1 INTRODUCTION

This report examines selected representative case studies of interconnectivity, looking at solutions already implemented to improve interconnections among different transport modes, as well as planned solutions and problems to be solved. The goal is to identify existing good practice and potential solutions, analyse them and establish if they are likely to improve interconnectivity in European transport networks.

Deliverable D4.1 is part of INTERCONNECT WP4 *In-Depth Analysis through Case Studies.* WP4 has two main purposes.

- First of all, it has identified and studied in-depth examples of good practice of interconnectivity from a number of case studies and,
- Second, selected case studies will be used as 'test beds' to investigate the effects of the solutions proposed already in INTERCONNECT WP3, testing their applicability and likely performance. This analysis will be reported in milestone M4.5, and is therefore not included in D4.1 yet.

1.1 INTERCONNECTIVITY AND CO-MODALITY IN EUROPEAN TRANSPORT NETWORKS

The topic of intermodality, co-modality and interconnectivity in transport has been an important topic of discussion over the years in Europe. The case studies described in this report provide new evidence based on real situations, highlighting solutions already found and applied successfully, and exploring problems encountered in the developing of plans and implementation of projects by regional authorities.

INTERCONNECT deals with the role of local and regional interconnections in the context of longer distance journeys. It starts from the premise that, with the continuing increase in trip length in interregional travel, effective interconnection between trip legs will become a necessary feature of a growing proportion of passenger journeys, particularly of those which contribute most to the regional and national economies.

The topic 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 intermodal opportunities is a key ingredient to future policy development.

In 2006 the report *Keep Europe Moving*[1] introduced the concept of co-modality to define a new approach for all transport modes by enforcing a "use of different modes on their own and in combination" in the aim to obtain "an optimal and sustainable utilisation of resources". Optimal interconnections between different modes are fundamental, as they allow users to optimise their trips by using each transport mode only in its most efficient segment and then transferring to another mode.

1.1.1 The Complexity of Planning and Managing Interconnections in European Transport Networks

Effective interconnection requires the provision of integrated networks and services which are attractive to potential users and this is likely to require a close co-operation between a range of authorities and infrastructure and service providers in the public and private sectors, often with contradictory and competing business and political goals. The creation of effective interconnection may sometimes conflict with the priorities of market regulators, transport infrastructure managers and service providers.

- Infrastructure managers, e.g. private airport operators, may have a limited interest on improving interconnections, even with local and regional public transport networks, as an important part of

[1] *Keep Europe Moving. Mid-term review of the European Commission's 2001 transport White Paper,* European Communities, Luxembourg 2006.

their business comes from the shopping areas within the terminals and the car parking lots, and their business interest is therefore to maximise the time spent by users within terminals while having important private car access shares to the airport. Only when congestion threatens airport competitiveness, or there is a real competition between neighbouring airports, private operators may prefer to improve interconnections onto other transport networks, like in the case of Heathrow Express.

- Transport service operators, e.g. rail operators and airlines, can be interested in improving interconnectivity as it helps to make their services more attractive for passengers. In this context, many initiatives arise such as the onboard bus ticket sales by Ryanair, the easyBus from easyJet or the many rail-airline operator co-operations such as AirRail by Lufthansa and DB or the TGVAir in France. In the case of alliances between different service providers, e.g. in the aviation sector, interconnections between services within companies of the same alliance are promoted, while interconnections with other services are restricted. The planning debate concerning the interconnection between the two terminals in the airport of Barcelona has been deeply influenced by these considerations.
- Regional planners should mostly be interested in assuring efficient interconnections, whenever they increase the regional competitiveness and welfare. With the increasing scarcity of budgets, regional planners are usually not eager to spend funds on facilities that are not intended to serve local users, but national or international users, therefore they require broader intervention.

INTERCONNECT focuses on those journeys which might benefit from more effective interconnection between different modes and services, and on those situations where effective interconnection is currently hampered by institutional barriers, lack of investment, or failure to innovate of the different actors involved the potential solution. By identifying examples of good practice from Europe and elsewhere, the project will show how these situations could benefit from a more enlightened approach.

Most multi-modal trips in Europe will pass through major intermodal hubs located in large metropolitan regions. Improving such interconnections is of European interest, but only indirect local interest since local travellers rarely transfer in their own city. Therefore, intermodal connections developed in a given hub produce more than benefits to local residents, network benefits spread to travellers all across Europe (e.g. the missing direct connection between the HST and Madrid airport in Spain will mostly produce savings to travellers from many European cities to any provincial capital in Spain).

In the next section a first analysis of the geography of intermodal connections on European transport networks is provided to better introduce the actual case-studies considered. Most of these intermodal connections are used by both locally originated or bound travellers getting access to an international or long-distance terminal, and long-distance travellers in between their journey.

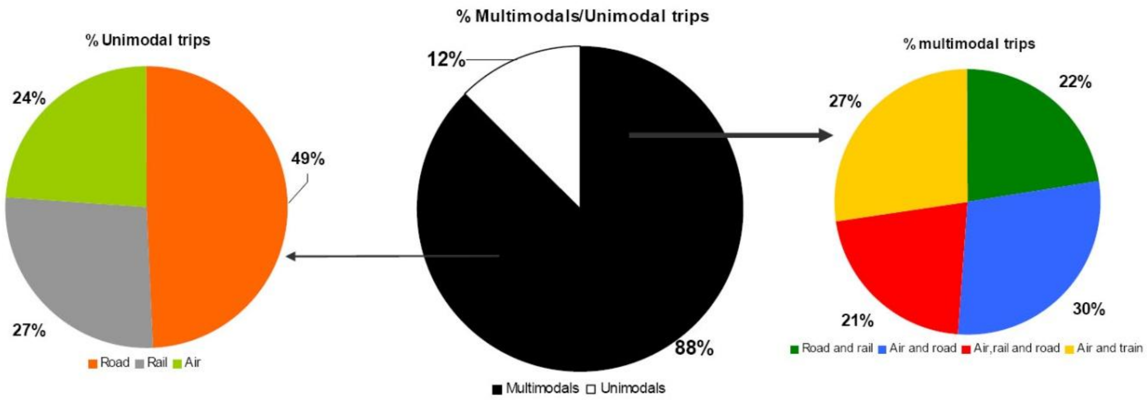
1.1.2 The Geography of Interconnections in Europe

In order to represent and analyse the interconnections of European transport networks, three concepts have been defined:

- Multi-modality is defined as the number of modes used in a trip; this measure can be refined considering the diversity of modes used in the trip (measured in length, time, cost…), independent from the number of changes or modal shifts.
- Intermodality is defined as the number of modal shifts in the same trip.
- Interconnectivity is defined as the number of steps or changes in the trip, between different modes or between different services in the same mode.

These concepts are partially overlapped. While all intermodal trips are multi-modal, interconnected trips can be either uni-modal or multi-modal.

Next, graphics from Transtools databases (organised by modes), analysed using INTERCONNECT multi-modal graphs and assignment algorithms, were used to illustrate basic features of intermodality in Europe, that will be further developed in INTERCONNECT’s next deliverables.

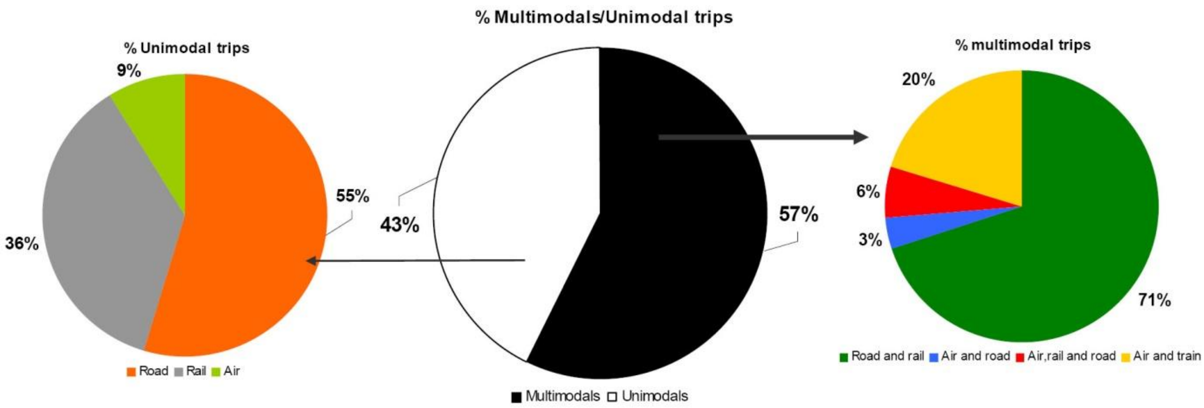


(source: INTERCONNECT multi-modal assignment)

Figure 1-1 Multi-modality in long-distance travel around Europe (all NUTS3 to all NUTS3)

(shortest multi-modal paths from all NUTS3 to all NUTS3, itineraries longer than 300 km)

Shortest path itineraries In Europe (EU27) would involve in almost 9 out of every 10 trips using more than one transport mode (for trips over 300km long, not considering the modes used to access the long-distance transport networks, i.e. taxi to airport not computing as a road trip). For uni-modal trips, in the hypothesis applied, the road mode would weight as much as 50% of all trips, while for multi-modal trips the usage of different transport combinations would be roughly equal.



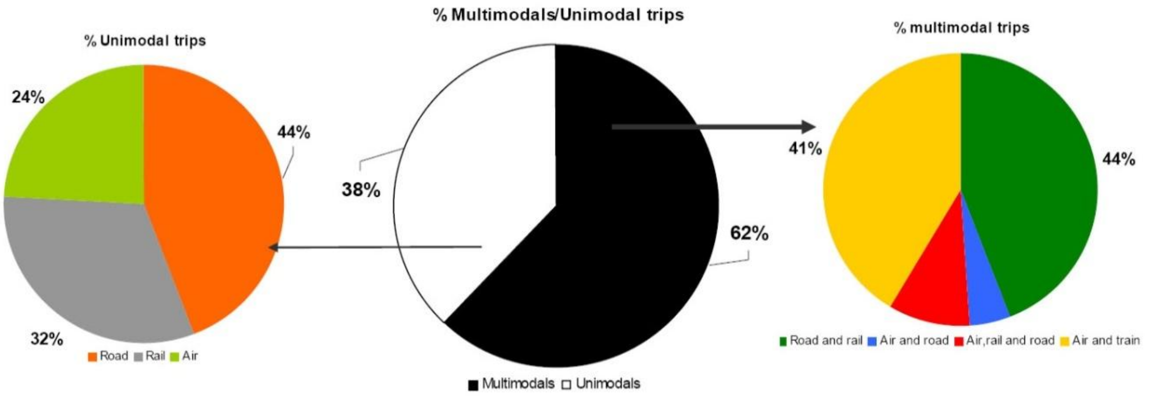
(source: INTERCONNECT multi-modal assignment, based on Transtools 2005 databases)

Figure 1-2 Multi-modality in long-distance travel around Europe (number of trips)

(in number of trips from Transtools 2005 between NUTS3 longer than 300 km, assigned on INTERCONNECT multi-modal graphs using an OAN algorithm and generalised costs as travel time by the shortest multi-modal path)

In terms of trips[2], more than one out of every two long-distance trips in the continent could be multi-modal (for trips over 300km long, not considering the modes used to access the long-distance transport networks, e.g. taxi to airport not computing as a road trip). For uni-modal trips, in the hypothesis applied, the air mode would represent 9% of total trips, while intermodal trips involving air journeys would involve almost 30% of the total number of trips. Intermodal interconnections in long-distance trips are often made in airports and rail stations with long-distance services, but increasingly also make use of local and regional transport networks.

[2] Trips from Transtools 2005 between NUTS3 longer than 300 km, assigned on INTERCONNECT multi-modal graphs using an OAN algorithm and generalised costs as travel time by the shortest multi-modal path



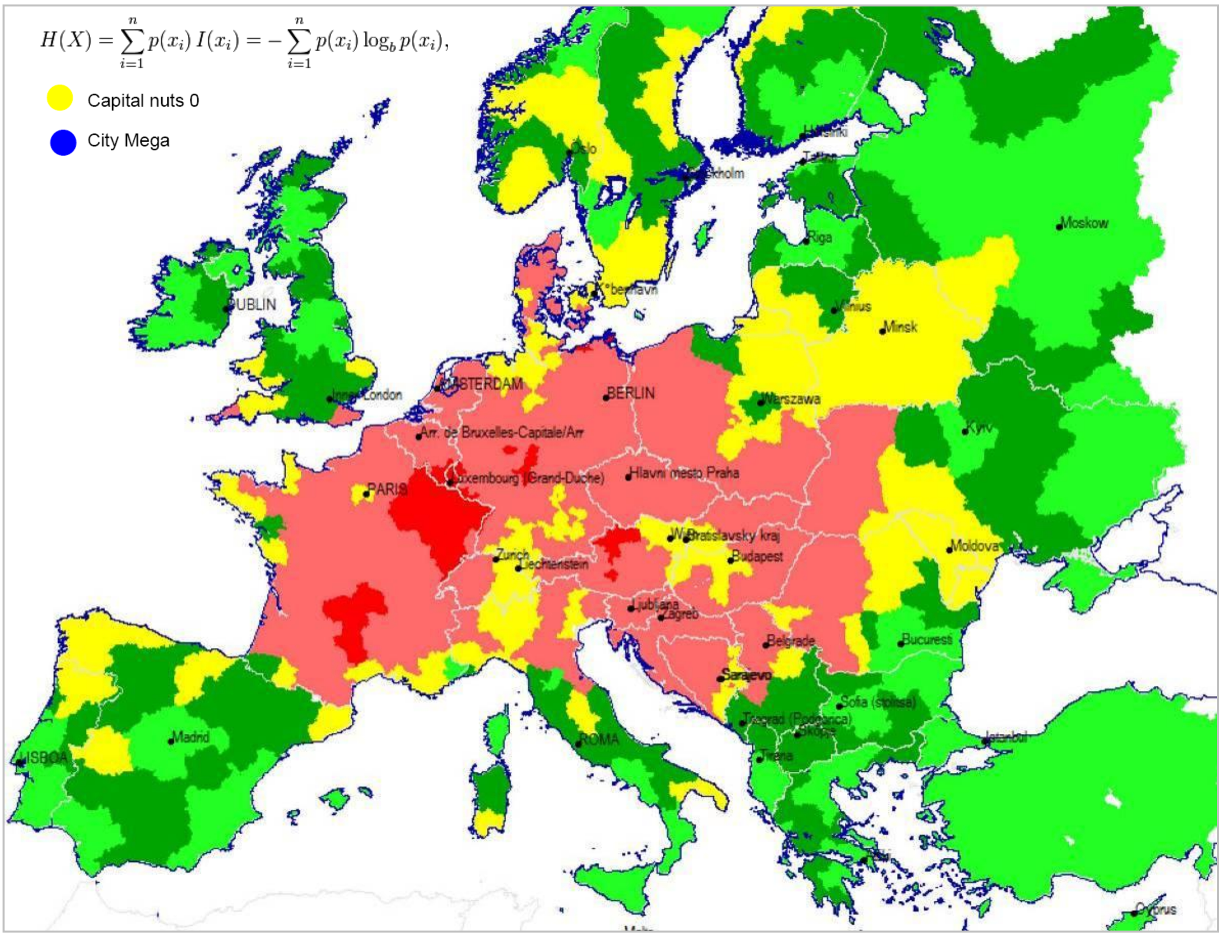
(source: INTERCONNECT multi-modal assignment, based on Transtools **2005** databases)

Figure 1-3 Multi-modality in long-distance travel around Europe (trips x km)

(in number of trips x km from Transtools 2005 between NUTS3 longer than 300 km, assigned on INTERCONNECT multi-modal graphs in a OAN. Generalised costs calculated as travel time)

In terms of trip x km, multi-modal trips in Europe would represent 62% of Europe's trip x km (in terms of veh x km, for trips over 300km long, not considering the modes used to access the long-distance transport networks). For uni-modal trips, in the hypothesis applied, the air mode would represent 24% of total trips x km (for only 9% of the trips, see Figure 1-4), while intermodal trips involving air journeys would represent almost 60% of total trip x km.

The map in Figure 1-4 shows the intensity of modal use in Europe. *In red, NUTS-3 using higher diversity of modes are displayed, while NUTS-3 using less modes are displayed in dark green.*



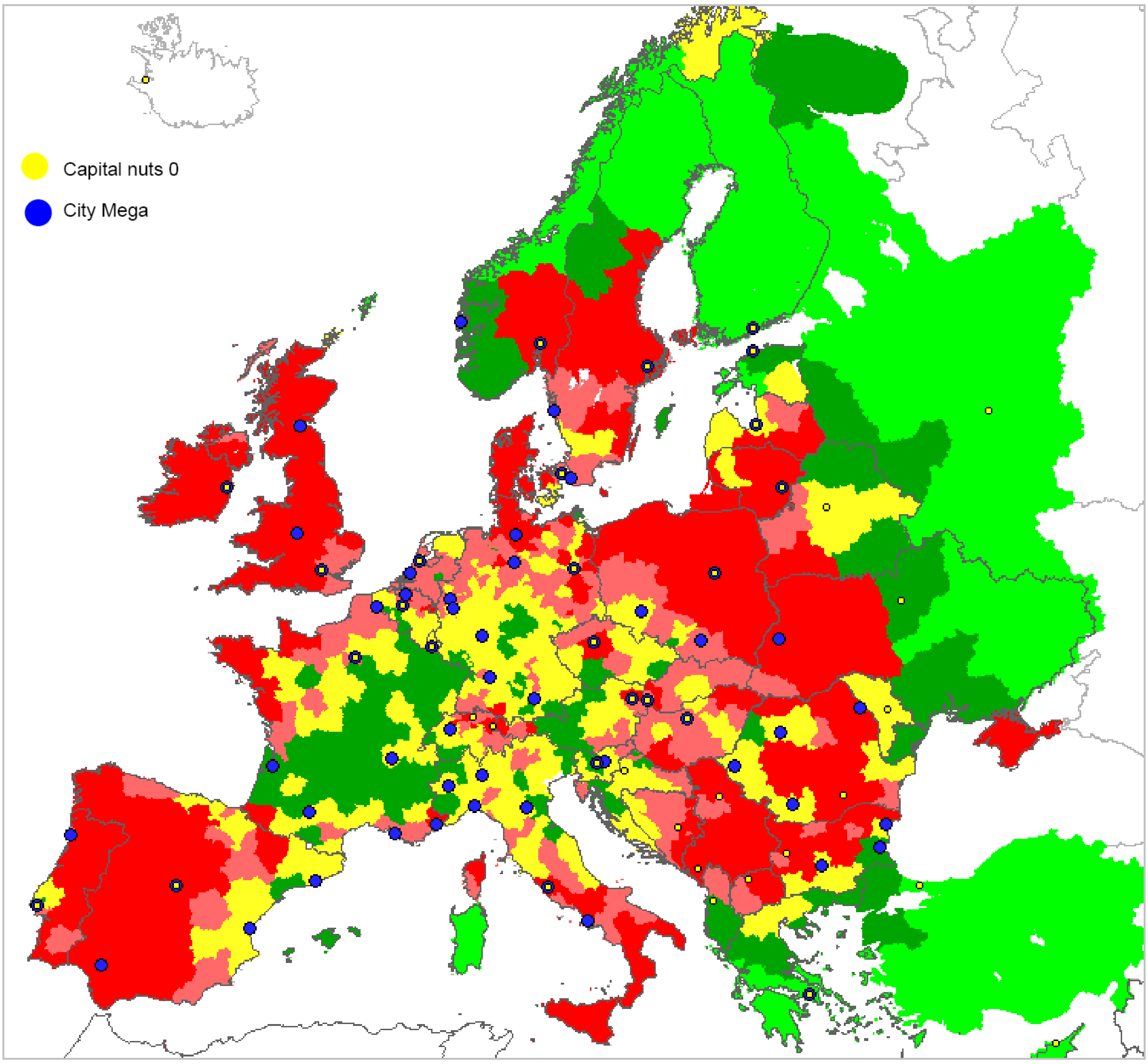
(source: INTERCONNECT, based on Transtools 2005 databases)

Figure 1-4 Intensity of modal use in Europe

(for each NUTS3, the total length of road, rail and air used to get access to all others NUTS3 are aggregated according to the Entropy formulation. All uni-modal and multi-modal trips are included)

Cities and regions in most central areas in Europe would use more diversity of modes in long-distance trips in order to minimise the travel time to all other European NUTS3, as there is a higher availability of alternative transport modal networks. NUTS3 with important long-distance transport hubs, like international airports and HSR stations, mostly corresponding to important urban agglomerations and city national capitals, tend to have relatively less multi-modal long-distance trips as many NUTS-3 relations can be served straight with one single mode.

Figure 1-5 reveals that trips originating from peripheral NUTS3 regions involve more interconnections than in core regions (e.g. airport to airport connections in core Europe regions).

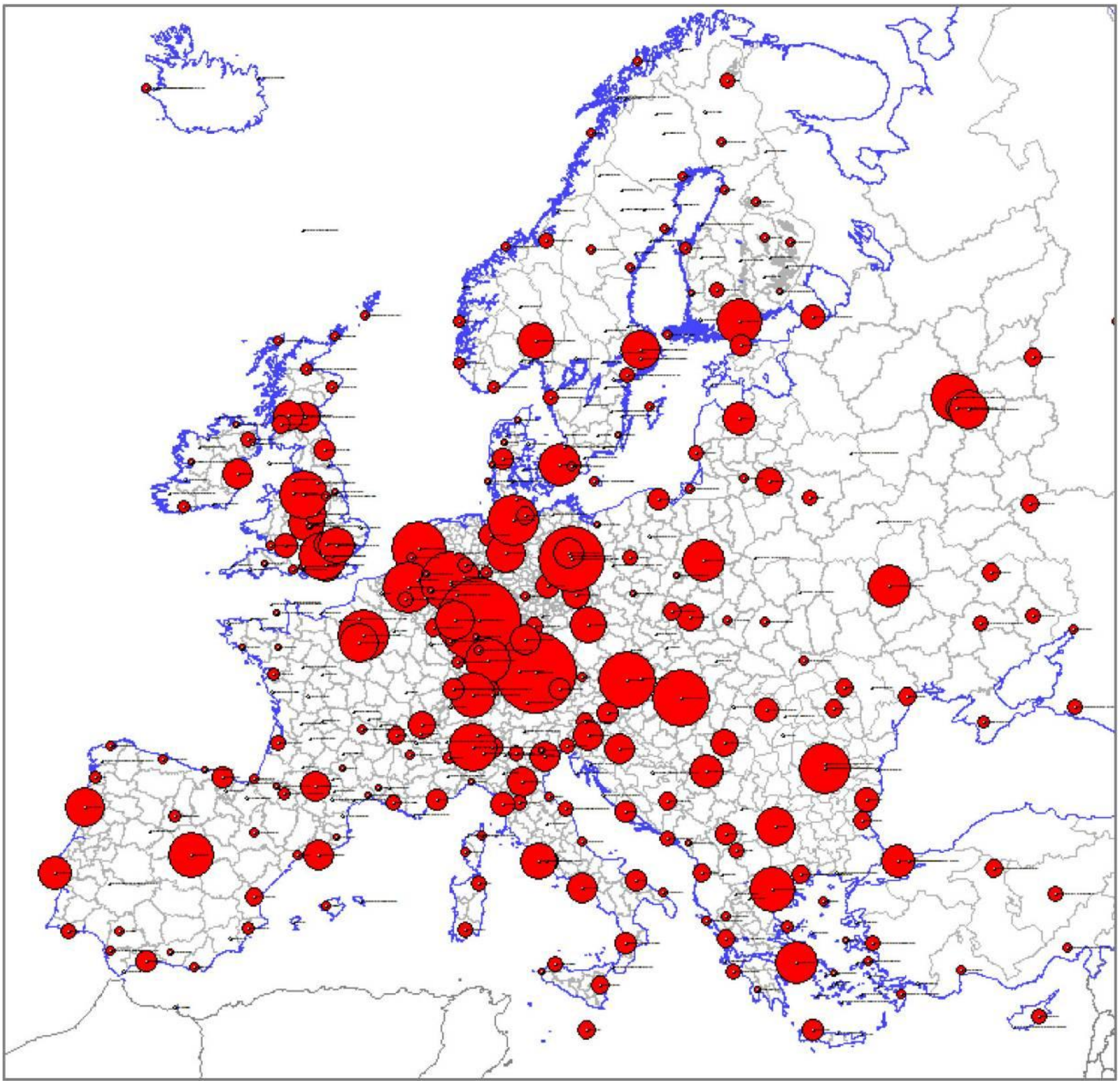


(source: INTERCONNECT, based on Transtools 2005 databases)

Figure 1-5 Intermodality in Europe

(for each NUT3 the number of modal shifts measured as the number of rail stations and airports to get access to all other European NUTS3 in minimum travel time, aggregated by the Entropy formulation. Changes in rail stations not considered. In red, NUTS-3 requiring more modal shifts are displayed, while NUTS-3 requiring less modal shifts are displayed in dark green. Large cities and national capitals also displayed)

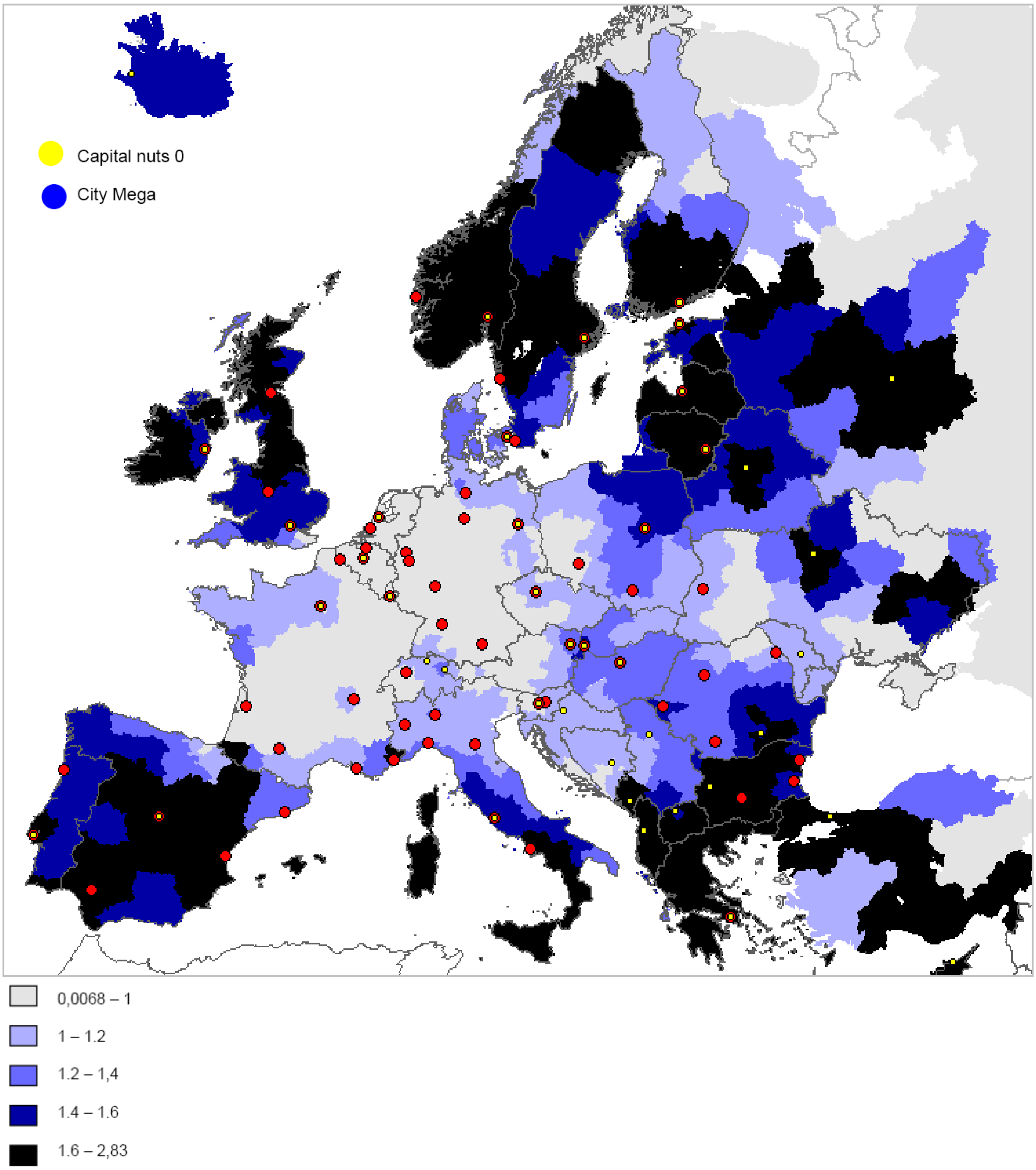
The following maps show that, while most interconnecting airports for NUTS3 travelling in Europe are located in the core of the continent (see Figure 1-6), NUTS3 having the highest amount of aviation in long-distance travel (e.g. involving more than one air service per trip) are located in the periphery of Europe (see Figure 1-7). The solutions of interconnectivity and intermodality in Europe involve complex network redistribution of costs and benefits not just between actors (regulators, infrastructure managers, service providers…) but also among territories.



(source: INTERCONNECT, based on Transtools 2005 databases)

Figure 1-6 Most used airports in Europe in NUTS3 pair to pair trip itineraries by short-path optimising criteria

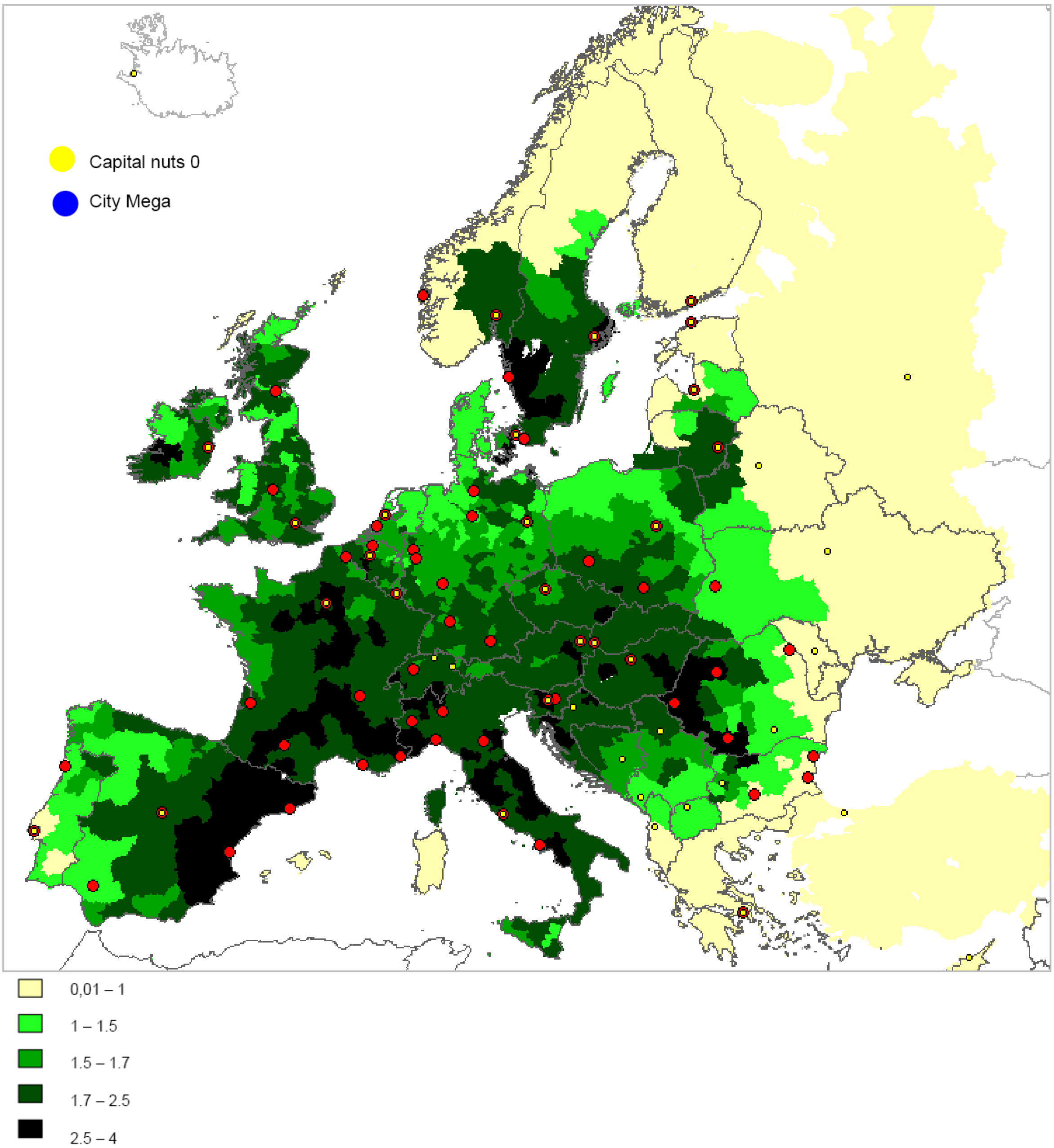
See below for interconnectivity maps for different modes reflecting the need of successive changes of mode or service in trips involving air or rail transport.



(source: INTERCONNECT, based on Transtools 2005 databases)

Figure 1-7 Air interconnectivity

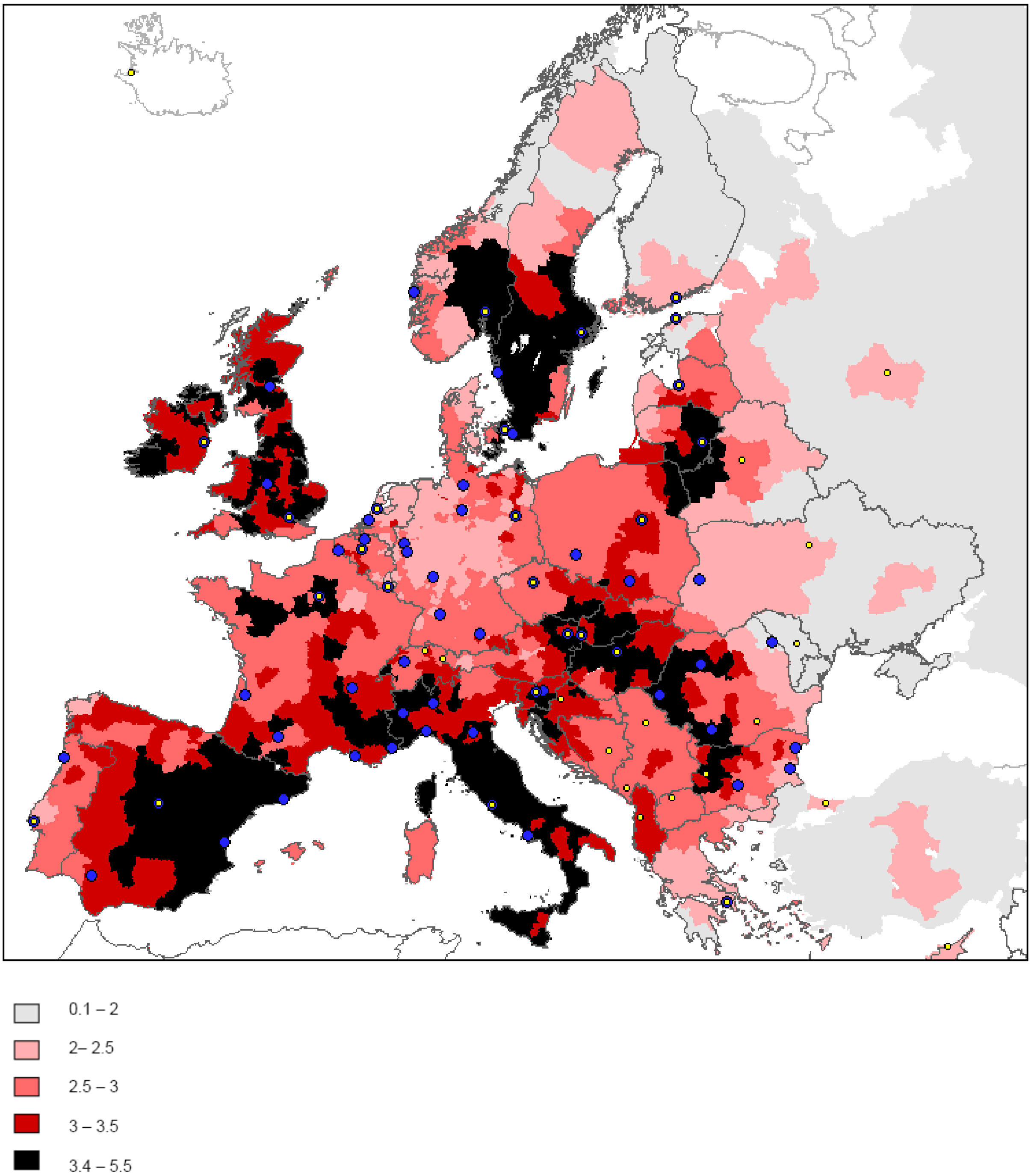
(Number of air links used from each NUTS3 to all others in Europe in minimum travel time paths, according to Transtools direct air services)



(source: INTERCONNECT, based on Transtools 2005 databases)

Figure 1-8 Rail interconnectivity

(Measures in number of times that the rail network is accessed in shortest time paths from each NUTS3 to all others in EU27. Changes in rail services are not considered since rail services are not available in Transtools)



(source: INTERCONNECT, based on Transtools 2005 databases)

Figure 1-9 Interconnectivity (rail and air)

(Number of times that the rail network is accessed plus number of airports used in shortest time paths from each NUTS3 to all others in EU27)

1.1.3 Technological and Organisational Innovation in European Transport Networks

In Europe there is a large variety of innovative interconnections, often making use of advanced technological and organisational solutions. The images below illustrate some of the most well-known possibilities:

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.

TramTrain systems combine tram lines in the city with railway lines in the surrounding countryside, combining an efficient of urban railway in city centres with suburban railways, overcoming the boundary between trams/light railways and heavy railways. It is both possible to make compatible tramway vehicles into the heavy rail network, like in Karlsruhe, or otherwise to allow heavy trains into tram networks like in Zwichau. The interconnection of rail and tram networks has brought important benefit to public transport usage in many German cities.

Toyota and its truck-making subsidiary Hino Motors have signed on with Japan Rail Hokkaido to develop this dual bus-rail vehicles, which carry 25 people and reportedly burn one-fourth the amount of diesel fuel required by conventional buses. Japan Rail started testing them about 18 months ago, and bringing Toyota aboard could speed up development and commercialisation of what may be the mass transit vehicle of the future.

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.

People movers or shuttle buses are intended to improve interconnections between different long-distance means of transport.

The SkyTrain in Düsseldorf enables passengers to transfer quickly and comfortably between the train station, long-term parking garages and the airport terminal building, allowing to transfer between air and rail modes in no more than five minutes despite the 2.5 km stretch to the terminal.

Low-cost carriers have developed different products to integrate access to city centre in their strategy. For instance, easyJet through easyBus service or Ryanair through agreements with several bus operators illustrate this trend. Public transport operators provide services whose schedules coincide with LCC's schedule. Agreements between operators include the on-board commercialisation of bus tickets. While LCC solve the eternally claimed problem related to distance to city centre in the airports where they operate, the bus company benefits from an important niche of captive demand.

Figure 1-10 Examples of various kinds of interconnection in Europe, related to different kinds of technology

1.2 A CASE STUDY APPROACH

In order to further investigate questions of interconnectivity there is an obvious need to follow a case-study approach.

A first operational list of candidates for case studies was already included in the *Description of Work* (DoW), but it was task T4.1 which confirmed a final list, according to a proposed set of criteria which was based on the findings of WP2. In order to select, among all possibilities, the specific case studies to be investigated in INTERCONNECT, a total of 50 criteria were defined in the pre-selection process, reduced later to 36 criteria which were assigned to the three groups: 10 general criteria, 23 descriptive criteria and 3 technical criteria. The criteria of selection for case studies were meant to be applied on a basic list of 80 case studies, which in principal qualified to be considered within the INTERCONNECT project, as they dealt with relevant aspects of intermodality.

According to the INTERCONNECT project's DoW, the final list of case studies should include at least 12 cases to be considered in the workpackages 4.2 (*Identification of Problems and Good Practice*) and 4.3 (*Applicability of Potential Solutions*). The selection process was based on maximising ranking of case studies according to the 50 criteria, while assuring coverage of all INTERCONNECT topics (overall and in-depth) and all modes of transport. The cases listed had to ensure they:

- have been drawn so as to achieve a wide coverage across Europe, so that the final sample will allow for a comprehensive analysis;
- show solutions ranging from urban transport over regional to long distance transport, whereby interchanges within a mode of transport as well as between modes have to be considered; and
- do not overlap with the case studies carried out in the HERMES project.

There are four groups to which the case studies belong, namely to airports, train connections, ferry terminals and to other case studies where several modes carry similar weights. In respect to origin and destination of a trip, switching from individual transport to regional or high speed trains as well as from public transport to air transport has been covered.

The list of chosen case studies is shown in Table 1-1 and Figure 1-11 below:

Table 1-1 Selected case studies for the INTERCONNECT project

Name of Case Study	# Topics	# Topics in depth	Thematic Group	Modes	Countries
Frankfurt airport interconnections (1)	9	3	1	Rail, Air, Bus	DE
Catalan airport system interconnections (2)	9	0	1	Rail, Air, Tram, Bus	ES
Milanese airport system interconnections (3)	7	1	1	Rail, Road, Air	IT
Scottish airport system interconnections (4)	6	2	1	Rail, Air, Bus	UK
Leeds railway station (5)	11	1	2	Rail, Tram, Metro, Bus	Various
Milan railways Node (6)	10	1	2	Rail, Metro, Tram, Bus, Air	IT
The dual-mode railway system: the Karlsruhe model (7)	13	2	2	Rail, Tram, Bus	DE
Train-Taxi and feeder bus services (8)	6	0	1	Rail, Taxi (road)	UK
Amsterdam ferry services (9)	6	1	4	Rail, Tram, Bus, Ferry	NL
Lisbon ferry services (10)	8	0	3	Ferry, Rail, Metro, Tram, Bus	PT
Ferry terminal of Helsingborg (11)	6	1	3	Ferry, rail, bus	DK, SE
Ferry terminal of Rostock (12)	6	1	3	Ferry, rail, bus	DK, DE
Tri-city: Gdansk / Sopot / Gdynia transport networks' interconnectivity (13)	9	0	4	Ferry, rail, tram, bus, air	PL

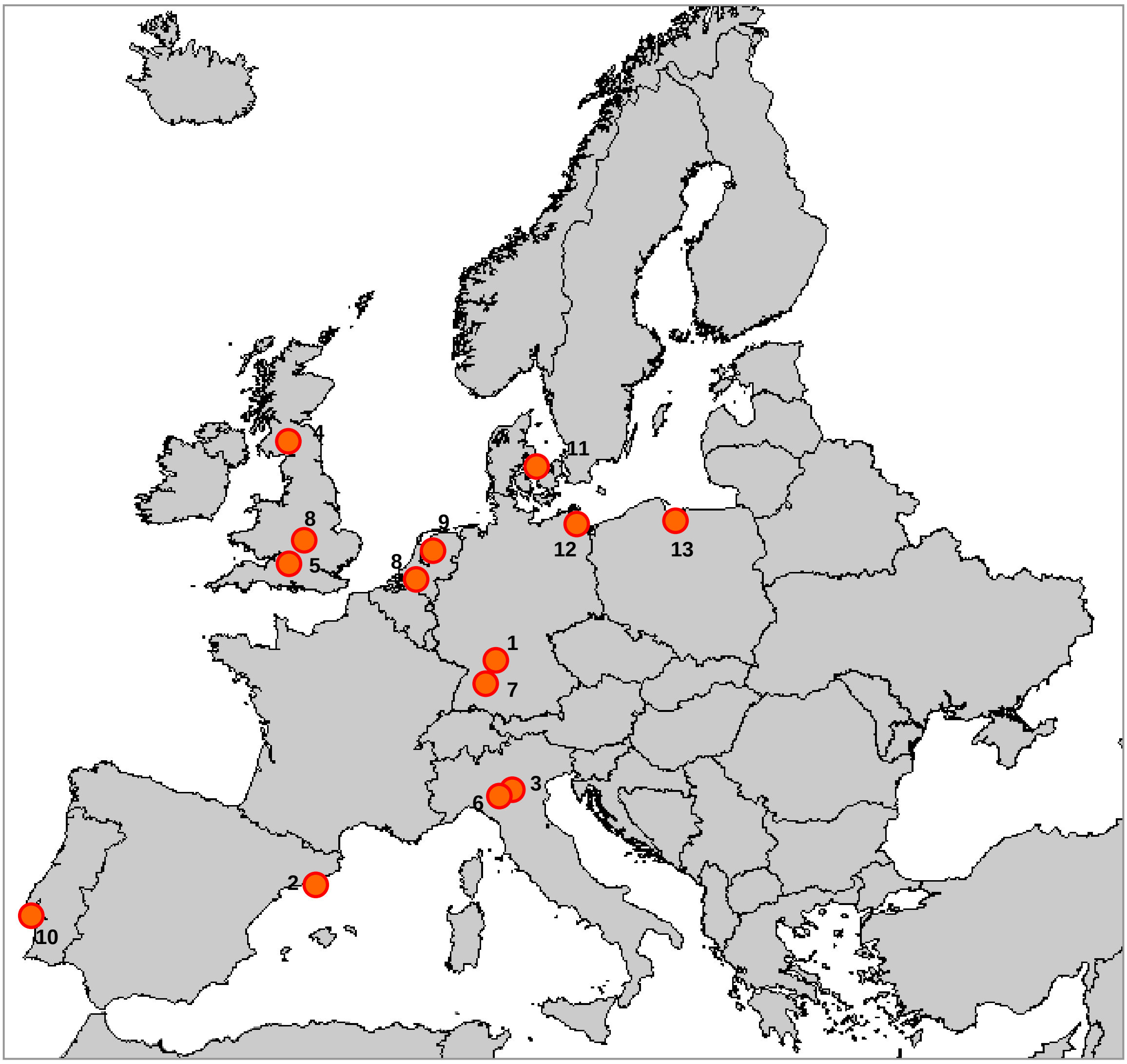


Figure 1-11 Geographic location of case studies in Europe

Task 4.2, culminating in this deliverable, has gone through the 12 selected case studies identifying problems and good practice as can be found in the real world today. This task has: :

- collected evidence on the nature of problems of poor connectivity, e.g. precarious access to long-distance terminals, poor quality of interchanges, lack of information
- investigated the causes of these problems, e.g. high investment requirements, scarcity of funds, multiplicity of stakeholders, low demand levels
- identified solutions which have been put forward, e.g. stakeholder co-operation, infrastructure optimisation or upgrading, multi-modal terminal
- described the degree of success so far achieved ,e.g. increased traffic figures, increased public transport mode share

The criteria used to determine the quality of the interconnections investigated correspond to those defined in WP3 as "criteria of success", refined later within the methodological work in T4.1, and under consideration of the results found within KITE, to include the assessment on how far they contribute to

- Decongesting overcrowded transport corridors,
- Encouraging the shift towards the more sustainable transport modes, and
- Reduction of GHG emissions

Table 1-2 shows the "criteria of success" defined in order to assess solutions for good interconnectivity in order to detect elements of good practice and problems still to be solved.

Table 1-2 "Criteria of success" to detect elements of good practice

Type of Criteria	Criteria of success
Monetary	Cost of the solution
Feasibility	Technical feasibility
	Financial feasibility
	Organisational feasibility
	Acceptance by users
	Political acceptability
Impacts on users	Door to door travel time
	Door to door travel cost
	Comfort and convenience
	Improved safety
	Increased personal security
	Incidence on access for low income users
	Incidence on access for disabled users
Impacts on non-users (users of other modes, territory, environment)	Increased regional prestige
	Decongesting overcrowded transport corridors
	Encouraging the shift towards the more sustainable transport modes
	Reduction of GHG emissions

The major steps within task 4.2, which now concludes in this report, have been the following:

- **Structuring of types of results expected from case studies**. "Criteria of success" has been set at the core of the discussion to lead the case studies' analysis towards a common set of results. For the execution of the case studies, a common method has been used but still with enough flexibility to cope with specifics.
- **Development of a framework for presentation of case study results.** A common structure was agreed for each case study to provide consistency and coherence in narratives and to allow for comparison between different cases.
- **Conduct of case studies.** Case studies have integrated a wide range of tasks, among which are: literature reviewing; revision of local, regional and national planning documents to identify

implemented or foreseen solutions; data acquisition and analysis (traffic figures, surveys…); interviews with relevant stakeholder and decision makers; discussion of available materials.

- **Analysis of case study results**. Each case study has provided concluding remarks about the performance of implemented solutions, learned lessons and analysis of transferability of findings.
- **Preparation of deliverable**

In task T4.3, a subset of five case studies out of the selected 12 case studies will be used as 'test beds' for simulations, in order to investigate the applicability of solutions found in WP3 - either from case studies or from theoretical considerations - in a new environment. This study will be performed in milestone M4.5, and is therefore not included in D4.1. The selected test beds are listed below:

- Frankfurt airport interconnections applied to the airport of Stuttgart
- Scottish airport system interconnections: Edinburgh, Glasgow and Prestwick
- Milan railways node
- Catalan airport system interconnections: Barcelona, Girona, Reus and Lleida
- The Intermodal platform in the Delta del Llobregat

KITE deliverable D10 (*A knowledge base for intermodal passenger travel in Europe. General methodological framework*) has particularly been taken into account in the context of this workpackage, while task 4.1 has co-operated with the HERMES project; in particular, the two projects have endeavoured to establish a common set of definitions for "good practice".

1.3 CASE STUDY PORTRAITS

The ***Frankfurt airport interconnections*** case study analyses the state of land interconnections at Frankfurt airport, how the airport is interconnected with urban, regional and long distance rail services and with the road network. It especially deals with the fact that besides the rich interconnection with the highway network, the incorporation of the airport into the high speed railway system has been a big step forward to increase the intermodality at the airport, together with the co-operation between air and rail operators for through ticketing, thus constituting an element of good practice. This case study argues that the improvement of the rail-airport interconnection and operator co-operation has resulted in substantial rail demand in the airport, allowing liberation of slots from no longer necessary feeder flights to be used for other long-haul flights, therefore improving transport co-modality. This case study will be used in T4.3 as an in depth 'test-bed' analysis to check for transferability of findings from Frankfurt to Stuttgart airport.

The ***Catalan airport system interconnections: Barcelona, Girona, Reus and Lleida*** case study discusses the interconnections of Reus, Barcelona, Girona and Lleida airports with regional transport networks and also with their corresponding city centres. All airports are located within 200 km of each other, and the new HSR line will pass within reach of all of them. The interconnection of airports to the HSR is intended to create a network of specialised airports, with small airports being able to provide the capacity that Barcelona will lack sooner or later. But the interest and feasibility of these rail connections have always been under debate and now they are just partially achieved. This case study concludes that it is difficult to plan optimal solutions in a multiple stakeholder framework and a highly populated territory. It has also pointed to the fact that designing optimal interconnections requires ad-hoc solutions for choosing best transport modes in each case. Territorial impacts beyond optimisation of travel times and travel costs are to be taken into account in long-term impact appraisal. This case study will be the object of two different 'test beds' in T4.3.

The ***Milanese airport system interconnections: Malpensa, Linate and Orio al Serio*** case study looks at the condition of interconnectivity in the airports of Malpensa, Linate and the low-cost airport of Orio al Serio. All are located around Milan within a radius of 60 km, at the core of the densely populated Lombardy region. Following the trends all around Europe, the passenger traffic of these airports has been growing during the last years, especially in Orio al Serio which has become the main Ryanair hub in Italy and has climbed to the fourth position of Italy's busiest airports in 2009. The case study analyses the typology of air traffic in the airports, their connection with Milan and the rest of the region, their connection airport to airport, and their link with the long distance national network. The case study concludes that the lack of adequate planning has resulted in poor interconnections in the Milan area, with long-distance rail network connection missing in Malpensa, an absence of reserved road infrastructure for public transport even when accesses to airports in Milan is congested, or missing passenger facilities at terminals that would increase interconnection quality. Most worryingly, the completion of planned infrastructures is affected by great uncertainty.

The ***Scottish airport system interconnections: Edinburgh, Glasgow and Prestwick*** case study analyses the issues concerning the competition between the three Scottish airports, and more crucially, the connections between them, their connections with the conurbations of the so called "Central Belt" around Glasgow and Edinburgh where the majority of Scotland's 5 million inhabitants live, and the large but sparsely populated 'rest of Scotland'. Although Scotland comprises a land area of nearly 80,000 km^2, Glasgow and Edinburgh airports are only 67 km apart from each other, and Prestwick, a third major airport, is just 41 km to the south-west of Glasgow. Glasgow and Edinburgh cater for all types of flight operators, while Prestwick focuses on low-cost airlines and holiday tour operators. Out of these three airports only Prestwick has a direct rail connection, and the three are only interconnected by very busy motorways. The case study concludes that even if infrastructure costs are not likely to be recovered rail services serving airports may be profitable, while bus services can attract large patronage. It will also note that intermodal ticketing strategies help attract users to public transport in airport to city trips. Following this case study, a specific 'test-bed' analysis will deal with the key question of how far an efficient high-speed land connection between these airports could reduce the total number of take-offs and landings there by bundling connections from in-coming long and mid-distance flights and flights from the many small airports scattered around Scotland for which there is little chance to replace them by efficient over-land services.

The ***Leeds railway station*** case study deals with the interconnectivity of rail in one of Britain's most significant railway stations, which in the past decade has seen a number of enhancements designed to, or having the effect of, enhancing interconnectivity via the improvement of access and egress. The rail reforms of the past 15 years have, throughout Europe, dismantled barriers to new entry of operators into local, regional and national rail markets in order to promote competition and a more vibrant rail industry. In most cases there are now more – sometimes considerably more - actors involved in the planning, development and operation of rail services than ever before. Through the analysis of the case of Leeds, this case study will focus on the interface between national, regional and local rail networks within this framework of increased competition and fragmentation of the industry, a process which has brought new opportunities in terms of competitiveness and innovation, and challenges particularly in relation to the maintenance of an interconnected network of rail services for passengers. The case study concludes that while passenger figures grew at Leeds rail station over the last 10 years, there is a lack of evidence that the observed growth is related to the enhancements undertaken at the station, while it is not clear whether or not competition promotes interconnectivity or detracts from it.

The ***Milan railways node*** case study analyses the current level of interconnectivity of rail networks in Milan and the existing plans concerning future connections with the new high speed rail services, providing useful elements concerning good and bad practice from several points of views, in particular with the issues regarding interconnection at stations, accessibility of stations, services for the airports and integration of fares***.*** Milan is a key node of the rail network in northern Italy, linking long distance routes to the regional network (operated by two separate companies on two independent infrastructures), to the local transit system of the main business metropolitan area in Italy and, in principle, also to the Milan airports. Continuous efforts have been made for improving the interconnections with local public transport as well as with the underground network, so that the main rail stations are currently reachable by at least one metro line and by bus or tramway. On the other hand, the lack of harmonisation between the services of the multiple providers, a minimum-stage ticketing integration and the lack of user information and scarcity of facilities to reduce transfer times at interchange points leaves room for improvement in the future. The issues discussed in this case study will be further developed in a specific 'test bed' in task T4.3.

The ***dual-mode railway system: the Karlsruhe model*** case study analyses the solutions of interconnectivity established in Karlsruhe concerning the urban tram system and its integration on the suburban railway network, constituting a case of good practice in interconnectivity. Karlsruhe trams run on the urban light rail system and on the heavy rail tracks of the German Railways, allowing for tramway and suburban rail networks to operate together with relatively moderate investment requirements. In addition to the technical aspects concerning the tracks and the vehicles, this case study analyses the advantages, limitations and shortages of the model, concluding that it fits mostly in medium-sized urban areas with non-centrally located rail stations, resulting in important growths of passenger figures - including substantial catchment from private modes- and providing excellent cost-benefit ratios and helping relieve deficits of public transport.

The ***train-taxi and feeder bus services*** case study focuses on different concepts developed in the attempt to encourage travellers to take the train instead of the car in long distance and inter-regional journeys, by providing information and services that would help these travellers to overcome a key barrier, the "final few miles" corresponding to access and egress to and from train stations. The UK train-taxi (T-T) service provides online information about taxi services serving the UK's rail, tram and underground stations, while the Dutch T-T version provides discounts on the costs of taxi travel if journeys are shared both to and from the train station. More recently, Plusbus in the UK offers an optional ticketing add-on when purchasing a train ticket, which allows a train traveller unlimited travel on the buses serving both the origin and destination urban area on the day of travel. This case study concludes that while relatively inexpensive services to operate such as UK's T-T and Plusbus have been successful in the past, high costs have made Dutch T-T system difficult to sustain, resulting in a 65% offer reduction in the last 15 years. Large scale network coverage is usually beneficial for these schemes to be functional and attractive to customers.

The ***Amsterdam ferry services*** case study focuses on the efforts that are being made in the Netherlands to increase the interoperability of different transport services and to co-ordinate and synchronise tariff and ticket systems. The geographic location of Amsterdam has traditionally allowed the development of waterborne and land transport in parallel, creating a high level of accessibility, but resulting also in a significant number of different operators. A mobility card has been introduced allowing seamless transfer between modes to overcome barriers to interconnection, and provides at the same time new technological possibilities to assess and manage mobility. The top-down approach in the process of transport integration, which has been driven from a national perspective so as to integrate all public transport within the Netherlands, has resulted in the need for a synchronisation between large numbers of parties, but there seems to be a high notion of co-operation between these parties towards a single goal. This case study concludes that ticketing in Amsterdam is moving from a modal or operator led approach towards a "mobility" approach, but it also will question who is the overall beneficiary of the new system, even when integration and interconnection between operators bears the potential to increase services and to expand the reach of the transport network, pointing out that emphasis should be placed on the analysis of user benefits of current developments.

The ***Lisbon ferry services*** case study aims at exploring the driving forces that have maintained the ferry services in the Tagus river, even after the construction of bridges which brought significant competition from road and rail traffic. Lisbon has an intensive network of ferry services across the river, despite the imposing Ponte 25 de Abril bridge which links the two sides of the city and carries both rail and road traffic. Even a car ferry service has survived the arrival of the bridge, unusual in such circumstances. The case study identifies diverse elements of good practice which can help explain the survival of ferries, among them the co-operation (and finally merging) of the two operating ferry companies, the improvement of terminals for easier interconnection to other means of transport, the investment in boat renewal which has resulted in decreased travel times, and the introduction of smart cards to overcome a complex fare system.

The ***ferry terminal of Helsingborg*** case study focuses on the strategies which have made the ferry services between Helsingborg and Elsinore a competitive means of transport, even after the construction of the Øresund bridge. 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, located right at the port, facilitating direct and rapid interchange between the ferries and all modes of public transportation. The terminal incorporates two former train stations, the central bus station and the ferry terminal, and currently serves local, regional and national trains and buses to and from Helsingborg, and boat services to Elsinore. This case study concludes that the project was only possible due to intense institutional co-operation and understanding, and identifies additional elements of good practice such as the driving concept of terminals which has forced designs specifically targeted to easy interconnectivity, and the co-operation of ferry operators to take account of each other's timetables and increase service quality.

The ***ferry terminal of Rostock*** case study analyses the case of Rostock as an example of a harbour where interconnectivity of transport networks for non-motorised passengers has for a long time been disregarded as the majority of passengers travel by car or bus. This case study argues that the little investments made to improve conditions for the non-motorised segment in the terminal have led to decline and poor conditions of access to and egress from the terminal. The case study explores solutions that have been more recently implemented or which are being planned for the future to improve this situation. A shuttle bus link connecting the passenger terminal with the city centre and the rail station is planned, saving non-motorised passengers at least 20 minutes of travelling and waiting time. The shuttle will run during a trial period from May 2011 until December 2011. A joint ticketing scheme will be in place with one ticket valid for both the ferry and the buses on both shores.

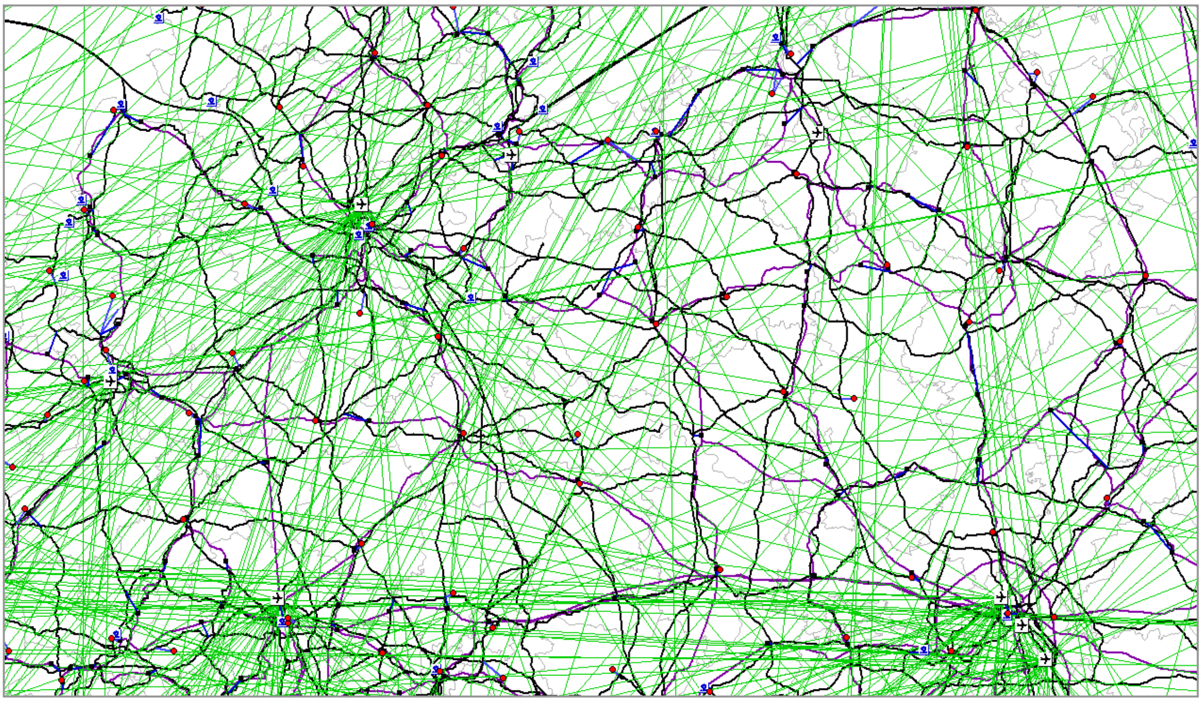
The ***Tri-City: Gdansk / Sopot / Gdynia*** case study focuses on the discussion of the many interconnectivity challenges that the Tri-City region is facing in the next years, identifying potential solutions already envisaged. The analysis involves several transport networks in this dense Polish urban agglomeration. The Tri-City and its metropolitan area concentrate 55% of the region's population; two Pan-European transport corridors run through the region and although there are two major seaports in Gdansk and Gdynia, ferry links are not very well developed and many direct connections were abandoned during the economic transformation. Lech Walesa airport operates domestic connections to Warsaw and direct international links to European airports served by 13 airlines; a new terminal and airside constructions are underway and fixed rail link to the airport is planned. Urban public transport requires improvement to increase efficiency, as do the rail and the road networks. The case study shows that interconnectivity is a priority for local and central administrations, having a clear vision that there is a need to improve services to increase regional attractiveness, and will identify financial requirements as being the most important barrier to improvement, with rivalries between the two major cities of Gdansk and Gdynia also a barrier.

1.4 FOLLOWING UP CASE STUDIES: WP4 INPUTS FOR WP5

Later in INTERCONNECT WP5 will build on the in-depth analysis carried out in the WP4 case studies. WP5 will study the possibility of transferring these outcomes at the European scale. The point of view of the European Union will be then be assumed for reviewing what has been developed in the different local contexts examined by the case studies. One of the goals of WP5 will be the integration of precise but dispersed knowledge that has been gathered through the case studies in a systematic way - quantitative whenever feasible - to assess the impact of improving key local and modal interconnections at European level.

Task 5.2 in WP5 will e based on a graph of transport networks in Europe, including road, rail, air and ferry networks, for which simulations will be performed to observe the impacts of interconnectivity improvements. Lessons learned from case-studies in WP4 will allow the work of WP5 to state a set of hypotheses as departing points for European wide simulation.

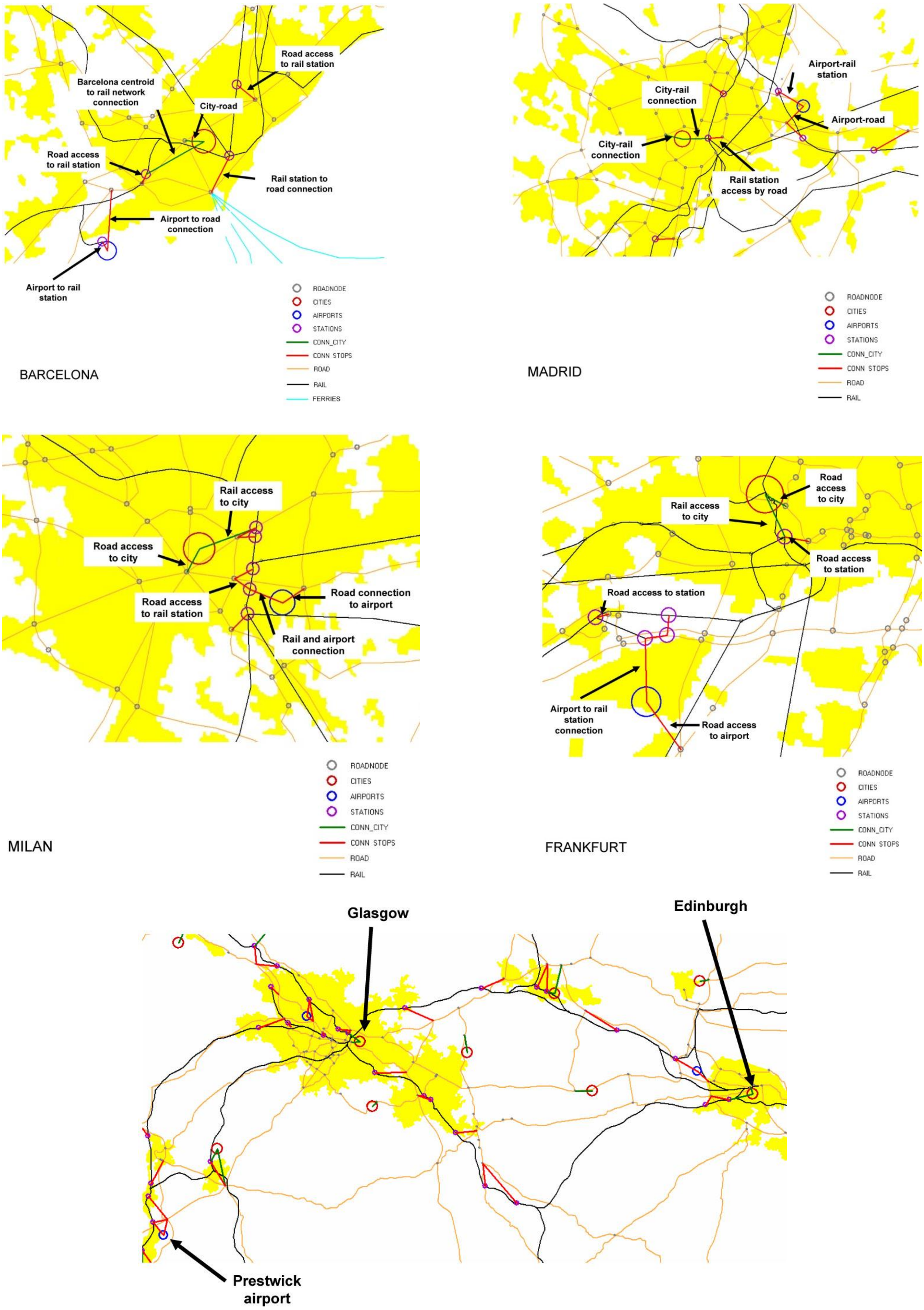
Figure 1-12 is a representation of the graph to be used for this purpose. The many networks are linked to each other in nodes representing transport terminals, such as airports, rail stations and ferry terminals. NUTS3 centroids are also connected to these networks through these terminals.



(source: INTERCONNECT 2010)

Figure 1-12 Graph of transport networks in Europe (road, rail, air)

A closer zoom to the graph around urban areas allows a better view of this structure. Segments linking rail stations to airports represent access to airports by train (either long-distance or local trains depending on which segments are being considered). These links contain information on travel-time length, a parameter which considers the Euclidean length of the segment plus other penalties to be imposed such as transit walking time or check-in time requirements. The mesostudy of these interconnections is to be introduced through hypothesis into the connectors and checked in the European graph to study resulting potential impacts.



(source: INTERCONNECT 2010)

Figure 1-13 Zoom of European transport graph in Barcelona, Madrid, Milan, Frankfurt and Scotland showing interconnection of networks (road, rail, air)