ORIGAMI and COMPASS – seamless passenger journeys in Europe

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1 Introduction and background

Two recently-completed EC FP7 projects, ORIGAMI and COMPASS, have investigated solutions to improve interconnected passenger journeys in Europe in line with European policies on future integrated, sustainable transport, and in the context of changing transport demands from socio-economic and demographic trends.

The area of research covered by ORIGAMI and COMPASS has particular relevance at the European level because the European Transport Networks' role as integrated international networks is compromised by poor interconnectivity and because the next generation of European transport policies (for the Transport White Book 2010-2020 revision and TEN-T update) will have to be sensitive to the differences between short, medium and long-term transport markets and the market advantages of each transport mode. In this context, a realistic assessment of co-modal and intermodal opportunities is a key ingredient to future policy development. Clearly these factors are also important in a Scottish context. COMPASS took this general background and focused on how improvements in seamless transport can achieve environmental goals in reduced CO2 emissions, in particular with the application of ICT solutions.

ORIGAMI addressed the potential for greater efficiency and reduced environmental impact of passenger transport by judicious encouragement of integration, co-operation and, where appropriate, competition in the provision of connections. Thus the project encompassed physical characteristics of the network, as well as the users of the transport system, their demand for travel, their expectations and their reaction to the transport supply that will be on offer. The profile of users varies across European countries and regions and so will their actual and future travel behaviour, meaning that factors such as demographics and social groups influence this behaviour and need to be taken into account when trying to assess the potential effectiveness of any intervention.

The general focus of ORIGAMI was on all those long-distance journeys which might benefit from more
effective co-operation and/or interconnection between modes and services, and on those situations where this is currently hampered by institutional barriers, lack of investment, or failure to innovate and which could benefit from a more enlightened approach. One particular focus of the project was the identification of technical solutions for improved co-modality and, in particular, intermodality, and the project has investigated how examples of how good solutions found in one mode can be transferred to other modes.

The research undertaken in the COMPASS project has recommended solutions that will allow improvements to the planning and operation of the passenger transport network to enhance co-modality in transport thus contributing to the reduction of carbon emissions.

COMPASS aimed to provide an overall picture of what travellers require from the transport system at the present time and what they will require in the future based on an investigation of key socio-economic trends. COMPASS analysed how solutions based on ICT (information and computer technology) and ITS (intelligent transport systems) applications can meet the future demands identified, in particular to provide for the integration of multimodal and co-modal transport solutions, and then assessed how these solutions can contribute to the de-carbonisation of transport activities.

The central question on the contribution of ICT solutions to achieve reduced CO2 emissions has been addressed in COMPASS in three main ways: the development of the *Handbook of ICT solutions*; the realisation of eleven case studies on the implementation of specific ICT solutions in different European regions, including one study related to Scotland; and the European assessment of ICT solutions through scenarios analysis.

This paper will outline the work undertaken in ORIGAMI and COMPASS, key outputs, and conclusions reached. The conclusions cover both the actions that can be implemented to achieve better connected journeys, and the identification of gaps in knowledge and the potential for future research.

2 ORIGAMI: Optimal Regulation and Infrastructure for Ground, Air and Maritime Interfaces

2.1 Work undertaken in ORIGAMI

2.1.1 Overview of key steps

The work of ORIGAMI can be broken down into a number of steps that encompassed literature search of previous studies, analysis of national travel survey data, surveys undertaken for ORIGAMI, and modelling and forecasting. The key steps in ORIGAMI are listed and briefly described below, while the resulting public deliverables and online resources are described in sections 2.2.2 and 2.2.3.

Identification of the current pattern of long-distance passenger trips in Europe

Recognising that there is a shortage of data on long-distance travel across Europe, the first aim of this part of ORIGAMI was to bring together what data is available from different sources and to make that available to the wider research and modelling community. Within ORIGAMI the data gathered here was able to feed into subsequent work on modelling future transport demands.

Identification of socio-economic trends affecting future demand for long-distance trips

The identification of trends focused on demographic factors, ageing population, GDP and household income, and the resulting impacts on mode choice and future transport demand. This was intended to provide a basis for further research and model development for the research community and to inform the development of the modelling of scenarios for 2050 in ORIGAMI.

Surveys of users' attitudes to future choices in long-distance travel

This work presented data on existing patterns of long-distance travel in Europe and then, through a survey of revealed and stated preference, determined the likely responses from long-distance travellers to different policy initiatives in the provision of transport services.

Key user requirements for seamless long-distance travel

This work identified user needs in long-distance intermodal journeys, that is the factors that are important to travellers and improve the quality of their experience. Identification of

user needs considered different modes of transport and different types of interchange, the varying needs of different groups of passengers, and the different user needs that may arise according to the purpose of the journey.

Key system requirements for seamless long-distance travel

This work identified system needs for seamless long-distance passenger travel, taking into account the entire trip transport chain, with a focus on the first/last mile, the interchanges and the main trip, in order to identify the system requirements that best enable these different trip stages to efficiently interlink. System needs identified focus on enabling existing transport service to work together.

Best practice and suggested solutions for co-modality and intermodality in long-distance passenger transport

Identification of solutions for the improvement of co-modal and intermodal travel was a core part of the work of ORIGAMI. ORIGAMI developed an online directory of best-practice solutions for optimising long-distance passenger journeys. These are solutions that are currently implemented and operating and which serve as a guide to what may be possible to implement in other locations.

Seamless intermodal travel: identification of gaps and bottlenecks

With the user and system needs identified as described above, and with the development of the directory of best-practice solutions, this part of the work of ORIGAMI aimed to categorise all the solutions and assess their effectiveness against certain criteria within an evaluation framework. The results of this work are described in a project milestone, *MS11 Finalised analysis of gaps and bottlenecks*, that was not initially intended to be made public, but which is now available to download on the ORIGAMI project website.

Modelling of scenarios for future long-distance passenger travel

ORIGAMI developed medium and long-term scenarios for future long-distance passenger travel through modelling, forecasting and analysing factors influencing transport and travel behaviour. The MOSAIC modal split and traffic assignment model, developed in the earlier EC-funded project INTERCONNECT, was applied to the 2030 horizon, and the LUNA system dynamics model, developed in ORIGAMI, was applied for the 2050 horizon. Modelling covered a number of scenarios, based on different "packages" of European policies affecting transport demand.

2.2 Key outputs of ORIGAMI

2.2.1 Overview of key outputs

The key outputs of ORIGAMI are listed below and briefly described in the following subsections:

the public deliverables referenced here and that can be downloaded from the ORIGAMI project website at www.origami-project.eu

web-based resources:

1. ORIGAMI survey on trends;
2. online solutions directory;
3. Presentations from the ORIGAMI stakeholder workshop (May 2012); and
4. final conference (April 2013)

2.2.2 Public deliverables

The key public deliverables are listed below and are all available at www.origami-project.eu

D4.1 Review of needs of long-distance travellers

This deliverable reported on a comprehensive review of available literature on the needs of travellers using transport interchange facilities. The review took into account the needs of all travellers, including more vulnerable groups such as older people and those with impaired mobility. The review identified eleven categories of user needs that apply to all long-distance intermodal journeys (network characteristics, interchange facilities, baggage handling facilities, door-to-door information, cost, comfort, safety, personal security, journey time, accessibility, and promotion of intermodality) as well as four additional categories relating to individual mode components (employees, effort, in-vehicle facilities and environmental concerns).

D4.2 Analysis of system requirements for co- and intermodality in long-distance passenger travel

This deliverable reported on the identification of system needs, that is the pre-conditions of the transport system (technical and organisational) that can best accommodate the most relevant identified user needs. The identification of system needs looked at three parts of the transport chain – the first/last mile, the interchanges, and the main trip stage – as well as the overall trip. Key system needs identified were multimodal information systems and integrated ticketing, improved physical design of infrastructures and interchanges, and the presence of integrated transport infrastructures and networks (rail, road, local public transport) at interchange points. These would require a level of standardisation, regulation and stakeholder co-operation.

D3.1 Current travel behaviour, future trends and their likely impact

This deliverable presents the results of a review of current travel behaviour in Europe and a forecast of future trends in transport demand. The review of current travel behaviour summarised the current travel behaviour of European residents for long-distance trips based on three main data sources – Eurostat tourism data, national travel surveys, and the DATELINE supranational household and personal survey. A set of national population cohort models was developed taking into account future trends that will influence travel behaviour - economic growth, population growth, aging of population, changes in household structures, and increasing access to cars - in order to quantify the impact of these trends on transport demand, with demand by age group, household group and mode share.

D3.2 Results from survey of behavioural response

This deliverable describes the results of an online survey developed in order to understand current patterns of long-distance passenger travel, and likely passenger responses to policy initiatives in transport service provision. The online survey collected data from nine European countries, with close to 6,000 responses received, and included a mix of revealed preference and stated preference questions that covered various aspects of making a journey such as accessing the main mode of transport, the egress journey, the main journey itself and the impact of soft factor solutions (such an online planners) on overall journeys. Results presented include, for example that travellers place a high value on having good information available regarding onward travel when arriving in an unfamiliar destination.

D6.4 Technical solutions for the improvement of co- and intermodality for long-distance travellers

This "deliverable" is the best-practice solutions directory, described in detail in section 2.2.3 on online resources from ORIGAMI. The deliverable exists as a paper version of the online directory of best-practice examples and suggested solutions for optimising long-distance passenger transport and lists the solutions, details their applicability and transferability, and outlines discussions with stakeholders at project workshops that were part of the process of defining the listed solutions.

D7.1 Scenarios for future co- and intermodality in long-distance passenger travel

This deliverable describes the development of scenarios for future long-distance passenger travel, the results of forecasts developed by modelling these scenarios and evaluation of the modelling results. Four specific scenarios for 2030 and 2050 time horizons with a "prosperous Europe" or a "lagging Europe" were developed and were based on four alternative "policy packages" operating on the supply side of the transport system; these covered combinations of better public regulation and infrastructure investment (public and private sector), better vehicle technological standards, and liberalisation of transport policies. These scenarios were modelled and results are reported, for example a decrease in fuel consumption was predicted for the nearer future, but in the 2050 scenarios consumption is rising again in later years, largely driven by the increase in air travel, and in most scenarios ends up well above 2010 level.

D2.1 ORIGAMI Final technical report

This deliverable provides an overview of the work carried out in ORIGAMI and presents a synthesis of the results of each task undertaken, together with the overall conclusions from the project. It summarises the highlights of work carried out, presents the areas for further research identified in the project and presents the overall conclusions and recommendations from the project. This deliverable provides a good introduction to ORIGAMI and references where further information can be found on each strand of work carried out.

2.2.3 Web-based resources

ORIGAMI survey of trends, online report

The ORIGAMI online survey on *Trends in long-distance passenger transport by 2030* was completed in November 2011, with 262 responses received from expert stakeholders. As a follow-up to the European Transport White Paper 2010-2020 and the redefinition of the Trans-European Transport Networks Guidelines recently approved, the survey aimed to provide new inputs to the definition of new scenarios for long-distance passenger transport towards 2030. A report on the survey is available on the ORIGAMI website.

ORIGAMI online directory of best practice examples and suggested solutions

The ORIGAMI online directory of best-practice examples and suggested solutions for optimising long-distance passenger transport through enhanced intermodality and co-modality, thus allowing for seamless passenger journeys, contains 176 solutions. The directory can be viewed on the ORIGAMI website.

The solutions directory provides a comprehensive yet concise one-stop resource where transport practitioners can view a wide range of solutions to improve connectivity in long-distance passenger transport in Europe. The best-practice solutions directory has been live and online since November 2011 and has received many thousands of hits. It provides an interactive experience where visitors can view all the solutions listed and comment on them. Solutions can be viewed as a list, by category, by mode, or by popularity rating.

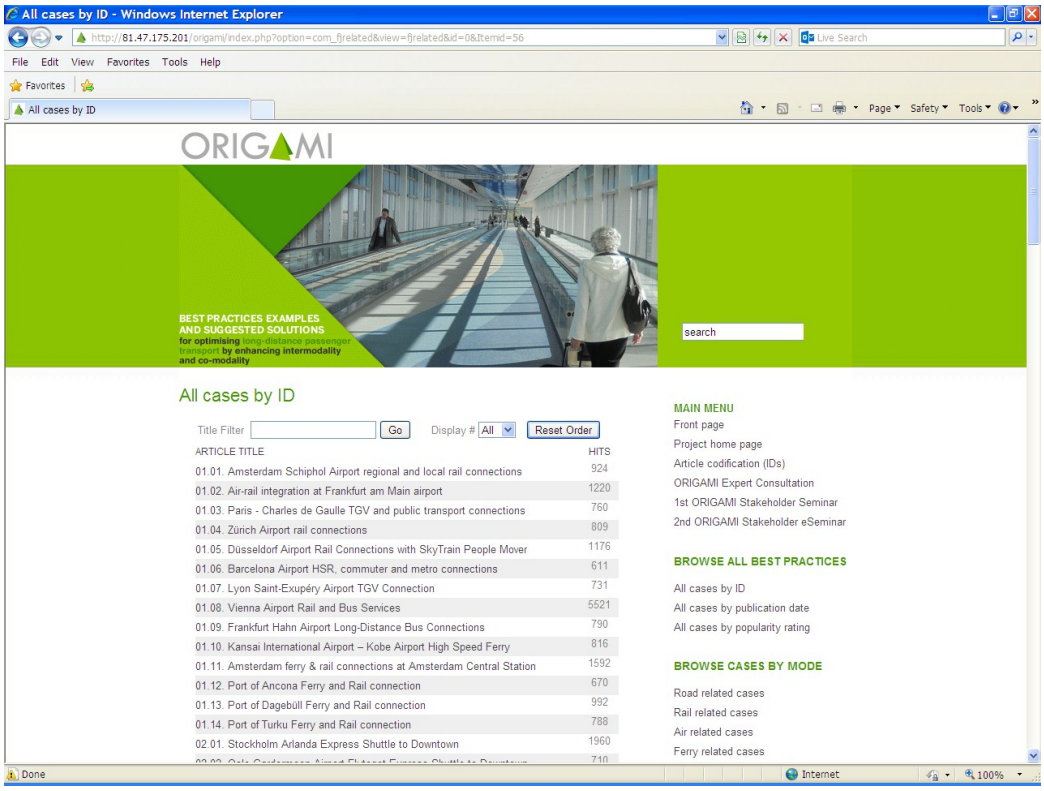

Figure 1 ORIGAMI best practice examples and solutions screenshot 1: all cases

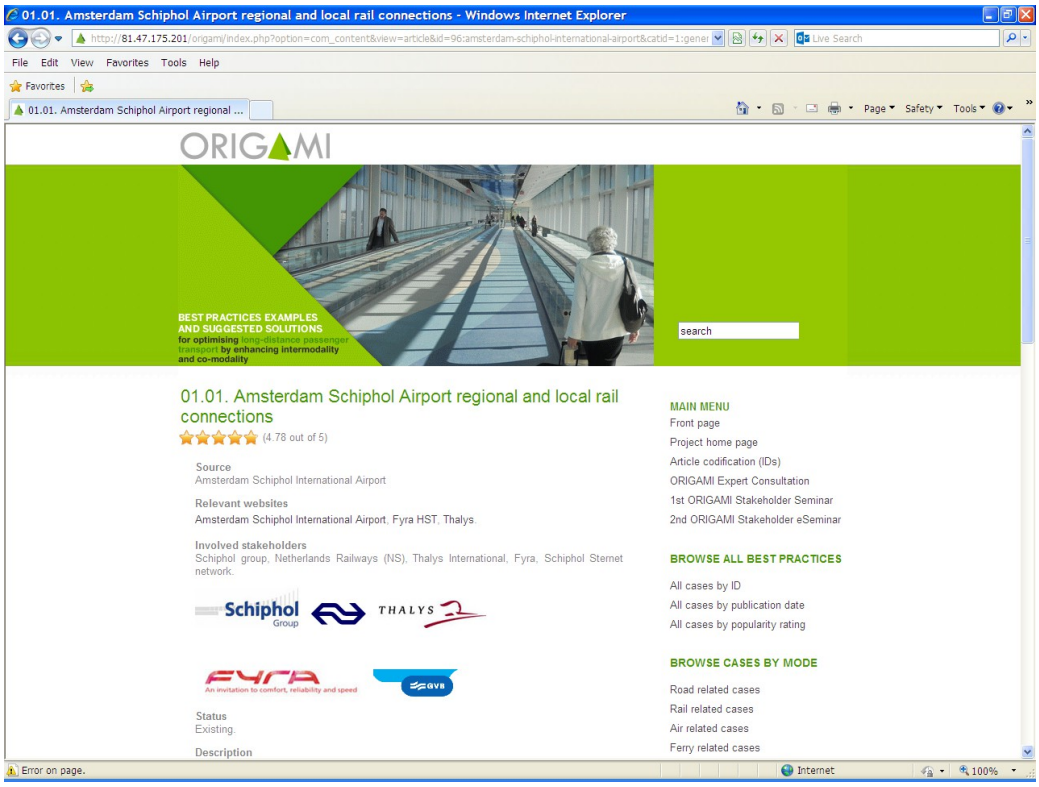

Figure 2 ORIGAMI best practice examples and solutions screenshot 2: detail for one case

Presentations from the ORIGAMI stakeholder workshop and final conference

The ORIGAMI workshop, *Upcoming Innovations and Future Scenarios for a Seamless European Mobility*, took place in Barcelona on 4th May 2012. Expert stakeholders were invited to make presentations and contribute to discussions on future scenarios for European mobility, focusing on infrastructure, management and technological. All workshop presentations are available on the ORIGAMI website.

The final ORIGAMI conference took place on 17th April 2013 in Brussels. Members of the ORIGAMI consortium presented the results of the project and this was followed by round-table discussions with invited expert stakeholders. All final conference presentations are available on the ORIGAMI website.

3 COMPASS: optimised co-modal passenger transport for reducing carbon emissions

3.1 Work undertaken in COMPASS

3.1.1 Overview of key steps

The work of COMPASS can be broken down into a number of steps that encompassed literature search, analysis of available survey data, development of a handbook of solutions, detailed analysis of case studies, and modelling the impact of selected ICT solutions for improved passenger mobility. The key steps in COMPASS are listed and briefly described below, while the resulting public deliverables and online resources are described in sections 3.2.2 and 3.2.3.

Identification of key trends in mobility patterns in the 21st century

This work looked at the variables that are likely to influence future mobility and demand for transport in Europe. Demand for transport is generated by factors that are exogenous to the transport sector and mobility is required to meet specific individual needs with different trip types and journey purposes. In COMPASS the key trends in mobility were identified using a framework with four domains – social, economic, technical and environmental – to provide a comprehensive overview of key drivers that will influence mobility in the future.

Emerging traveller needs for short-distance trips

The main objective of this COMPASS task was to perform a systematic and comprehensive review of available literature on 'the needs' of current (and potential) travellers, taking into account the forecast key mobility trends across Europe. This review included the needs of the full range of travellers, although the focus was on those groups identified as important in terms of forecast key trends, and covered all transport modes. In contrast to ORIGAMI, the focus of this work in COMPASS was on short-distance trips. However, it was found that user needs for short-distance trips are generally the same as those for long-distance trips. Sixteen main user needs were identified

Potential role of ICT solutions for seamless passenger transport

Early in the COMPASS project work focussed on identifying ICT solutions with potential to favour seamless co-modal journeys and investigating the role of these ICT solutions in transport data collection and management, and assessing how they can improve data collection in the passenger transport sector. A literature review was carried out and the work of previous EC-funded projects was considered in order to come up with an initial list of ICT solutions.

Data availability for transport demand

This work conducted a review of existing travel survey sources to establish current data availability regarding long-distance, rural and urban travel. The aim was to identify, collate and synthesise travel-related data available in national and local travel surveys across Europe, specifically to identify travel behaviours and trends. First, available surveys and data sources were identified, then a review of the availability, accessibility and costs of each data source was carried out, then the data was analysed to give an overview of traveller behaviour, for example who travels, how often people travel, reasons for travel, and specific barriers to travel.

The role of ICT in travel surveys and data collection

Moving on from the work on identification of transport surveys and data sources described above, this task looked at the potential of ICT-based transport data collection and its potential benefits, as well as potential problems. There is potential to harmonise travel surveys carried out in different parts of Europe, and in particular to exploit ICT for data collection, for example using web-based surveys and questionnaires, or collecting data via smartphones or smartcard ticketing applications, though in these cases there are administrative burdens and privacy concerns.

Development of a Handbook of ICT solutions for improving co-modality in passenger transport

The *COMPASS Handbook of ICT Solutions* brings together a set of 96 solutions applying to urban and metropolitan mobility, long-distance passenger transport and also innovative ICT solutions aimed at increasing the quality of transport services in areas where demand levels are low, like rural or sparsely populated regions. The *COMPASS Handbook of ICT Solutions* is available as a paper edition and also as the *online Handbook of ICT solutions*.

The ICT solutions presented in the Handbook are classified in the five broad categories: transportation management systems; traveller information systems; smart ticketing and tolling applications; smart vehicles and infrastructure; and demand-responsive transport (DRT) and shared mobility systems. Unlike the solutions in the ORIGAMI directory, the COMPASS ICT solutions are generic descriptions of solution types rather than specific implemented solutions.

Eleven COMPASS case studies

The COMPASS case studies were carried out to test ICT solutions in the context of real world situations in order to assess their real impact on the transport system and user behaviour. The analysis of a balanced set of case studies, in terms of geographical coverage and diversity of ICT solutions applied, allows for the discussion of the effects of different conditions existing at different urbanisation levels on proposed ICT solutions. Early in the project a methodology to select the case studies was developed and on this basis the final proposal of eleven case studies for detailed research was formulated. These are shown in Table 1.

Case studies had to build upon well researched data about user responses to proposed ICT solutions and in several of the case studies in-depth surveys were conducted within COMPASS while other case studies relied on data already available from existing sources.

The case study of ICT modelling in the Scotland Region 2007 to 2027 used the LATIS transport model to produce quantitative estimates of traffic and emission reductions resulting from the implementation of two ICT solutions: reduction in urban bus journey times as a result of ICT; and mobile technology to encourage car sharing.

Table 1 the eleven COMPASS case studies

COMPASS case study / ICT solutions investigated	COMPASS partner responsible
An EU-Wide Multimodal Travel Planner: routeRANK • An online Europe-wide travel planner with several available versions	MKmetric GmbH
A Regional Multimodal Travel Planner: Marche Region of Italy • A regional traveller information system	ISIS
Accessibility Applications for Disabled People • Smartphone travel apps for disabled travellers	ITS, University of Leeds

ITS Solutions for Barcelona's Local Bus Network • Smartphone apps • Smart bus stops • Smart applications for demand-responsive transport services in mountain neighbourhoods	Mcrit
Future Interurban Public Transport in Warminsko-Mazurskie Voivodship • Internet-based travel planners; • Electronic real-time information at bus stops; • Ticket purchasing via mobile phones / internet; • Real-time information on services via mobile phones / internet; • Real-time information on estimated arrival times, stops, route on board of vehicles; • Demand-responsive services	University of Gdansk
Mobile Applications for Taxi Services • Smartphone apps for taxi users	TRI, Edinburgh Napier University
Bike Sharing in Vienna and the Surrounding Region • Citybike in Vienna • Nextbike in Lower Austria	Technical University of Vienna
Car Sharing in Karlsruhe • Car club car-sharing scheme	MKmetric GmbH
Grass-Root Co-operative Smartphone-Based Car Sharing in Austria • Grassroots co-operative car-sharing scheme called CARUSO	Technical University of Vienna

Sant Cugat Intelligent Motorway Toll System • Automatic detection of high-occupancy vehicles and applications of discounts • Environmental discounts for ecological vehicles • ViaT electronic toll system • Automatic incident detection system	Mcrit
ICT Modelling in Scotland Region 2007 to 2027 • Existing transport model used to produce quantitative estimates for traffic and emission reductions from implementing two ICT solutions: reduction in urban bus journey times as a result of ICT; and mobile technology to encourage car sharing	TRI, Edinburgh Napier University

European assessment of ICT solutions through scenario modelling

Based on the case studies findings and on knowledge gained from the analysis of ICT transport solutions in the COMPASS Handbook, quantitative modelling was then used to assess the potential impact of ICT solutions at European scale. The assessment of long-distance ICT solutions was based on quantitative modelling using MOSAIC, a modal choice and assignment module originally programmed to investigate how upgrading the interconnections between transport networks in Europe impacted on the European transport system.

3.2 Key outputs of COMPASS

3.2.1 Overview of key outputs

The key outputs of COMPASS are listed below and briefly described in the following subsections:

the public deliverables referenced here and that can be downloaded from the COMPASS project website at www.fp7-compass.eu

web-based resources:

5. key drivers website
6. COMPASS Handbook of solutions
7. presentations from the COMPASS final conference (November 2013)

3.2.2 Public deliverables

The key public deliverables are listed below and are all available at www.fp7-compass.eu

D3.1 The potential role of ICTs in favouring a seamless co-modal transport system

This deliverable was prepared early in the project and reports on the identification of ICT solutions that have the potential to improve seamless co-modal journeys, to be fully analysed later in COMPASS. Potential solutions are identified with a particular focus on the role of each solution in data collection and on how each solution can meet future needs of passengers

in view of the trends that will influence future demand for travel. At this stage of COMPASS the identified solutions were grouped into six broad categories.

D3.2 Key trends and emerging traveller needs

This first part of this deliverable presents the key drivers that influence mobility trends in Europe. Within COMPASS the identification of these key drivers focussed on four "domains"– social, economy, environment, and technical – in order to provide an in-depth snapshot of factors affecting current and future mobility patterns. The domains are divided into subsections and each key driver identified is presented and discussed in some detail, supported by a list of over 250 source documents. The second part of this deliverable presents the findings of a review of available literature on user needs for current and future travellers taking into account the forecast key trends in mobility. Given the work on user needs already carried out on user needs for long-distance passenger journeys in ORIGAMI, the COMPASS review focussed on shorter journeys and considered user needs in the context of socio-economic and demographic factors.

D4.1 Transport demand related information overview on long-distance, rural and urban travel

This deliverable presents an analysis of the range of available data sources related to individuals' travel behaviour and wider travel behaviour trends across Europe. The deliverable outlines available sources of data (for example, national travel surveys, Eurostat repository data, and data derived from European Commission statistical reports), and other potential data sources such as the use of online travel planning sites, ticketing sales, and then discusses problems with data such as the lack of survey continuity or limited geographical coverage. Analysis of available data does show there are major national and regional variations in travel behaviour in Europe, though private car remains the dominant transport mode in the vast majority of European countries. Conclusions reached are that data harmonisation across Europe is desirable, data needs to be more accessible and needs to cover all transport modes.

D4.2 The role of ICT in travel data collection

This deliverable presents requirements for data on travel behaviour, applicable ICT solutions that may be applied for data collection, and assesses the future potential of ICT for data collection. The deliverable first outlines existing travel data collection methods, the indicators (such a number of trips, modal split) collected with these methods and an overview of how this data is used. The deliverable then reports on a web-based survey undertaken with stakeholders in order to determine their data needs and how well these are met, presents the current status of travel data collection in Europe and concerns such as data privacy, costs of data collection and the reasons for gaps in data collection. The information presented is supported by comprehensive tables on available data.

D5.1 Handbook of ICT solutions for improving co-modality in passenger transport

The deliverable version of the Handbook (also available as the online Handbook discussed in section 3.2.3 below) lists all relevant ICT solutions identified in COMPASS for improving co-modality and presents their individual merits and shortcomings. A total of 96 solutions are listed under five category headings: transport management systems, traveller information systems, smart ticketing and tolling, smart vehicles and infrastructure, and shared mobility and demand responsive transport (refined from the six categories in D3.1).

Each solution is presented systematically as an individual factsheet listing its key characteristics and the problems or situations it seeks to address. Each solution is also scored according to an analysis framework that looks at the necessary preconditions for application of each solution (technical, organisational, legal and political feasibility and acceptability of each solution are analysed) and the possible barriers to their implementation. Each solution is also assessed for its potential impact when implemented in different circumstances, particularly for modal split and CO2 emissions.

Finally in the handbook deliverable four "business models" are discussed for selected applications (shared bicycle systems, shared taxis, mobile information systems and parking management systems) focussing on the basis of the product, customer interface, infrastructure management and financial aspects.

D6.1 User response to suggested ICT solutions

This deliverable reports on the results of surveys carried out as part of the assessment of solutions in the COMPASS case studies. Surveys of transport users were part of the case studies in: Barcelona's bus network, the Warminskie-Mazurskie Voivodship, bike sharing schemes in Vienna, and grassroots co-operative car sharing in Austria. This deliverable outlines the surveys carried out, their aims and methodology, the sample sizes and respondents, and describes the results. Actual survey questionnaires are included as an appendix. The survey results are detailed in this deliverable but also feed into the more comprehensive case study reports detailed in D6.2 described below.

D6.2 An assessment of the potential impact of ICT solutions on a co-modal transport system

This deliverable presents the synthesis the work carried out through case studies on the assessment of ITS transport solutions to improve co-modality in Europe. Each of the 11 case studies (as listed in Table 1 above) are presented according to a similar outline with the background and specific characteristics briefly described before the results of the assessment of each individual solution within the case study are detailed. The case studies were selected to cover a representative range of technological solutions applied in a wide range of different territories in Europe so this deliverable provides an extensive coverage of implemented ICT solutions and an analysis of their effectiveness and potential transferability. The case studies deliverable also presents the results of the "European assessment of ICT solutions" – an analysis based on modelling a set of alternative ITS scenarios at EU-scale by means of the network model MOSAIC (also applied in ORIGAMI).

D2.1 COMPASS - Final results and conclusions

This deliverable provides an overview of the work carried out in COMPASS and presents a synthesis of the results of each task undertaken and overall conclusions from the project as well as a summary of the contents of each project deliverable. This deliverable provides a good introduction to COMPASS and references where further information can be found on each strand of work carried out.

3.2.3 Web-based resources

COMPASS Key drivers website

The *COMPASS key drivers website* presents the results of the COMPASS research activity to identify key drivers that are expected to influence current and future mobility patterns across Europe. The key drivers website has been live since July 2013 and can be accessed via the COMPASS website at www.fp7-compass.eu

The main feature of the website is the *key drivers roadmap*, a visual representation of the four key domains which can be used to categorise the factors that influence travel demand and mobility patterns. The four domains - social, economic, environmental and technological – are then outlined in more detail. The key drivers website also contains a comprehensive library of documents on the subject, with hyperlinks, so that the website is an important resource for practitioners in this area.

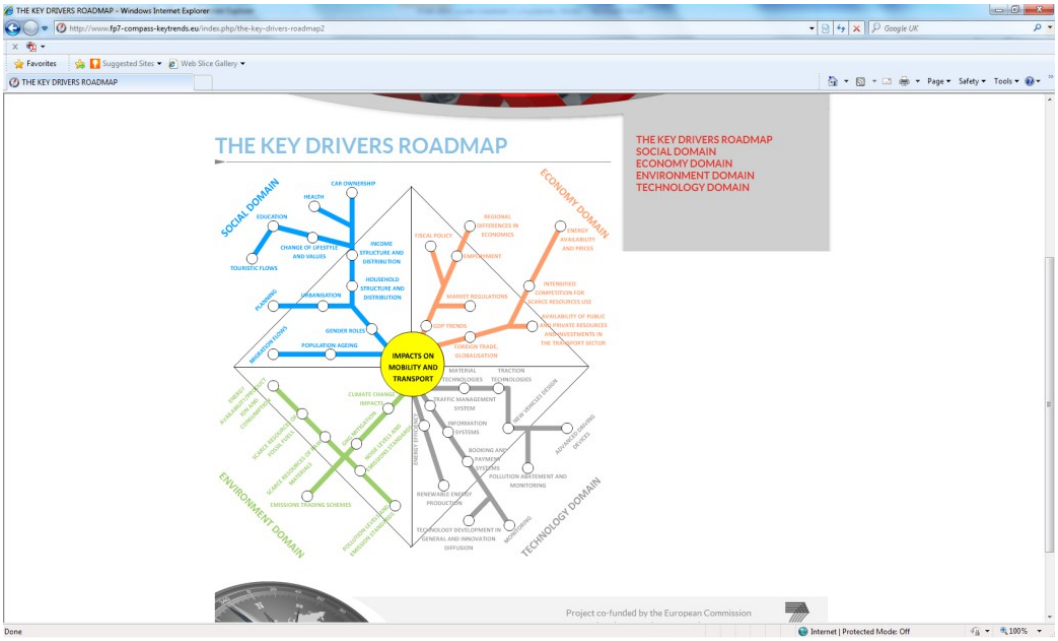

Figure 3 COMPASS key drivers website screenshot; key drivers roadmap

COMPASS Handbook of ICT solutions

The COMPASS *Handbook of ICT Solutions* brings together a set of 96 solutions applying to urban and metropolitan mobility, long-distance passenger transport and to transport services in areas where demand levels are low, like rural or sparsely populated regions. The COMPASS *Handbook of ICT Solutions* is available in paper edition (D5.1 described in section 3.2.2 above) and also online via a link from the COMPASS homepage.

Unlike the examples of best practice presented in the ORIGAMI solutions database, the solutions listed in the *COMPASS Handbook* are generic descriptions and not necessarily specific to one particular implemented example.

The ICT solutions are presented classified in five categories. Each of the 96 generic solutions has a page which describes the solution, and according to the assessment framework developed in COMPASS gives example of its application or potential application, barriers to implementation, interest for users and score against the COMPASS criteria. Each solution has links to "illustrative materials", which may be web links, videos, photographs or documents. In this way the *Handbook* provides a key and comprehensive resource in itself, as well as providing a gateway to further information.

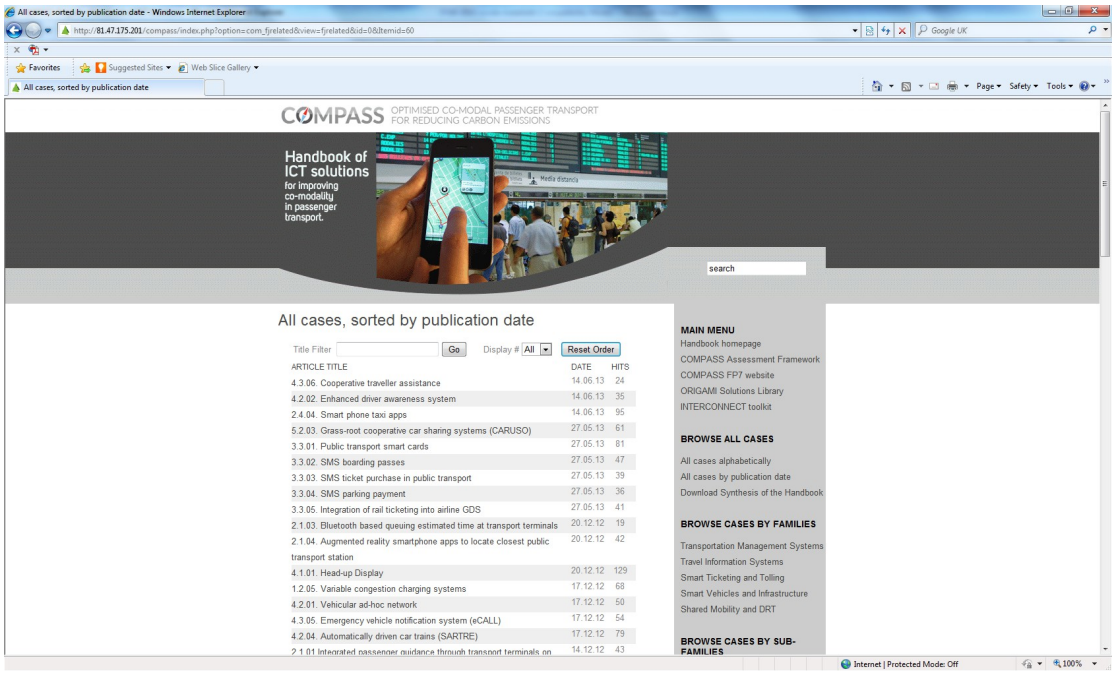

Figure 4 COMPASS Handbook of ICT solutions screenshot 1: all cases

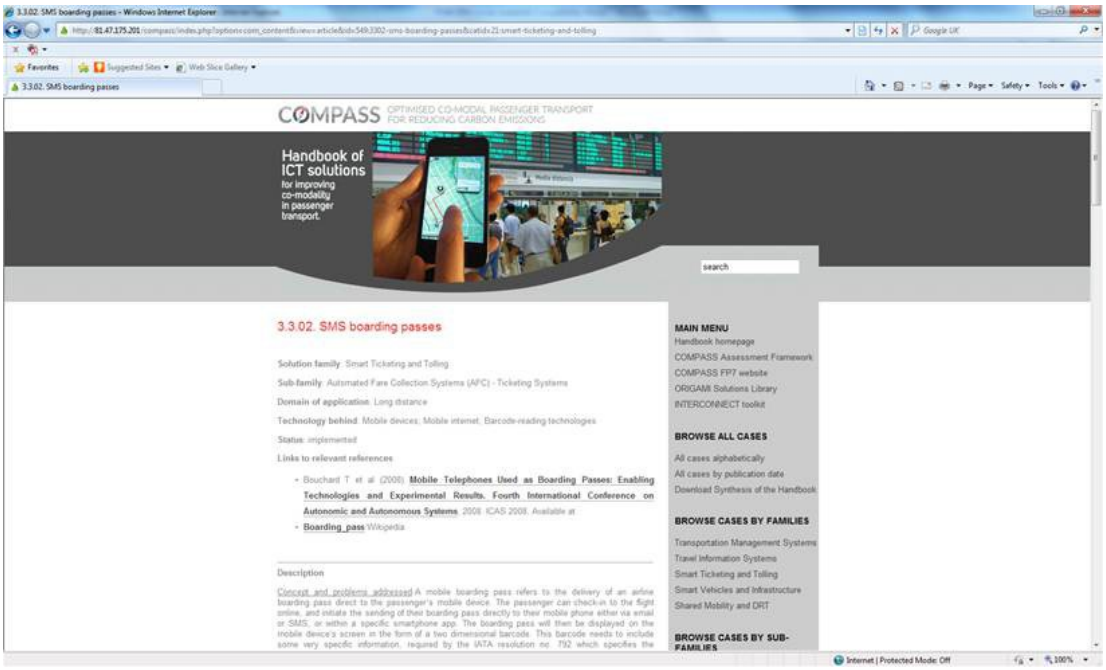

Figure 5 COMPASS Handbook of ICT solutions screenshot 2: detail for one case

Presentations from the COMPASS final conference

The COMPASS Final Conference took place in Rome on November 13th 2013. The conference included presentations and discussions on the key findings from the COMPASS project, with feedback and interaction from key stakeholders. All presentations are available on the COMPASS website.

4 Conclusions from ORIGAMI and COMPASS

4.1 Conclusions from ORIGAMI

By reviewing potential solutions and assessing their applicability and usefulness in a range of scenarios for the medium- and long-term future, ORIGAMI aimed to contribute to the formulation of future transport policies promoting co- and intermodality. Furthermore, the project contributed to the wider dissemination of best practice and a process of cross-fertilisation between modes. The conclusions from ORIGAMI can be summarised as below.

The work on identifying of the current pattern of long-distance passenger trips in Europe revealed some areas where there is a shortage of data, for example in trips that do not require an overnight stay (these are generally business trips), and revealed that the car is the dominant mode for trips up to 500 km, rail and air become more prominent in trips longer than 500 but shorter than 1000 km, while air is absolutely dominant for trips longer than that, although there are variations depending on trip purpose (work versus leisure).

The work on traveller needs revealed that travellers place a high value on *soft* improvements that in some way or other reduce the level of uncertainty associated with making a long-distance trip and the cognitive burden of organising and taking such a trip, particularly a trip that may involve a number of different modes or different segments by the same mode (e.g. interchange).

The best-practice solutions presented in the online solutions directory have been discussed with stakeholders and this revealed that the solutions with highest EU interest, according to these experts, were road pricing, airport interconnections, ICTs for smarter road management, just-in-time travel planners, energy-related solutions and collaborative mobility solutions. The rating of these solutions according to the a framework of assessment criteria developed in ORIGAMI revealed that the best solutions (those that will transfer easiest to other situations) are those in the category *Travel planners and passenger information* solutions which have relatively high interest for travellers, operators and public authorities and are easiest to implement.

The scenario modelling for 2030 and 2050 came up with a number of common findings, for example: the most effective way to decrease the number of cars, or at least the growth in the number of cars, is to increase vehicle occupancy with policy incentives; investment in rail, in particular in high-speed rail, and policies to reduce the cost of rail travel can significantly increase rail usage; air travel will rise in all scenarios well above 2010 levels with the lowest assumption for 2030 being +36% to the highest of +66% by 2050 for a “prospering” Europe; both sets of scenarios foresee a decrease in fuel consumption for the nearer future (based on assumptions in future vehicle technologies), but in the 2050 scenarios consumption is rising again in later years, largely driven by the increase in air travel. Although the conclusions from scenario modelling are greatly influenced by assumptions on socio-demographic and economic trends, emphasising the need for research in identifying these trends, one overriding finding throughout all scenarios was that the reduction in CO2 emissions targeted by the EC for 2050 cannot be achieved with any mix of transport policies, but only with a step change in propulsion technologies.

ORIGAMI identified future research needs – in availability of statistics, identification and assessment of solutions, the behavioural response from users to these solutions and analysis of future trends in transport and mobility needs.

It was noted in ORIGAMI that the European transport system is increasingly complex and that a large number of smart transport solutions are already implemented and operating, and are potentially transferable to other situations.

ORIGAMI therefore concluded with a number of policy recommendations::

Enhance real-time interaction between transport carriers and passengers, with two-way information flow, though taking into account privacy concerns.

Implement online pricing systems, particularly on roads, as well as integrated fees for public transport for better service management.

Promote new and smarter vehicles, and online information exchanges between vehicles and between vehicles and infrastructure.

More integrated intermodal exploitation is feasible if carriers are able to exchange real-time information concerning not just the timing of the services and unexpected events, but also on the actual needs of their travellers, and optimise services accordingly.

Favour public-private infrastructure management.

Emphasise synergies with urban and regional development and transport infrastructure investments as a necessary condition for good planning in the mid- and long-term.

Continue to monitor transport and travellers' behaviour; it is indispensable to collect and store data and surveys because policy decision making relies on freely available data and independent analysis.

4.2 Conclusions from COMPASS

The fundamental research questions of COMPASS were to establish to what extent ICT and ITS solutions can influence de-carbonisation of transport activities. This main focus of COMPASS research was based on the analysis of factors and challenges determining the shape of future mobility. Project results can be viewed from two perspectives: external factors in wider society, and internal factors in the transport sector. The external perspective consists of a complex analysis of factors determining trends on mobility, while the internal perspective covers evaluation of traveller needs. This background enables a study of the potential influence of ICTs on the reduction of CO2 emissions from transport.

The analysis of key trends influencing mobility patterns in the future focussed on trends in four domains (social, technical, environmental, economic) and concluded that each domain plays an important role, either on its own or in combination with the others. In most cases it is difficult to predict the scale and timing of such impacts, for example the speed by which environmental and technological shifts, and thus their impacts on the planning and development of the future transport system remain uncertain. It is also difficult to predict the development and implications of economic, political and financial decisions on global markets, and the secondary impacts of this on the overall mobility of people and goods. It is generally more straightforward to predict the impacts of demographic factors whose dynamics can be more easily understood and forecast.

One key trend identified is the impact of the culture of "sustainable consumption" and general awareness of environmental concerns and the shift towards alternative mobility by walking and cycling. These can be promoted through fiscal policy measures and market regulation can be more widely implemented in order to take account of environmental costs. Another trend is that the increasing scarcity of fossil fuels and environmental concerns are accelerating the pace of technological development.

User needs for travellers in urban, metropolitan and rural areas were investigated and a list of sixteen key user needs for short-distance intermodal journeys have been identified and described. These key needs are identical to those identified for long-distance intermodal journeys in ORIGAMI, which suggests they are generic for all intermodal journeys, irrespective of distances involved. These traveller needs concern both physical and psychological aspects, covering network characteristics, interchange and baggage handling facilities, information and ticketing issues, and more subjective needs such as environmental concerns or comfort. It was concluded that further research is needed to establish the relative importance of user needs to each other and to investigate the extent to which if 'certain' user needs are unmet, this can prevent people from making certain journeys. It is noted that the relationship between user requirements and modal choice decisions is complex and also dependent of the personal attributes of travellers as well as their trip purpose, prevailing conditions and trip location.

The contribution of ICTs to reduced CO2 emissions has been analysed in through the development of the *Handbook of ICT Solutions* improving co-modality, the realisation of eleven case studies covering various ICT solutions in different European regions, and the European assessment of ICT solutions through modelling scenarios analysis.

Identified ICT solutions were grouped into a number of broad categories:

Transportation management systems – covering ICTs which aim is to help planning and running the transport system in efficient manner;

Traveller information systems – solutions designed in order to provide travellers with information (travel time, routes, traffic conditions, etc.);

Smart ticketing and tolling applications - ICTs addressing ways to get tickets and to pay for using transport services;

Smart vehicles and infrastructure – including:

ICTs aimed at improving vehicle operation,

vehicle- to-vehicle (V2V),

vehicle- to- infrastructure (V2I) communications,

Demand-responsive transport (DRT) and shared mobility systems – covering ICTs fostering transport services adjusted to demand.

Several sub-themes within those main groups were further established and solutions within these groupings were identified, for example in transport management systems sub-themes include ICTs designed for urban traffic control, road transport management, strategic transport management for corridors and networks, public transport management, railway traffic management, air transport management and maritime transport management.

All specific solutions have been evaluated against major factors determining their performance: feasibility (investment costs, operational and maintenance costs, financial viability, technical feasibility, organisational feasibility, administrative burden, legal feasibility, user acceptance, public acceptance); interest to travellers (door-to-door travel time, door-to-door travel cost, comfort and convenience, safety, security, accessibility for mobility impaired); impact on modal change (car usage, bus and coach usage, rail usage, ferry usage, aeroplane usage); and other impacts (mobility, congestion, CO2 emissions, contribution to user pays principle, contribution to European economic progress). This practical assessment

of real-life ICT solutions is a useful tool for the selection of the optimal ICT solution for a particular set of circumstances. The *Handbook* helps to analyse whether a particular solution fits well into particular conditions. Having certain characteristics and being able to compare to the scores for relevant real-life cases from the *Handbook* makes it an efficient policy support tool.

The conclusions of the COMPASS case studies of ICT solutions are case-dependent and cannot be treated as one EU-wide response to the ICTs. Certain trends are evident. First, there is relatively high acceptability among users, who generally welcome introduction of ICTs though this is dependent on user age with older users more often rejecting ICTs than younger. Second, user acceptance arises from improvements to door-to-door (D2D) travel time, D2D travel costs, comfort and convenience. Most ICTs - as case studies confirm - contribute to travel time reduction and comfort increase. The major barrier for ICTs application revealed by case studies is financial. Users are generally unwilling to pay extra for ICT solutions. From the society point of view ICTs could contribute to a reduction in CO2 emissions from a reduction in congestion and therefore in fuel consumption, and also from a shift towards more sustainable modes.

This suggests that ICT solutions could be introduced into the transport system without much opposition from users and with no substantial legal or organisational barriers. There are however high financial barriers resulting from high initial investment needs accompanied by moderate maintenance costs. This is reinforced by users' widespread unwillingness to pay for improvements.

The modelling assessment of ICT solutions in COMPASS looked at three scenarios, of low- medium- and high ICT implementation defined with a particular set of changes in travel times, travellers' value of time, operating costs, and fees applied by modes. The results show that the extent to which ICTs will affect travel times, travellers' value of time, operating costs, and fees for long-distance travel as well as total CO2 emissions depends on the specific ICT system being used and the specific place where it is implemented. Detailed results show, for instance, that if optimised infrastructure and service management is the main effect of ICTs introduction into the transport system, then it is road mode which benefits most. ICTs, provided that they are able to impact evenly on the perception of travel time costs on users in all modes the same, increase the attractiveness of the road mode more than others. It is therefore impossible to reduce road use without severe government intervention which will decrease positive effects of ICTs on comfort and convenience.

COMPASS also investigated how ICT can contribute to data collection in transport. Overall, ICT technologies are still not yet widely used for travel surveys at the time of this research, although a number of experimental ICT-based travel surveys have been carried out in different countries. The current speed of development of ICTs in the transport system in general allows the prediction that by 2020 they will be widespread, especially when necessary components for ICT-based travel surveys such as a POI database (point of interest database) on a GIS system exist; no other real barriers are foreseen. They are cheap and allow for easy data processing. Some difficulty might however arise from the issue of privacy protection.

4.3 In summary

The legacy of each project lies in the completed public deliverables and the online resources that remain publicly available for viewing, as described in this paper. In addition each project

came up with policy recommendations resulting from the extensive analysis carried out, and identification of gaps in current knowledge and proposals for future focus of research.

Common findings from the two projects emphasise the importance of identifying the key trends in mobility that will need to be addressed in the future, and in identifying solutions for seamless intermodal passenger transport, whether these are specific implementation of solutions as in the ORIGAMI directory of best-practice solutions, or more generic solution types as in the COMPASS Handbook of ICT solutions. In addition each project included modelling of future transport demands based on trends identified, and the effectiveness of identified solutions in meeting these transport demands.

5 References

ORIGAMI website at: www.origami-project.eu

COMPASS website at: www.fp7-compass.eu

All ORIGAMI public deliverables listed in section 2.2.2.

All COMPASS public deliverables listed in section 3.2.2.

And further references contained within these

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