connections for coaches. However, for the latter the Austrian Postbus operator is aiming to install such a system in the near future, and the two former may even already exist somewhere unbeknown to the project team, and in any case can be easily realised with technology already in use for other existing real-time information.

- On the other end of the spectrum, there are just a few needs for which, at least in principle, there are universal solutions available. These are:
  - Hire cars at airports for the last mile;
  - Park & Ride facilities for the first mile;
  - Demand responsive public transport services;
  - Cars with assisted driving facilities to make cars safer; and
  - Electric vehicles to make cars cleaner, even though facilities to reload batteries are in some countries still very rare.
- ORIGAMI solutions identified in WP5 have been assessed in relation to their potential generalisation across modes and territories all over Europe. To do this assessment, a set of six criteria was defined reflecting six (not always conciliated) dimensions in the transport market. A solution is considered to have a high generalisation and transferability potential when it may have a manifest interest for a wide range of stakeholders (users, operators, government), and when conditions are such that a there are not feasibility barriers to its transferability (regulatory, technical, externalities). Criteria were based on INTERCONNECT FP7 Evaluation Framework and on the EIB's RailPAG Evaluation Criteria.
- Starting from a transferability discussion at a family level, particular scores are also proposed for each individual solution identified in WP5. Scores under each of the transferability criteria were qualitatively determined based on discussions by the stakeholder community (along in participatory activities, and comments at the solutions web directory), literature review and expert judgment by the ORIGAMI FP7 consortium.
  - Travel planners and passenger information solutions have shown highest transferability potential; followed by
  - Traffic management solutions,
  - Access and egress to long-distance transport networks (local Interconnections) solutions;
  - Enhanced vehicle performance solutions;
  - Enhanced vehicle safety solutions;
  - Security & fee collecting procedures solutions;
  - Environmental management solutions;
  - Ticketing schemes solutions;
  - Interconnections between long-distance transport networks;
  - Organisational arrangements;
  - Segregation of freight and passenger traffics solutions;
  - Dual-mode transport solutions; and
  - Missing links: mega-projects.
- ORIGAMI transport solutions identified in WP5 are the basis for the definition of prospective transport scenarios in WP7. ORIGAMI scenarios are supply oriented and characterised by different degrees of emphasis on infrastructure investment, infrastructure management, enhanced regulation, more liberalisation and further technological implementation.

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JOURNALS ON TRANSPORT INNOVATION

- *International Transport Journal (ITJ),*

  http://transportjournal.com/index.php?id=415&no_cache=1&L=1
- *World Highways* http://www.worldhighways.com/
- *Traffic Technology International* http://www.ukipme.com/mag_traffic.htm
- *Journal of Transport, Economics and Policy (JTEP)* http://www.bath.ac.uk/e-journals/jtep/
- *Transport Policy* http://www.journals.elsevier.com/transport-policy/
- *Journal of Transport Geography* http://www.journals.elsevier.com/journal-of-transport-geography/
- *Transportation Research Part A: Policy and Practice*

  http://www.journals.elsevier.com/transportation-research-part-a-policy-and-practice/
- *Transportation Research Part B: Methodological*

  http://www.journals.elsevier.com/transportation-research-part-b-methodological/
- *International Journal of Intelligent Transportation Systems Research*

  http://www.springer.com/engineering/electronics/journal/13177
- *Journal of Regional Science* http://eu.wiley.com/WileyCDA/WileyTitle/productCd-JORS.html

NEWSLETTERS

- Transport and Environment Bulletin http://www.transportenvironment.org/
- Future Travel Experience http://www.futuretravelexperience.com/
- Airport Business http://www.airport-business.com/
- Anna.aero http://www.anna.aero/

ANNEX – 1ST STAKEHOLDER SEMINAR

AIM

The first ORIGAMI stakeholder workshop took place in Barcelona on 4th May 2012.

The workshop was planned as a follow-up to the stakeholder consultations already carried out within ORIGAMI on trends within long-distance passenger transport by 2030. Expert stakeholders from government, transport agencies consultancies and research institutions from throughout Europe were invited to make presentations and contribute to discussions on future scenarios for European mobility, focusing on infrastructure, management and technological innovations that have significant potential impacts on European transport in the short and long-term.

The main aim of the workshop, according to the ORIGAMI DoW, was to bring together stakeholders responsible for the design and implementation of successful innovative solutions and those who are potentially interested in adopting a given solution. Building on this and on the work already completed within ORIGAMI, the workshop focused on two areas:

- The database compiled within ORIGAMI on proposed innovative solutions for seamless passenger journeys and the analysis of these solutions carried out within the project, with presentations from stakeholders responsible for some of these solutions
- Trends and scenarios for European mobility beyond 2020, taking as a starting point the results of the ORIGAMI on-line expertsô consultation, with presentations from a number of different viewpoints

ORIGAMI joined the Global Cat network for the organisation of the event. Global Cat is series working sessions and discussion forums organised in Barcelona by the Department of Territory and Sustainability of the Catalan Administration[13], with the main aim of identifying and analysing territorial conditions and opportunities favouring the internationalisation of Catalonia in the European framework. With the participation of a wide group of experts in the fields of economy, sustainability, territory and transport, these workshops are aimed at evaluating the current situation of Catalonia and to identify the opportunities and priorities for action, as well as for territorial planning.

The total number of stakeholders who confirmed attendance at the workshop (participating for a full day or partially), including those who gave presentations, was of 96. This included representatives from 12 different countries and from EC, from the European Parliament and other trans-national organisations, as well as local stakeholders. Both in terms of the actual numbers in attendance, and in the quality of stakeholders present and organisations represented, the workshop was considered to be a great success, bringing together a particularly interesting group of participants with much focused interests in the sort of work being carried out in ORIGAMI.

Figure 0-1 List of Institutions Participating

Institution	Institution
EC - Directorate-General for Mobility and Transport	MKmetric GmbH Karlsruhe
EC - Directorate-General for Research and Innovation	Edinburgh Napier University (TRI)
European Parliament	Mcrit Barcelona
Government of Catalonia	University of Gdansk
Ministry of Fomento, Government of Spain	Institute for Transport Studies (ITS), University of Leeds
Metropolitan Public Transport Association of Gdansk Bay	Technical University of Vienna
Fundació Mobilitat Sostenible	Barcelona City Hall
Aeroporto Milano Malpensa	Metropolitan Transport Authority (ATM)
Gdansk Lech Walesa Airport	FGC Railways of Catalonia
European Passengers' Federation	Port of Barcelona
Campaign for Better Transport	AsecorpChina Business Consulting
University of Bochum	Transfer Enginyeria

13 http://www20.gencat.cat/portal/site/territori/menuitem.14fa444b994def145f13ae92b0c0e1a0/?vgnextoid=789d9418daba3310VgnVCM1000008d0c1e0aRCRD&vgnextchannel=789d9418daba3310VgnVCM1000008d0c1e0aRCRD&vgnextfmt=default&newLang=en_GB

Institution	Institution
EU-Spirit / Public Transport Authority Berlin-Brandenburg	Barcelona Regional Agency
EUROCONTROL Maastricht Upper Area Control Centre	Departament de Territori i Sostenibilitat. Govenrnment of Catalonia
UK Office of Rail Regulation	Department of Presidency. Government of Catalonia
routeRANK	Corporació Universal del Management
FIA	Diputació de Barcelona
CETMO	GRUP Curanta
CENIT, UPC	Gestió i Promoció Aeroportuària - GPA
ISIS Rome	Territorial Studies Institute (IET)
European Investment Bank	President of China Consultants
Polytechnic University of Catalonia (UPC)	Senior Researcher at DTU Transport, Denmark
Network Rail	DHC Consultancy, UK
South Yorkshire Passenger Transport Executive (SYPTE)	European Railway Agency
Ambassador for Portugal at Association for European Transport	Imperial College London
Abertis Infraestructuras	University College London
Cambridge University	Glasgow Airport
Metropolitan Research Institute, Budapest	Wuppertal Institute, Germany
Institute of Transport Economics, Norway	Freelance Consultant, Italy
Karlsruhe Institute of Technology	City of Bratislava
Signosis Consultancy, Belgium	TRT Consultancy, Milano
SINTEF Technology and Society, Norway	

WORKSHOP SESSIONS

The workshop opened with welcome presentations from Xavier Baulies, representing Global Cat, and Andreu Ulied, representing Mcrit and the ORIGAMI consortium. This was followed by two presentations placing the workshop in the context of the future of transport in the EU after the 2011 Transport White Paper from Vicenç Pedret, European Commission Directorate-General for Mobility and Transport, European Mobility Network adviser, and Ramon Tremosa, Member of the European Parliament.

The main part of the morning session introduced the database compiled within ORIGAMI on proposed innovative solutions for seamless passenger journeys and the analysis of these solutions carried out within the project, as a starting point for discussions. There were three parts to the morning session, each given a slightly different theme, and with the presentations and speakers shown below.
Morning Session 1: Upcoming Solutions for Seamless Travel

- Christiane Bielefeldt, TRI Edinburgh Napier University
  Mobility: Gaps, Bottlenecks and Transferability of Innovations
- Edmund Krieger, Professor, University of Bochum
  The Düsseldorf SkyTrain
- Michal Dargacz, Spokesman for Gdansk Lech Walesa Airport
  Gdansk Airport Access
- Massimo Corradi, TEN-T Project Coordinator, Aeroporto Milano Malpensa
  Malpensa Rail Connections

Morning Session 2: Upcoming Management and Organisational Solutions

- Jean-Marie Leboutte, EUROCONTROL, Maastricht Upper Area Control Centre
  Free Route Airspace Implementation
- Paul McMahon, UK Office of Rail Regulation
  UK Rail "Value for Money" Study
- Garry White, Network Rail (UK)
  Management and Organisational Solutions
- David Young, South Yorkshire Passenger Transport Executive
  Bus Quality Partnerships or Quality Contracts?

Morning Session 3: Upcoming Innovative Solutions for more User-friendly Transport Services

- Kamil Bujak, Metropolitan Public Transport Association of Gdansk Bay
  Good-practice Solutions in Local Public Transport
- Enric Cañas, Fundació Mobilitat Sostenible Barcelona
  Solutions for User-friendly Transport Services
- Jochen Mundinger, routeRANK (link to the routeRANK website)
- Jona-Moritz Kundel, Public Transport Authority Berlin-Brandenburg
  Cross-border Door-to-Door Travel Information Services

The afternoon session was dedicated to discussions on trends and scenarios for European mobility beyond 2020, taking as a starting point the results of the ORIGAMI on-line expertsô consultation launched in November 2011. The presentations given are detailed below.

Afternoon Session 1 (Global Europe): Contribution to Upcoming Solutions to the Future of European Transport

- Luca Pascotto, Fédération Internationale de l'Automobile (FIA) Region 1
  Upcoming Solutions for the Future of European Transport
- Christopher Irwin, European Passengers' Federation
  Upcoming Innovations and Future Scenarios for a Seamless European Mobility
- Stephen Joseph, Campaign for Better Transport
  Solutions for the Future of European Transport: Scenarios for 2030
- Francesc Robusté, Centre of Transport Innovation at UPC
  Future Urban Mobility for 2030

Afternoon Session 2 (Global Europe): Europe, the Mediterranean and the World towards 2050

- Oriol Biosca, Mcrit Barcelona
  Future Trends in European Transport - the ORIGAMI Expert Consultation
- Saki Aciman, Centre for Transportation Studies for the Western Mediterranean
  Visions for the Future of Mediterranean Transport
- Carlo Sessa, ISIS, Rome
  Global Europe
- Paul Pfaffenbichler, Technical University of Vienna
  Europe, the Mediterranean and the World towards 2050

Following the second afternoon session closing remarks were given by Christiane Bielefeldt, Coordinator of the ORIGAMI project, Ioana-Olga Adamescu of the European Commission Directorate-General for Research and Innovation, and Damià Calvet, Secretary of Territory and Mobility in the Catalan Government. Again representing Mcrit and the ORIGAMI project, Andreu Ulied then closed the workshop and thanked everyone for their participation.

Figure 0-2 Participating Speakers at the 1st Stakeholder Seminar in Barcelona, May 2012

Main Discussions

After the introductory session by V.Pedret (EC DG MOVE) and R.Tremosa (Member of the European Parliament), an intense debate was held around possible approaches to mobility in Europe in the future according to White Paper. Some claimed an increasingly relevant role required for rail, especially in the range where high speed rail is especially competitive with air transport (300km to 1000km), mostly due to its environmental benefits (the electrification of transport is to allow for an increase of the renewable energies share in the European transport). Other argued that the required investments to create a HSR network in Europe of the magnitude proposed by the White Paper are far too important (required budget may have very much stronger positive impacts if invested in alternative areas of the transport system), and that exploitation and maintenance of HSR lines remains economically unsustainable in most of the existing lines today. It was also reminded the important potential of technology for relieving externalities of transport (GHG, accidentsé)

This same discussion was picked up once again in the first afternoon round table session. Some suggested that established forecasts for rail modal shares in the transport White Paper seem difficult to be achieved with current trends, and especially with current levels of satisfaction of rail users with the provided service, while others pointed out that significant changes in the current road based paradigm could already be noticed in some areas of the continent (possible ĩpeak carö), providing for positive messages towards the future (see C.Irwin and S.Joseph),

The three morning sessions discussed about upcoming solutions with potential to increase efficiency of the European transport system. These sessions were mostly focussed on the increased permeability of the air ï rail interface, the better rail, bus and air space management, and the improvement of services to users of public transport for a better European system as a whole. Some relevant contributions can be read below:

- E.Krieger presented the Düsseldorf Sky Train as a story of success, constituting an efficient link between the airport and the regional rail network at relatively low costs. The key issue of this case was the fact that the decision was taken to connect the airport to a close rail line with a light rail shuttle, instead of diverting the trunk rail lines towards the airport, resulting in substantial economic savings in the investment stage. M.Corradi and M.Dargacz presented the experiences of the Milano Malpensa and the Gdansk Walesa airports respectively.

- J.Leboutte presented the plans to increase efficiency of air space management, being implemented in the Maastrich area, allowing for direct airplane routing. This operation is to result in shorter flight paths (reduced operation costs, reduced emissions).
- P.McMohon, G.White and D.Young discussed about management strategies in the liberalised UK rail and bus market, concluding in the need to achieve better models to increase passenger satisfaction.
- J.Mundlinger and J.Kundel presented the potential benefits of using integrated travel planners allowing for multi-modal trip chains in Europe. The example of RouteRank showed the potential benefits of an integrated EU-wide search tool.
- E.Cañas claimed for better coordination of European car sharing companies. Being car-sharing a solution increasing the rational use of private car, as users perceive the cost of its usage at a higher extent, a strong limitation today for expansion of the system is the impossibility for users to utilise car sharing companies when away from their home city.
- K.Bujak and F.Robusté showed several examples of promising solutions to increase the user experience of the Gdansk and Barcelona public transport. M.Bujak claimed the need for an increased dialogue between operators and users to know to a higher extent what are the real needs in the system, and which solutions are more likely to have high acceptability by users.

Finally, the last session on the agenda provided insides on how transport needs and transport trends may evolve in Europe in the very long term (e.g. 2050). In this context, C.Sessa reminded the possibility for important transitions in the current socioeconomic paradigm, such as the evolution towards Green and Blue Economies, with potentially deep impacts on transport (presented the conclusions of the “Global Europe 2050” prospective exercise carried out by an expert panel for the EC), while S.Akiman claimed the need to consider neighbouring regions while envisaging transport scenarios, as the demands generated by these regions (e.g. North of Africa or Eastern Europe) may be of very big magnitude in the coming years.

Figure 0-3 1st ORIGAMI Stakeholder Seminar in la Pedrera, Barcelona May 2012

ANNEX – 2ST STAKEHOLDER SEMINAR

AIM

After the a 1st online survey on Critical Transport Trends to 2030, held in November 2011, and the Barcelona workshop on Upcoming Transport Innovations and Scenarios in May 2012, ORIGAMI organised a second stakeholder seminar during the fall of 2012 centred on the analysis of 10 key solutions for European long-distance passenger mobility.

The second stakeholder seminar was developed as an expert online survey mostly disseminated to the European transport industry and scientific community.

The ORIGAMI FP7 aimed with these participatory activities at promoting the debate among transport stakeholders as a continuation of the discussions led by the EC prior to the publication of the European Transport White Paper 2010-2020 and the redefinition of the Transeuropean Transport Networks Guidelines.

Respondents of the survey were experts and researchers, civil servants involved in the field of transport, transport consultants and other transport stakeholders including vehicle manufacturers, service providers, infrastructure managers and groups of interest.

The survey remained open for input from participants between November 19th and December 14th 2012.

During this period 177 experts participated.

Table 0-1 List of institutions participating

Institution	Institution
Aalborg University,Denmark	Mcrit SL
Abertis Infraestructuras	Metropolitan Public Transport Association of Gdansk, Poland
Municipality of Vilafranca del Penedès, Spain	Metropolitan Research Institute, Hungary
Metropolitan Transport Authority (ATM) Tarragona	MIRA
Metropolitan Transport Authority (ATM) Barcelona	MKmetric GmbH
ATRA	Molde University College
AustriaTech GmbH	OSAC France
Barcelona Chamber of Commerce	Polish Airports
C&S Europe	Warsaw School of Economics
Cambridge University	Pontificia Universidad Catolica de Chile
Cardiff University	Reverdy Consulting
CEDIPSA	Rijkswaterstaat,Centre for Transport and Navigation
Center for the Study of Democracy	Royal Institute of Technology (KTH)
Citatis Engenharia S/S LTDA	RUF International
City of Bratislava	Sapienza University of Rome
City of Malmö	Sauvons le climat
Composite Solutions UK Ltd	SBB
Spanish Parliament	SEA Milan Airports
COPISA	SENER Ingeniería y Sistemas S.A.
CP-Comboios de Portugal	Serveis d'Enginyeria del Transport,S.A.
Creafutur	Seureco-Erasme
DB Netz AG	SINTEF,Norway
DHC	Spatial Foresight
Diputació de Barcelona	Spiekermann & Wegener
DLR	Ministry of Fomento, Spain
DTU Transport,Technical University of Denmark	T&E
European Commission	Technical University of Denmark
European Investment Bank	Tetraplan
EUROCONTROL	Barcelona Metropolitan Tramway (TRAMET)
European passengers' Federation	Transfer Enginyeria
European Railway Agency	Transport Innovations
University of Rijeka, Croatia	TRANSVER
Fast Future Research	TRT Trasporti e Territorio, Milan
Ferrocarrils de la Generalitat de Catalunya	TYPSA

Institution	Institution
FIA	UK ESPON Contact Point
Fraunhofer IVI	Ultra PRT
Fundacio Mobilitat Sostenible i Segura	UNESCO CHAIR
Gas Natural Fenosa	Universidad de León
Government of Catalunya	Universitat Politècnica de Catalunya
Ghent University	Universitat Politècnica de València
Glasgow Airport	University of Washington, Seattle
Government of Aragón	University College London
ICLEI - Local Governments for Sustainability - Europe	University of Aberdeen
IERMB	University of Belgrade
Imperial College	University of Gdansk,Poland
INECO	University of Leeds,UK
Institut d'Estudis Regionals i Metropolitans de Barcelona	University of Piraeus
Polish Academy of Sciences, Warsaw	University of Rijeka,Faculty of Maritime Studies
Institute of Transport Economics, Norway	University Politehnica from Bucharest
IR	University Politehnica of Bucharest/ Transport Faculty
Institut Ignasi Villalonga	UPC BarcelonaTech
ISIS Institue of Studies for the Integration of Systems	UWE/UCL
ITS - Leeds University	VBB Verkehrsverbund Berlin-Brandenburg GmbH
Karlsruhe Institute of Technology (KIT),IWW	Vienna University of Technology
LNEC and ECTRI	Winglets GmbH,Duesseldorf/Germany
Manufuture ETP	Wuppertal Institute

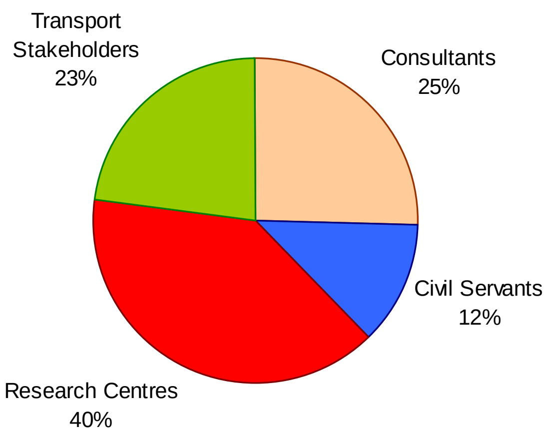


Figure 0-1 Distribution of respondents in groups

STRUCTURE OF THE SURVEY

The online survey was based on 10 questions on innovative transport solutions, with predefined answers. It provided the possibility to contribute with qualitative comments.

Each solution was presented with background information, illustrative materials and additional references, and respondents were asked to asses:

- The strategic interest of the solution (high / moderate / low / no interest)
- The likelihood of its spontaneous market implementation (very / quite / not very likely / will never happen)
- Added value of specific EU policies favouring the solution (based on qualitative remarks)

Additionally, participants were asked to provide additional key solutions for the future of passenger mobility in Europe in a final page.

Next figure shows a example page of the survey articulating the 2nd ORGIAMI Stakeholder Seminar.

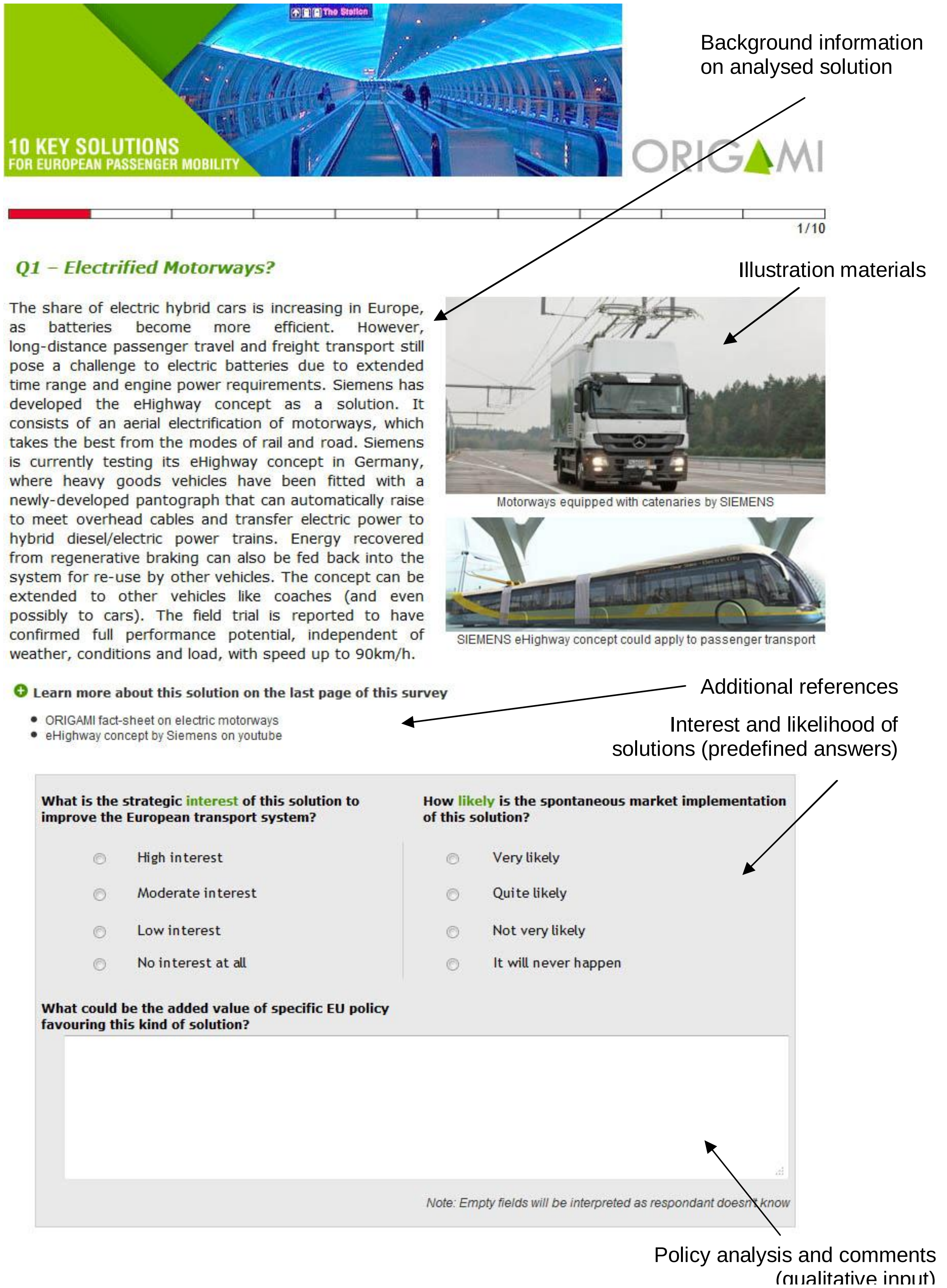


Figure 0-2 Example of a question of the 2nd ORGIAMI Stakeholder Seminar

KEY SOLUTIONS FOR EUROPEAN LONG-DISTANCE PASSENGER MOBILITY

Solution 1. Electrified Motorways

The share of electric hybrid cars is increasing in Europe, as batteries become more efficient. However, long-distance passenger travel and freight transport still pose a challenge to electric batteries due to extended time range and engine power requirements. Siemens has developed the eHighway concept as a solution. It consists of an aerial electrification of motorways, which takes the best from the modes of rail and road. Siemens is currently testing its eHighway concept in Germany, where heavy goods vehicles have been fitted with a newly-developed pantograph that can automatically raise to meet overhead cables and transfer electric power to hybrid diesel/electric power trains. Energy recovered from regenerative braking can also be fed back into the system for re-use by other vehicles. The concept can be extended to other vehicles like coaches (and even possibly to cars). The field trial is reported to have confirmed full performance potential, independent of weather, conditions and load, with speed up to 90km/h.

Motorways equipped with catenaries by SIEMENS

SIEMENS eHighway concept could apply to passenger transport

Solution 2. Paying as you drive

In the late 2000 the Netherlands studied the possibility of implementing a pay-per-use road pricing program which would replace fixed vehicle (ownership and gas) taxes. In 2009 Eindhoven ran the first distance-based pricing trial. A meter was placed on the dashboard of cars. It showed the price of the trip: based on GPS technologies, the system tabulated a charge for each car trip by using a mileage-based formula that also took account of a car's fuel efficiency, the time of day and the route. At the end of each month, the vehicle's owner received a bill detailing times and costs of usage. Approximately 70% of users in Eindhoven were found to travel off-peak and using highways rather than local roads to a higher extent, as the average costs per km of trips decreased by 16%, according to IBM. The proposed Dutch system was different from existing toll systems. While most toll systems aim at financing the costs of a specific road, the Dutch road pricing scheme was not linked to individual roads, but covered the entire network and was focused on the behaviour of the road user.

Distance based taxation has been implemented for freight in Germany since 2005, where the LKW-MAUT tax for trucks is based on the distance driven, time of the trip, number of axles and the emission category of the truck. The tax is levied for all trucks using German autobahns, whether they are full or empty, foreign or domestic, and it raises ú2.4 billion per year mostly dedicated to road investment

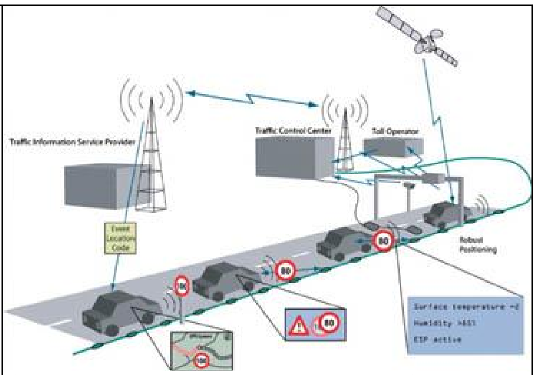
Equipment for smart road charging trial in Eindhoven

Scheme of smart truck road charging in Germany - LKW Maut

Solution 3. Real-time optimised traffic management

The Motorway Control System (MCS) installed on the E4 motorway through Stockholm aims at better managing traffic flow through ICT. The system includes a dynamic speed limiting system based on real-time speed detection in the motorway. Analysis of traffic on the motorway indicates that the MCS improves traffic homogeneity and safety, and reduces the frequency of short headways.

In France, the Rhone Valley motorway is equipped with ITS aimed at improving traffic flow. This motorway corridor is particularly busy during the summer time, and recurring congestion strongly lowers the level of service. Variable speed limits have improved overall corridor capacity (5% increase), safety (25% accidents decrease), driver comfort, and congestion events (20% decrease).



Speed limits are dynamically controlled in Stockholm to prevent congestion waves

Speed limit gantry on E4 motorway in Stockholm

Solution 4. Increased PPP in the provision of transport services

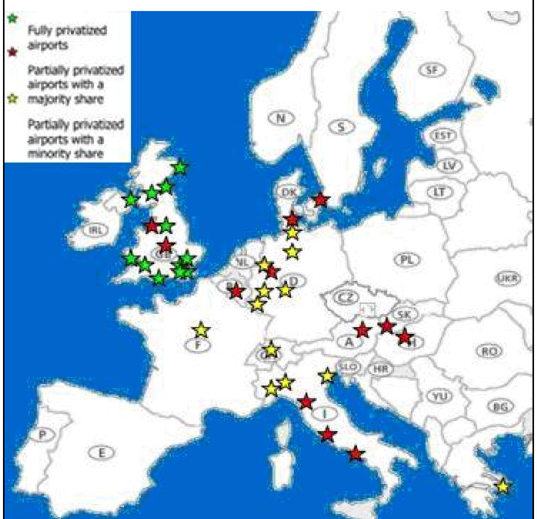
Public Private Partnerships (PPPs) have been promoted in the transport sector, especially during the past 20 years. Southern Europe and Britain have long lasting experience with PPP projects particularly in the road sector. Airports have also been gradually open to the private initiative, but today Bratislava, Brussels, Copenhagen, Malta and Vienna are the only privately owned airports in Continental Europe by a majority share (>50%). 78% of EU27 airports are still publicly owned(D.Gillen,H.Niemeier).

During the 80s and 90s the U.K. transport authorities deregulated and privatised bus services in the UK, ceasing to regulate routes and fares (they only continued to subsidise non-profitable services through public tender processes). According to critics, deregulation resulted in fewer services and increased fares, and did not stop the decline in bus usage. In the other camp supporters argued that bus services became more cost efficient.

The Spanish cities Madrid and Barcelona have a few stations that have been developed under PPP. Concessionaires receive revenues generated by fees paid by urban bus, coach, rail or metro operators for using the station, and by the commercial rents paid by shops and cafeterias.

In 1999, the Economist stated "the privatisation of British Rail proved a disastrous failure". The structure

Merseyrail in the UK runs on concession since 2003



Privatised airports in Europe (D.Gillen,H.Niemeier)

now in place is considerably different from that originally envisaged in 1993. Rail journeys in the UK appear to have increased by 84% since privatisation and passenger-km 88%, but there is controversy as to how much of this is due to privatisation. According to the McNulty report, the costs of rail are rising fast due to excessive government involvement among others. In Continental Europe, deregulation accumulates substantial delays, still large railway companies are dominant, with only few good cross border examples. .	

Solution 5. More connections between airports and railways in Europe

It is difficult to generalise how airports should be connected to regional public transport, as preconditions differ widely from one airport to another. Customised solutions are needed in each case.

Frankfurt airport opened in 1999 an in-terminal rail station for regional and high speed services (225Mú) taking advantage of the opportunity rose when a new rail link was required in the Frankfurt area to decongest the existing network. Long-distance rail at Frankfurt airport has now 23,000 daily users, resulting in a 30% share for public transport in access/egress of airport.

The Düsseldorf Skytrain (180Mú) was built out of the necessity to connect the Düsseldorf airport to the nearby passing rail network. It was done with half of the investment that would have been needed to divert existing rail lines into the airport, and with reduced delays of through-going passengers. Exploitation is partly recovered by user fees (1.5 Euro per trip).

Besides rail, coach services have also proved to be cost-efficient solutions to provide regional public transport connections at airports. At this point in time they are not widespread in all parts of Europe.

An Amsterdam bound ICE train waiting at Frankfurt airport

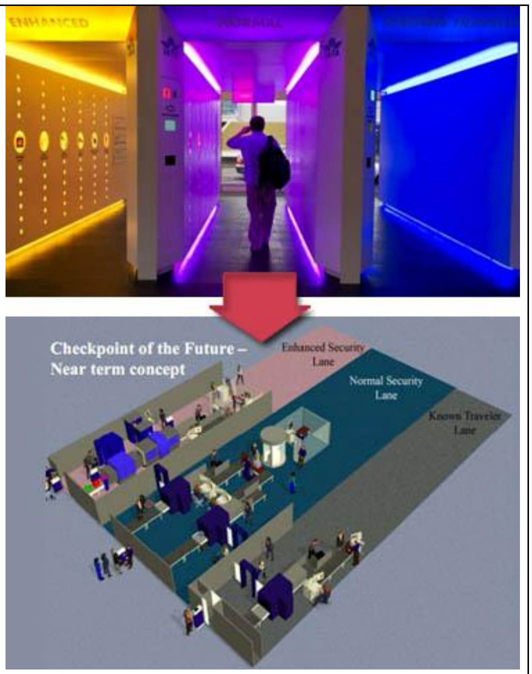

Skytrain connects Düsseldorf airport to regional rail network

Coach waiting outside Stansted airport in London

Solution 6. Much faster transits in transport terminals

ACARE, the Advisory Council for Aviation Research in Europe, envisages reducing times for formalities in airports down to 15 minutes by 2020 based on new management procedures and application of new technological solutions. In this direction, IATA envisages a new checkpoint concept aimed at improving security procedures at airports. Passengers approaching the checkpoint will be directed to one of three lanes according to the results of a risk assessment of the passenger conducted by government before they arrive at the airport.

"Known travellers" who have registered and completed background checks with government authorities will have expedited access. "Normal screening" would be for the majority of travellers. And those passengers for whom less information is available, who are randomly selected or who are deemed to be an "Elevated risk" would have an additional level of screening. Screening technology is being developed that will allow passengers to walk through the checkpoint without having to remove clothes or unpack their belongings. Combined with outbound customs and immigration procedures, further streamlining the passenger experience can be reached.



IATA future checkpoint-concept aims at decreasing the time for airport formalities

Solution 7. Advanced cruise control and driverless vehicles

Since the late 1990s, car manufacturers are implementing advanced control options in some vehicles aimed at automating an increasing number of driving functions. Cars that accelerate and break automatically according to the speed of the traffic flow, cars that automatically park, cars equipped with collision prevention devices and lane departure warning mechanisms, all are already present in the market.

In 2012, Volvo has been publicly demonstrating the outcomes of the SARTRE project with platoons of several cars automatically following human driven trucks in Spanish and Swedish motorways, while Audi, Volkswagen or Google are testing fully driverless cars based on artificial intelligence software combining GPS information and in-vehicle equipment such as cameras, radars and sensors. However, fleets of fully or partially autonomous vehicles are already being used in the mining industry since years ago thanks to vehicle to vehicle communication and satellite tracking in some of the World's largest iron mines in Western Australia. Several US States have legalised the use of driverless cars, anticipating a possible commercial development of this technology, which some experts point out could happen already over the next 15 years. Driverless cars are likely to increase road safety and vehicle energy efficiency.

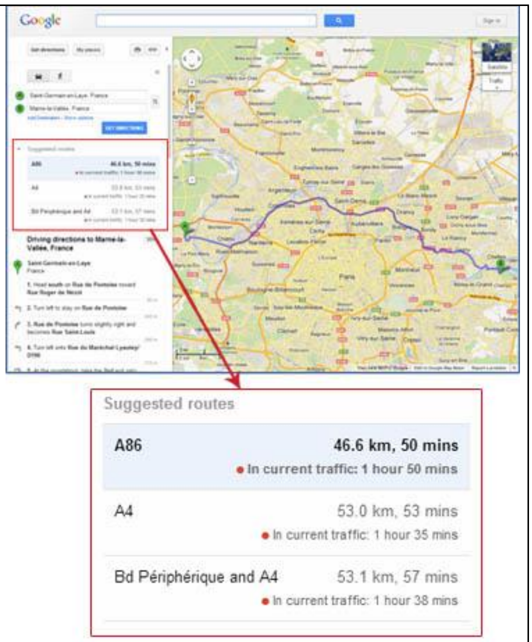
Audi TT prototype runs without driver

Car platoon autonomously following head truck close to Barcelona

Solution 8. Just in time journey planers

Integrated travel planners allowing for multi-modal travel information and ticket purchasing in Europe can have an important role in optimising passenger routes in the future. The DB Navigator has access to all schedules of public transport operators in Germany and calculates optimal journeys by train, bus, tram, subway and ship. Google Maps provides car routes taking into consideration real-time congestion on the roads. Providing just in time trip information, just in time information in smart phones or car navigating systems that will change the suggested route in case of road congestion or delayed public transport, promotes increasingly accurate decision making in transport.

Additionally, the inclusion of environmental indicators such as CO2 emissions in travel planners, like in routeRank, might promote more responsible behaviour by travellers. As the size of the transport systems covered by journey planners has increased, protocols for distributed journey planning like EU-spirit allow the computation of journeys using networks of journey planners, each computing parts of the journey for different parts of the country or different modes.



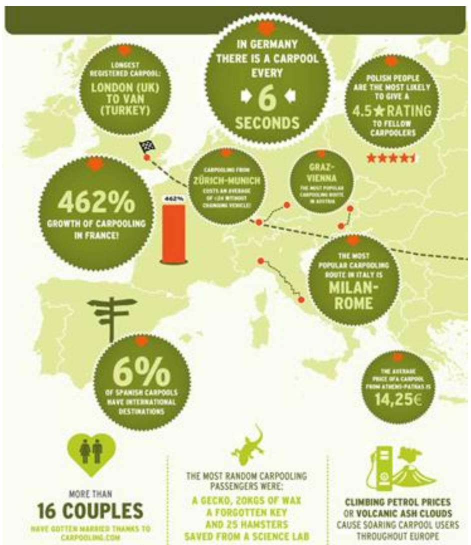
Google provides car itineraries taking congestion into consideration

Solution 9. Towards Collaborative Mobility

Carsharing is understood as a model of car rental where people who are members of a car club get access to a pool of cars for short periods of time. Carsharing promotes a more rational use of vehicles as pricing is applied to users systematically depending on time and distance. Insurance and fuel costs is usually included in the rate. Individuals then benefit from the private car without the costs and responsibilities of ownership. 75% of European carsharing today takes place in Germany, the UK or Switzerland. The number of total subscribers has increased a 35% in the last three years. Business agreements between operators increasingly allow members of one car club to use vehicles of other clubs when away from home. In Germany, for instance, Stadtmobile integrates 7 regional independent companies and has interoperability agreements with Cambio CarSharing, another merger of several carsharing companies in Germany and Belgium. Zipcar, Car2Go and other traditional car rental operators now in the carsharing business are also extending their networks in an increasing number of European and American cities.

Carpooling or "ride sharing" refers to the shared use of a car for a specific journey often by people who travel together to save costs. Carpooling promotes the increase of vehicle occupation. The Internet, smart phones and social networks now makes it possible to carpool in a way that was never possible before. Carpooling.com is the largest carpool network in

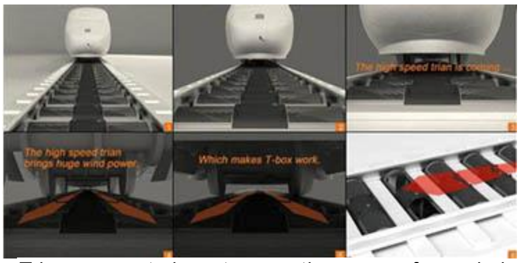
Carsharing application for smartphone



Carpooling in Europe according to "carpooling.com"

Europe connecting people in over 40 countries and moving over 1 million people each month with average carpooling distances up to 200km	

Solution 10. Towards increasing energy sufficiency in transport

Not only have transport systems implemented more energy efficient solutions, but there have recently even been a number of projects implementing electricity generation itself to contribute to the overall sustainability of the transport sector. Infrabel has built a solar farm on the roof of a two mile stretch of tunnel over Belgium's high speed rail line to provide power for trains running between Antwerp and Paris. London's Blackfriars rail station will produce 50% of its power consumption from an on-site solar farm. Wind farm concepts are envisaged to power the High Speed Line between Leuven and Liege, including the development of new wind electricity generators which can be placed below or above railway tracks to produce electricity as trains go by. The Brenner tunnel partially powers trains with electric power generated in hydroelectric facilities located in the mountain range above. Many shipping companies are experiencing with adding sails to ships: the MS Beluga is a 140 meter long cargo ship equipped with a 160 square meter sky-sail, and while it is not the main mode of propulsion, the kite is able to reduce fuel consumption by about 10% to 35% depending on wind conditions.	 *Solar farm on top of rail tunnel in Belgium*  *T-box concept aims at generating energy from wind produced by trains*  *MS Beluga cargo ship is equipped with kite sails*

MAIN OUTCOMES

- Solutions with highest EU interest are the following, according to experts consulted:
  - wide-spread smart road pricing
  - airport interconnections with cities and with other long-distance transport networks
  - ICTs for smarter road management
  - just-in-time travel planners
  - energy related solutions
  - collaborative mobility solutions
- Most likely solution to be spontaneously developed by the private sector or the European institutions is multi-modal travel planners.
- Least likely solution to be developed is the electrification of motorways.
- Wide-spread smart road pricing shows maximum deviation between its interest and its likely implementation, suggesting that further analysis and progress towards this solution might be interesting.

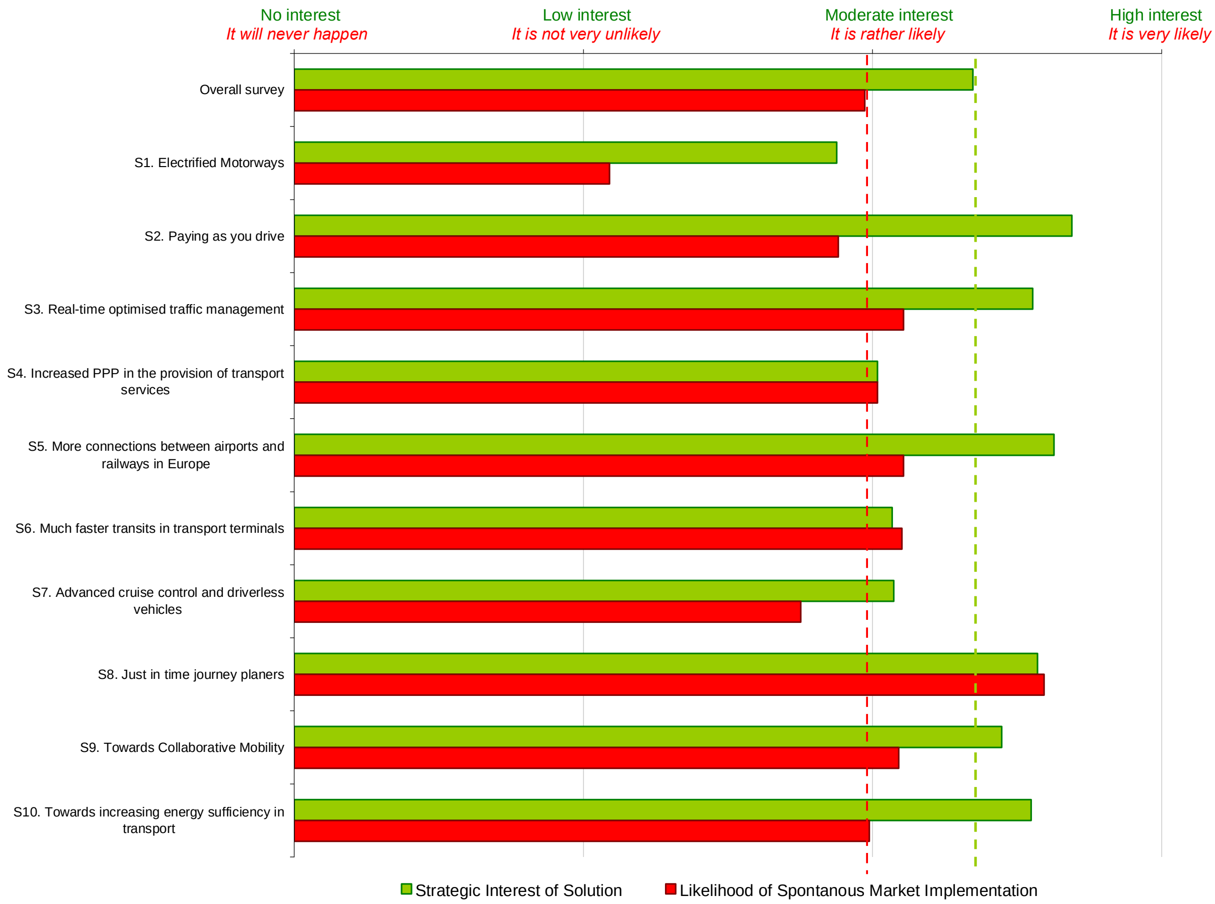


Figure 0-3 Average interest and likely implementation of 10 key transport solutions

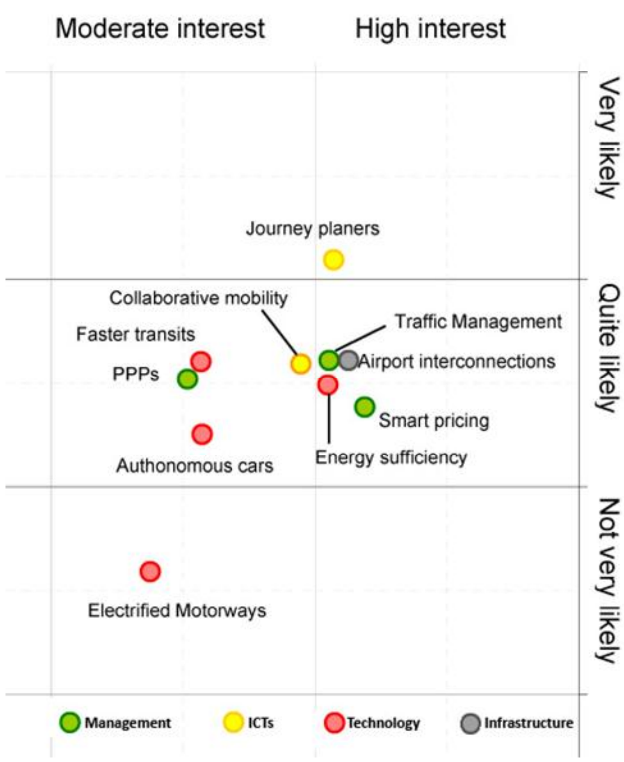


Figure 0-4 Average interest and likelihood of spontaneous implementation of solutions

- Wide-spread smart road pricing is also the solution for which a largest number of experts have stated a maximum level of EU interest (dark green)
- Interconnections of airports with other transport networks and cities have also been picked up a highest European interest solution, although many participants have suggested that the connecting mode has not forcedly to be rail.
- Electrified motorways have the largest number of sceptics, closely followed by PPPs and autonomous vehicles

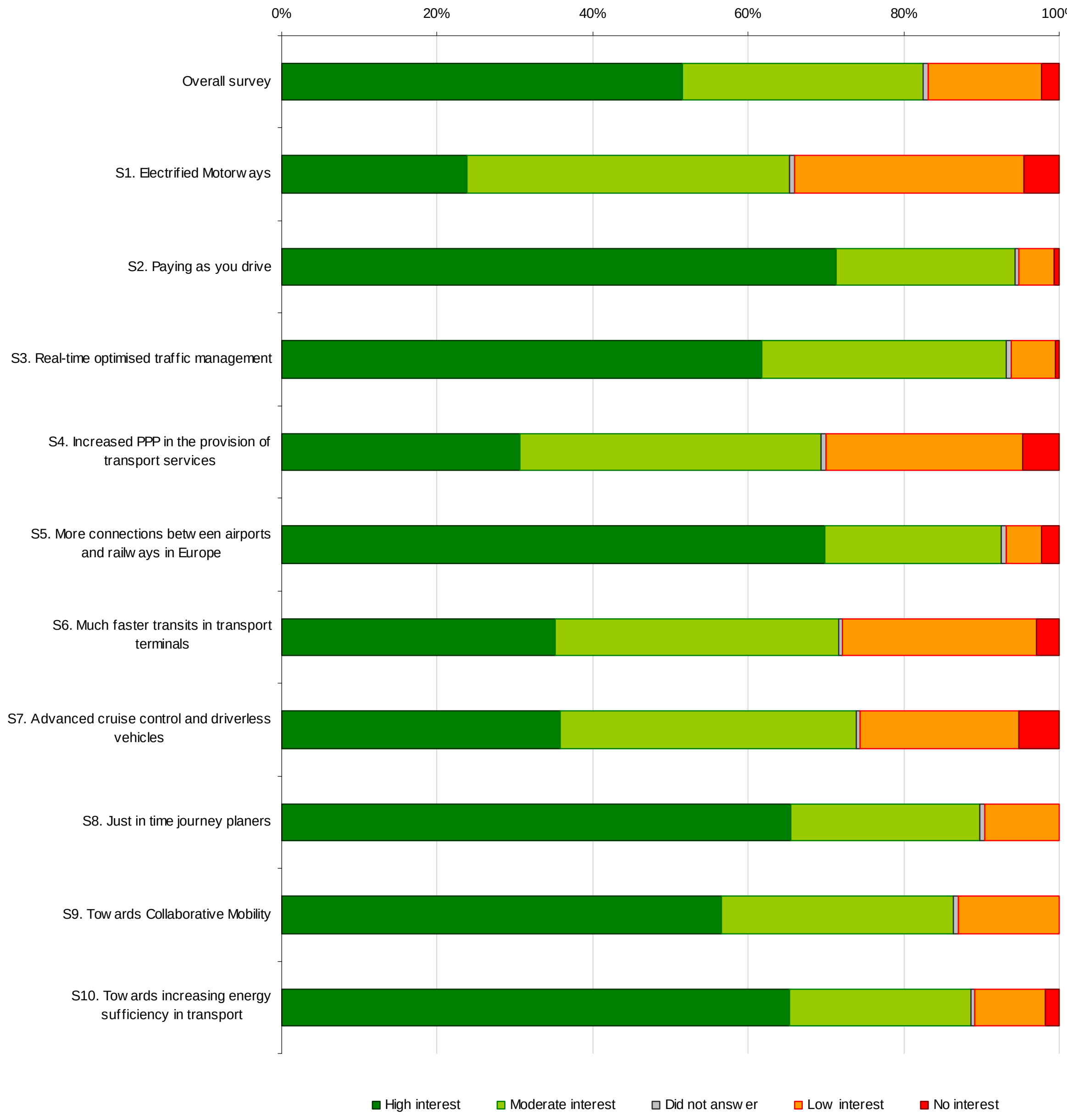


Figure 0-5 Interest of 10 selected key transport solutions, distribution of answers

- Electrified motorways and autonomous vehicles seem to be the most unlikely solutions to develop, unless directly supported by EU policies. More than four out five experts do not see electrified motorways spontaneously developing in Europe.
- More than three out of five experts think the spontaneous development of multi-modal just-in-time travel planners is highly likely, more than any other suggested solution.

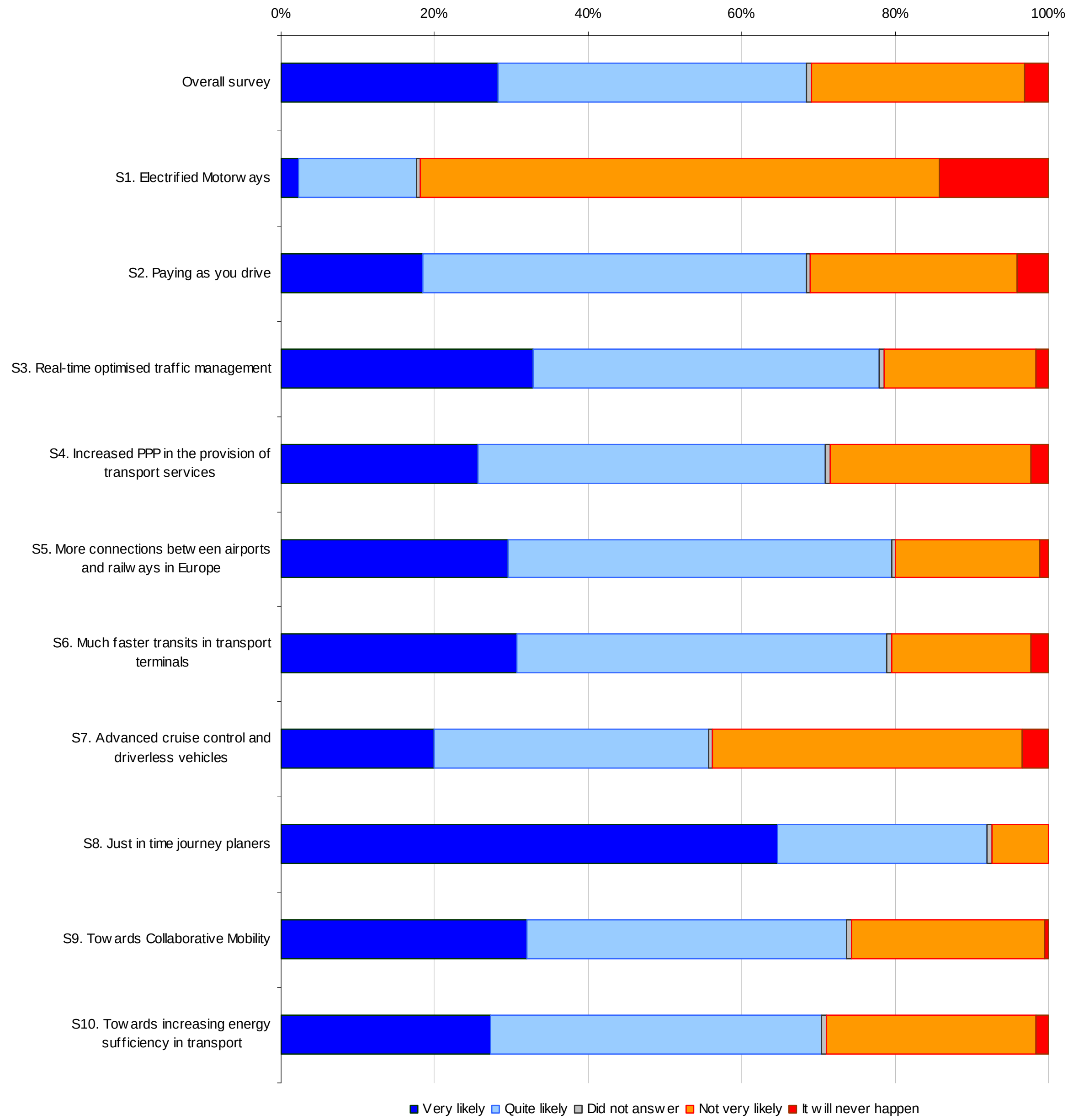


Figure 0-6 Likelihood of spontaneous market implementation of selected key transport solutions, distribution of answers

SYNTHESIS OF RELEVANT CONTRIBUTIONS

The following list is a synthesis of the most relevant opinions expressed by experts in the ORIGAMI eSeminar. Remarks are contradictory in many cases, reflecting the diversity of opinions provided by experts.

Solution 1. Electrified Motorways

- This concept should be applied only for the busiest selected parts of the network, e.g. the busiest segments of the TEN-Ts, or in large metropolitan areas. A minimum demand threshold would be required to make for the investment.
- Likely positive impact in terms of decreased GHG emissions and decreased oil dependency, also for cars in the future. However, the electric mix used to power solution needs to be taken into consideration to assess its contribution towards decarbonisation of the transport sector.
- Provides the environmental advantages of the rail technology, but much higher organisational flexibility as it doesn't require inter-modal changes to fulfil the last miles of a transport.
- Required investments may be too high to make this technology feasible. The system would most likely require public subsidies.
- Not worth making a bet on eHighways, as the rail technology already properly fulfils its role. There might be other priorities besides from eHighways.
- Standardisation and interoperability would be a major concern to develop the eHighways concept.

Solution 2. Paying as you drive

- A formula to introduce efficiency and rationality into the system, not just to rise funding. A primary tool better manage mobility: optimizing traffic flows, addressing congestion and pollution
- Mostly good to eliminate actual infrastructure deficit. Contributes to the user pays principle.
- It would allow required harmonisation of road fees and taxes all across Europe
- Technological standardisation of the system across Europe would be needed.
- Additional revenues should be used to promote competing cleaner modes like rail or urban public transport.
- Not only based on trip distance and type of road: the system needs to incorporate other variables like trip schedule or vehicle occupation.
- Privacy issues may be a concern
- Fuel taxes do the same task much more cheaply, and without the privacy issues involved with GPS-based road charging.

Solution 3. Real-time optimised traffic management

- Many positive impacts of this solution. Better use of existing road capacities. Reduced bottlenecks, reduced delays due to congestion. Reduced energy consumption and pollution. Reduced fuel consumption. Increased travel time reliability
- Spontaneous implementation by transport operators is relatively likely. There are already several examples of such practice in Europe.
- EU role limited to spreading knowledge as the initiative should lye on national/local administrations and industry
- Privacy-friendly framework is a relevant issue
- Might require more investment than appears and provide lower cost benefit returns.
- Only implementation in most relevant bottleneck areas, high-density high-congestion areas, not everywhere.

Solution 4. Increased PPP in the provision of transport services

- A good regulatory framework to transport sector liberalisation is necessary. Structuralised deregulation.

- PPPs should drop of prices for the consumers. They should bring additional funding sources, less pressure on public sector
- Time is required to acquire enough evidence to draw sensible conclusions. Major benefit to contrast and compare approaches taken in various EU countries. Further research needed to increase in-depth knowledge and learn from past experiences
- Risk that PPP solutions are mainly used to help short time financial issues, PPP postpones the payment for the infrastructure by the public sector at a much greater cost
- The financial risk cannot be transferred to the private operator: risk stays at the public body but profits are transferred to the private side
- The most appropriate model for public transport organization is regulated competition

Solution 5. More connections between airports and railways in Europe

- Good connections can also be made by bus at much lower costs
- A market niche will develop spontaneously, though not a very big one, as this is an expensive solution for selected busy airports in Europe. Rail/Air connections deal with relatively bound high value trips.
- It is important to promote train as an environmentally friendly mode. Because of that, rail connections should have more active support from the EU
- EU should not provide funding or policy support to airport rail connections - as these serve to increase (aviation) transport emissions, undermining a central transport policy goal.
- No EU policies should be made to favour these solutions because they are not enough cost effective.
- A case per case approach is needed. Difficult to generalise a protocol for airport interconnections.

Solution 6. Much faster transits in transport terminals

- Improves service quality and saves time. Enhance efficient security checks. Time saving. Increase capacity. Increase comfort.
- Reducing delay caused by formalities at airports can make medium distance flights more competitive to rail.
- Privacy issues may be a problem, as well as the right of passengers of being treated equally.
- The monopolistic position of many airports in Europe is not pushing for needed increased efficiency
- No EU added value. Insignificant issue compared to others like emissions, safety, congestion.

Solution 7. Advanced cruise control and driverless vehicles

- Transport safety seems the major benefit of this innovation
- Combines advantages of cars (individual freedom) and public transport (autonomous)
- Standardisation of technologies required all over Europe
- To be initially implemented under more controlled conditions, e.g. dedicated infrastructure or lanes in motorways, car platooning (SARTRE)
- Especially interesting for freight transport linked to the eHighway concept
- The approach to safety taken by many of the advocates of driverless vehicles would be totally unacceptable in industries (e.g. aircraft) where robot operations are routine.
- Significant concerns with privacy and liability
- More social research/market studies are required. Are drivers willing to cease driving?

- Private sector driven development

Solution 8. Just in time journey planers

- It enhances co-modality by allowing users to choose their route in a more informed manner. Cost-efficient solution.
- This will be developed by the market without any regulation needed
- Especially important for cross border collective transport services. Requires ticket sells incorporated.
- Connected with the nomadic devices inside the car or in smart phones, linked to real-time and multi-modal applications at a pan-European level.
- EU benefits seem rather marginal, but costs are also low.

Solution 9. Towards Collaborative Mobility

- These approaches appear to be developing spontaneously
- New mobility culture breaks the association between car and private concepts.
- Key to success is more at the local, and especially urban levels, rather than the international/long-distance level. Long-distance carpooling may render a relevant social service. May not be as successful in all areas of Europe either, due to cultural issues
- More general awareness required: policy statements of support and dissemination of existing systems. Incentives for car sharing / car pooling such as reduced tolls
- Granting safety of users of carpooling is a challenge is a need. Legal framework and protection.
- Unfortunately, it takes a lot of both the comfort and flexibility of car use away

Solution 10. Towards increasing energy sufficiency in transport

- The EU should promote research on RES applied to transport. Lots of alternatives available and some of these are of higher value than others.
- Much of the work in these areas is highly artificial and driven by incomplete cost and energy models. A repeated concern in relation to these RES solutions applied to transport is that they might not prove to be sufficiently cost-effective.
- Seed funding renewable energies in transport to start a wider network attracting private support.
- These seem like marginal energy resources and the full potential is difficult to see, but they have a strategic value as statement of support for RES
- The niche for these applications is small next to grid-derived power.

Other Key Solutions to be considered by European policies

- Personal electro mobility. Smaller, individual and customisable vehicles powered with electricity (ebikes, ultra compact cars,
- Soft modes. biking, bikeMetro, pedestrians areas
- Taxation and pricing to promote rational use of transport
- Telework and land-use regulation to reduce mobility needs
- Integrated Urban Public transport networks
- Mobility monitoring and pricing based on smart phones
- Alternative power modes: hybrid vehicles, biofuels, electric vehicles (including range extenders),

fuel cell powered vehicles

- More rigorous transport planning and ex-ante project appraisal
- People movers and dual-mode transit: PRT, podcars, RUF, TriTrack, MegaRail