WORLDNET Final Report (D11)

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Coordinator: NEA
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Acronym: WORLDNET

SIXTH FRAMEWORK PROGRAMME

European transport network model refinement regarding freight and intermodal transport to and from the rest of the world

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NEA, DEMIS, IWW, MKMETRIC, OSC, TINA Vienna

Sixth Framework Programme

European Network transport model refinement regarding freight and intermodal transport to and from the rest of the world

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1 Introduction

WORLDNET – Worldwide Cargo Flows – is a research project funded by the European Commission (DG-TREN), within the Sixth Framework programme. WORLDNET sets out to extend and refine the European Commission's freight transport policy knowledge base, focusing on improving the representation of medium and long distance flows, the multimodal aspects, and the relationships between trade and the development of trans-national corridors.

WORLDNET's subject matter relates to the context of an enlarging European Union, and the need to broaden policy perspectives to incorporate a better understanding of the relationship and dependencies between Europe, the global economy, and the global impacts of trade.

Key outputs are an extended freight origin-destination database, extended road and rail networks, new maritime and air-cargo networks, and a web tool for accessing the information. The outputs have been published IPR-free and developed according to TRANSTOOLS specifications.

DG-TREN's mission statement states:

> "*While transport and energy issues are becoming increasingly global, only resolute coordinated action by Europe can avert the risks in terms of security of supply and* ***promote worldwide action based on cooperation and interdependence***" (emphasis added).

WORLDNET has attempted to contribute to this objective by reorienting questions of transport planning and transport research towards an analysis of their global influences through the initiation of communication, data sharing and debate with non-European experts.

Through co-operation it is hoped that these inter-dependencies can be further explored and problems resolved.

2 Executive Summary

2.1 WORLDNET Objectives

Transport analysis frequently begins with a compromise; the definition of a geographically defined study area. Within this demarcation great detail in terms of transport flows, network interactions, and market mechanisms, is sought. Beyond these boundaries, information is less well elaborated. It is aggregated, crudely estimated or even omitted. However, in the transport industry, and particularly the aviation and shipping sectors it is evident that a more global perspective is taken. The idea of global economic interdependence has been further underlined by the upheaval in the Western financial markets during the second half of 2008.

European models such as TRANSTOOLS have promoted the concept of wide area transport analysis, taking on a Continental scale. This research has focused attention upon the freight traffic flows taking place across the EU borders, and identified a data gap. WORLDNET attempts to fill this gap and to foster a more complete set of generic resources which can be applied in future large scale model versions. As such it aims to link the processes that are associated with globalisation directly to transport policy implications.

The specific objectives of WORLDNET were:

- a more precise representation of the **freight flows** between European countries and the Rest of the World.

- an **extended network model** to other world regions, to facilitate the direct use and uptake for the countries/regions involved.

- **active participation from non-EU countries** and international organisations requiring a consistent, quantitative baseline for technological, environmental and economic trends, within the transport and energy sectors.

DG-TREN expects WORLDNET to enhance TRANSTOOLS as a support for policy making and infrastructure decisions, in terms of:

- Data
- Forecasting
- Representation of sea and air transport
- Extension to the rest of the world
- Ability to assess wider policy issues
- Sharing of information on policy, trade, transport, trends between EU and other world regions.

2.2 WORLDNET Organisation and Content

WORLDNET has undertaken this work by combining the technical objectives of database construction with a communication strategy, focusing upon the identification of non-EU contacts. A two-way dialogue has been initiated, culminating in the development of a web-based knowledge base through which information can be collected and shared.

Figure 1: Project Highlights

- 3 Seminars in 2008
  - Istanbul
  - Beijing
  - Buenos Aires
- Network Model
- Database of Cargo Flows
- Updating TRANSTOOLS
- Knowledge Base

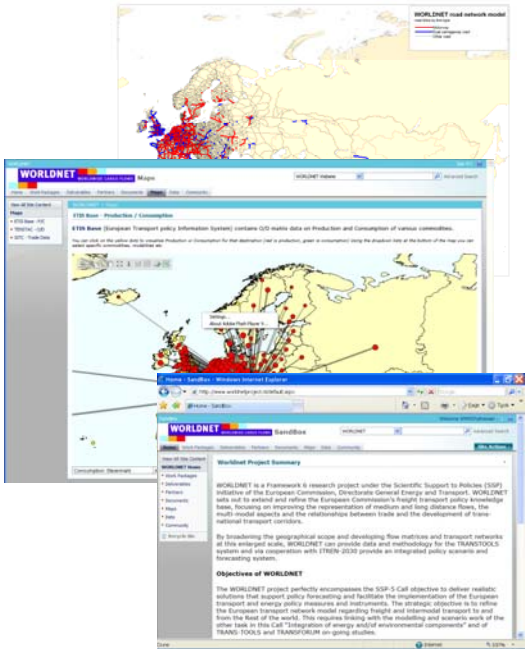


Table 1 WORLDNET Content

Objective	*Result Summary*
1. Communication Strategy	Three seminars were held in Istanbul, Beijing and Buenos Aires to initiate dialogue on mutual policy issues, to collect and share information, and to create the basis for future co-operation.
2. Freight Origin Destination Matrix	The freight OD database initiated by ETIS, and used within TRANSTOOLS was updated, extended geographically, with enhancements for the maritime and aviation sectors. The updating methodology was improved to allow future updates to be made more easily. Versions of this network have been used within TEN-Connect and iTREN 2030.
3. Extended Transport Network	Extensions have been developed for the road and rail network models developed originally by ETIS, and later by TRANSTOOLS and TEN-Connect. The delivered network includes all the updates made by those projects.
4. Integration with TRANSTOOLS	Data structures, and conventions such as the classification of zones and products have been designed according to the TRANSTOOLS specification. This allows the main results to be directly integrated.
5. Intermodal Impedances	A full set of transport impedances has been calculated for road, rail, inland waterway, air and sea transport, allowing all modes to be modelled in future versions of TRANSTOOLS.
6. Knowledge Base	An IPR-free knowledge base has been developed providing access to project results. Networks can be edited online, and in parallel, by the WORLDNET community. Tabular data can be queried using a simple web-based interface.
7. Dissemination	Usage of results is promoted through the development of a WORLDNET community, multi-lingual news-letters, focusing upon the collection and sharing of data via the website. See http://www.worldnetproject.eu.

2.3 WORLDNET Key Results and Conclusions

Communication

- Organising seminars in non-EU countries was challenging but ultimately successful. Without such a direct approach it would not have been possible to bring WORLDNET to the attention of the target organisations outside the EU.
- From the point of view of content, the seminars were strongly influenced by the choice of host countries. Particular effort was required to attract participants from organisations located outside the host countries.
- Although the objectives of the three seminars were broadly similar, the outcomes were distinctive, influenced by the need to focus on certain transport modes, and also by the proximity to the EU border.
- Certain key countries and regions were not well represented, including Russia, North Africa and the Middle East.
- Ultimately the seminar programme helped to raise awareness concerning bilateral transport policy issues, and to establish the basis for future co-operation.
- In future, European data and models need to be regularly maintained with respect to global developments, due to the pace of change.
- The WORLDNET consortium expresses gratitude for the valuable contributions made by the seminar participants.

Inland Freight

- Re-estimating the 2000 ETIS freight matrix is a major task that was not attempted within the TRANSTOOLS project.
- The methodology has been adapted so that it relies more upon multi-country data sources that are regularly updated, and upon flexible estimation processes that can be more easily automated.
- Estimation takes place within a typical four-step framework, using traffic assignment to a multi-modal network. Thus the need to develop the demand and supply databases in parallel is paramount.
- The result is a set of modelled transport chains. The main weakness is that these may disagree with known values where they exist. The main strength is that a very large set of flows can be regularly constructed with minimal new data collection.
- The core of the system is the COMEXT trade database, and harmonised EUROSTAT transport databases. By simplifying the EU data collection upon public EUROSTAT data, more attention can be placed upon collecting equivalent data for non-EU countries.
- As the EU enlarges, the reliance upon harmonised EUROSTAT resources and upon the agreed standards for data reporting, becomes greater.
- Within EUROSTAT, the two weakest areas, in relation to the outcome of WORLDNET, are the availability of rail-freight origin or destination data, and the absence of transport chain data.

Maritime Data

- Collection of maritime data has focused upon supply and demand within a global network of seaports. Main external sources have included EUROSTAT and the EUROMED database.
- Data has been collected on: Port Volumes, Port Facilities, Ship Sizes, Typical Vessels, Vessel Costs, Future Trends.
- There is no direct equivalent of a link-and-node network for maritime connections, so a simplified network has been used, based on the results of ETIS.
- By assigning all Europe-related freight flows to chains that include the maritime mode, it has been possible to estimate a more complete picture of modal share. On this basis, sea is the most important freight mode for European producers and consumers.
- This helps to provide scale and context for discussions concerning the development of Eurasian land routes competing with the established sea routes.
- By combining the origin-destination data with the maritime network data it is possible to capture the dynamic effects of trade growth upon maritime corridors (motorways of the sea), groups of ports, and to link these to hinterland impacts.
- Introducing the new data collected concerning port facilities and trends in vessel sizes it is possible to conduct a Europe-wide bottleneck analysis focusing upon maritime links and nodes, analogous to the TEN-Connect approach.

Aviation Data

- Collection of aviation data, and the construction of the information according to TRANSTOOLS conventions adds a new dimension to the combined system, through the prospect of modelling air cargo flows.
- By combining trade data (in which the air mode is identifiable) with airport-to-airport tonnages, and supply side data (schedules) it has been possible to estimate cargo routes. The approach combined trade and transport statistics, due to limited information available for the supply and the demand side. Flows resulting from this combined approach represent actual flows of 2005 much better than using just one of two components.
- In this way it becomes possible to relate trade growth to growth in cargo handling at airports.
- Thus the costs of environmental impacts can be more easily compared with the benefits (e.g. the development of high value-added sectors).
- As found in the maritime sector, the relatively long distances contribute towards a much higher mode share globally than normally estimated for intra-EU trade relations.
- With rapid expected long term growth in this sector it becomes increasingly important to monitor changes, improve data resources and to incorporate it into the mainstream of European freight modelling, particularly when integration between energy, environment and transport models is sought.
- Some cargo flights are not reported by commercial sources (OAG). To eliminate such information gaps the availability of Eurocontrol flight data would be a prerequisite.

- Increasing numbers of available statistics for 2005, 2006 and 2007 at EUROSTAT improves the quality of the approach chosen for future updates. Having direct access to the full data sets reported by the member states would even boost this quality improvement further.
- Concerning the air transport commodities just fragments of data are available which do not allow for a representative modelling approach. Thus more data have to be collected which should be dedicated to EUROSTAT. The same holds for trucking data.

Network Model

- WORLDNET has addressed the need to extend the TRANSTOOLS road and rail freight network models into neighbouring countries.
- Links have been selected according to their potential relevance for the transport of freight between Europe and other countries of the world by land-based modes.
- Consideration has been made towards politically agreed transport axes and trans-national corridors.
- Consistency with the TRANSTOOLS data structure, and the network has been defined for the base year 2005.
- One of the key problems in updating the networks has been coordinating network edits between WORLDNET and related projects. The objective has been to combine the new network sections with the completed network developed in parallel with TEN-Connect, thus the WORLDNET network models are geographical extensions of the TEN-Connect network models, keeping the TEN-Connect networks models unchanged in their scope of the European continent.
- Although advantageous to combine inputs from several projects this has created a critical path issue.
- In future it might be considered to apply a client-server approach to network publishing, as developed by WORLDNET in order to speed up the development of a shared resource.

TRANSTOOLS Application

- The testing and use of WORLDNET's data outputs as TRANSTOOLS inputs has not been brought to a satisfactory completion due to ongoing enhancements of the TT-models.
- WORLDNET has developed inputs according to the specification of TRANSTOOLS, and provisional versions of these have been used within model runs, for example within TEN-Connect.
- However, the final WORLDNET outputs, including the new air and maritime sections, the full NUTS3 zoning, the network extensions, and the later versions of the O/D matrix have not been tested.
- Consequently, the WORLDNET results needed to be prepared using an external set of semi-optimal harmonised freight modelling tools. While these are sufficient to demonstrate the new data elements, it remains necessary to bring about full convergence with TRANSTOOLS.
- Three example applications for the WORLDNET data have been prepared, relating to globalisation, motorways of the sea, and trans-national corridors.
- First, it has been demonstrated how to trace changes within the structure of EU27 intra and extra trade, and how to combine these into the O/D structure.

It shows that despite substantial trade growth, structural changes in trade patterns are only evolving slowly. Emerging market hot-spots are clearly visible, but their impact on European trade patterns is gradual. The EU's dependence upon other world regions is increasing, whilst the importance of the EU as an export destination for other world regions is diminishing. In 1995, the EU was the main export market for Latin America, by tonnage. In 2025 it is expected to have been overtaken by North America, Intra Latin America and Asia-Pacific regions.

- Second, it has been demonstrated how these detailed analyses of world trade can be combined with the WORLDNET maritime data to estimate flows on the European maritime corridors (motorways of the sea), and to link these to port and hinterland bottlenecks, as well as capacity constrained sea corridors such as the Turkish Straits and Suez. Even with relatively pessimistic trade growth scenarios, it is evident that only the often overlooked maritime network, with associated improvements in port capacity and hinterland connections, can offer capacity on the required scale.
- Finally, it has been demonstrated that with the geographical extensions on both the demand and supply sides, the system is equipped for analysis of the Accession and Neighbourhood regions, with equivalent coverage in EU27, Russia, Belarus, Ukraine, Turkey, North Africa and the non-EU Balkan countries.

Knowledge Base

- WORLDNET has based its dissemination strategy around the knowledge base system developed by the REORIENT project. The system provides a single portal for tabular, graphical and documentary data, with a purely web-based interface (no client applications required by the user).
- The outstanding feature of the system has been the improved interface for online map editing. Network data produced by WORLDNET has been published on the internet so that organisations can modify, extend and generally improve the existing resources.
- Using a WIKI-based approach, many users e.g. different research groups or national experts can independently work upon the same network database, and share the results. Thus, the problem encountered in WORLDNET where one project relies upon the final results of a concurrent project might be avoided.
- With an improved graphical client (based on Flash technology), and the ability to overlay WORLDNET networks onto Google-Maps images, the new system has been significantly improved, in comparison with initial versions.
- The WORLDNET freight O/D matrix has been published in full via the website, using the NESSTAR components of the REORIENT Knowledge Base, allowing users to make extracts from the database via an internet browser interface. The original ETIS-Base data is also available via the same portal.

2.4 WORLDNET Next Steps and Recommendations

WORLDNET has attempted to set a new precedent for the scope and scale that can be considered within European freight transport modelling.
To achieve this, many new supporting databases and estimation methodologies have been required to create a system that is automated and flexible enough to be updated, not only in theory, but at a pace that is demanded by the rate of

change in the global economy, and particularly within the regions close to the EU's Southern and Eastern borders.

Several important next steps/recommendations have arisen:

1. The contribution from the project participants, for example the seminar participants, is considered to be a valuable source and thus shall be sought via the WORLDNET website – www.worldnetproject.eu – where the project results can be circulated and effort from partcipants invited, as part of the ongoing validation of the transport networks and databases achieved in WORLDNET.

2. WORLDNET has revised and extended the freight-related aspects of the ETIS transport policy information system. **The data and the accompanying online tools should now be integrated into a more comprehensive update of ETIS.** (Note that the original ETIS database is currently hosted within WORLDNET.) **WORLDNET should be maintained as a sub-domain of ETIS, related directly to the data needs of the freight components of TRANSTOOLS**.

3. WORLDNET has produced data for 2005 according to the specifications of TRANSTOOLS, and according to the new zoning scheme developed between WORLDNET, iTREN and TEN-Connect. The application of this data within TRANSTOOLS is partial. The sequence of freight modelling steps with TRANSTOOLS needs to be revisited:

   (a) to **provide a quality control for WORLDNET concerning the TRANSTOOLS outputs**,
   (b) to **ensure future data format compatibility between WORLDNET and the new version of TRANSTOOLS**,
   (c) to **eliminate any pre-processing between WORLDNET's O/D matrix and TRANSTOOLS**,
   (d) to **test internal consistency of TRANSTOOLS freight modules following the change to new zoning**,
   (e) to **identify areas where the expanded coverage of WORLDNET's O/D matrix can be adopted within TRANSTOOLS**,
   (f) to **use WORLDNET data to improve the coverage of maritime flows in TRANSTOOLS**,
   (g) to **develop the WORLDNET air cargo methodology into an integrated component of the TRANSTOOLS system**,
   (h) to **enrich the TRANSTOOLS models and the WORLDNET database by the intramodality reflecting the competitive situation of routes,**
   (i) to **enrich the EUROSTAT data collection task by commodity, trip chain and cost information across all modes which could be done by a 10% sample to be delivered by the processor. Such data would allow a further significant step towards a consistent and comprehensive dataset which forms the base for policy decisions and further modelling tasks.**

3 WORLDNET – Objectives and Organisation

WORLDNET addressed the SSP-5 call objective to deliver realistic solutions that support policy forecasting and facilitate the implementation of the European transport and energy policy measures and instruments. The strategic objective was to refine the European transport network model with respect to freight, including intermodal transport, to and from the rest of the world.

This required the creation of a link to the modelling and scenario work of the other task in the "Integration of energy and/of environmental components" call (iTREN 2030), and with earlier studies such as TRANSTOOLS, TRANSFORUM, and REFIT.

The specific objectives of WORLDNET were:

- a more precise representation of the **freight flows** between European countries and the Rest of the World;
- an **extended network model** to other world regions, to facilitate the direct use and uptake for the countries/regions involved;
- **active participation from non-EU countries** and international organisations requiring a consistent, quantitative baseline for technological, environmental and economic trends, within the transport and energy sectors.

3.1 Project Abstract

The recently developed TRANSTOOLS model (TNO et al, 2007) will become the reference transport policy assessment tool for the EU. It complements the ETIS reference database which was used for its calibration. ETIS was developed in close cooperation with EUROSTAT to provide the Commission with a policy oriented information system. Although the scope of ETIS and subsequently TRANSTOOLS is EU25, there is a lack of recent information on the new EU member states and amongst the new neighbours.

Detailed national figures are also missing for many other parts of the world, including dynamic areas of East Asia. Innovation is therefore required to extend the modelling capability of these systems outside the EU borders, particularly as the extended geographical scope focuses attention upon different freight transport markets, including container shipping and air cargo. From this viewpoint, the forecasting capabilities and scenario development of TRANSTOOLS can be significantly improved, thereby supporting the parallel innovations required by the concurrent iTREN 2030 study.

A key task of WORLDNET will be to implement a graphical communication tool, using internet based GIS technology, allowing users in other parts of the world to interact with WORLDNET, and to obtain information about the development of EU transport patterns, and the impacts upon their own networks. The work will be carried out within the framework of existing platforms like TRANSFORUM or on an ad hoc basis.

3.2 Research Objectives

The research objective, stated by the European Commission is:

‘Refinement of a European transport network model regarding freight and intermodal transport to and from the rest of the world, in order to attain a more precise representation of the freight flows between European countries and the ‘Rest of the World’, as well as to extend the model to other world regions (to facilitate use and uptake for direct use in the countries/regions involved). Active participation of participants from INCO target countries and/or international organisations interested in this action will be sought. The work will be conducted in liaison with SSP-5 8.1.B.3.2 task 3.'

WORLDNET interpreted this objective as follows:

TRANSTOOLS developed a pan-European network model, i.e. one that includes representations of the transport networks for particular modes, and the ability to identify routes involving transfers between modes. A network model in the strict sense allows the networks with all relevant characteristics to be combined with algorithms to determine information such as route, journey times and transport costs. In the broader sense, network models also include O/D (origin-destination) flows with attributes such as commodity group and handling characteristics that can be assigned to the network links in such a way as to match observed link loads (number of trucks counted).

Models of this nature can be used to analyse transport bottlenecks, making it possible to find dedicated solutions. The broadly defined network models can also be used to analyse a future scenario in order to calculate the impact of adjustments or extensions of networks.

Comprehensive transport models that combine demand and supply forecasts allow future infrastructure scenarios to be tested with future demand scenarios, permitting packages of policies to be tested according to a wide range of indicators. i

The intermodal aspects will be also defined in a general sense as the interconnectivity between networks and not just with reference to containerised transport. Although container transport is a key sector, the model will also handle all other freight flows in order to be able to provide context and to permit the analysis of the remaining potential for growth in the containerised sector.
WORLDNET will be based upon this broad definition of an intermodal network model, following the structure of TRANSTOOLS, and the parallel requirements of iTREN.

The network model which has to be extended to the rest of the world is the TRANSTOOLS model which is also to be further extended with several parallel modules in task 3.

The freight and network models in TRANSTOOLS handle all freight flows to and from the EU, including those between the EU and the rest of the world for the year 2000.

However, outside Europe many other countries are **aggregated to country groups**. All modes are included. For the freight network model, the focus is on road, rail and inland navigation. Sea and aviation are taken into account in the freight flows in TRANSTOOLS but do not have corresponding networks and algorithms. Air cargo flows are classified under "other modes".

This will have to be elaborated further in this study. For passengers, the aviation information is included in TRANSTOOLS and could form a starting point for the development of the freight aviation network. The core countries in TRANSTOOLS and the input data originating from ETIS are the EU25, Norway and Switzerland. In this project Bulgaria and Romania have to be taken into account, and ideally the remaining accession countries, Turkey, Croatia and Macedonia, and neighbouring European countries including Ukraine, Russia and Belorussia.

With EU enlargement, the relationship between the EU and the rest of the world is changing. Important events in the geo-political landscape may have significant impacts on the functioning of the EU economy, and therefore upon policy making and by implication policy analysis and modelling work. For this reason we will extend the model to cover all trade partner countries at the national level at least. Since the countries neighbouring the EU already have been given attention in several projects and programmes (EUN-STAT, MEDA, REBIES (Balkan)) they will require a different approach to other parts of the world. The main point of attention is, however, the connections between the global, inter-continental networks and the EU networks.

Active participation, particularly with INCO (Specific International Scientific Cooperation Activities) countries should be established in this project, leading to the use and uptake of the project's results. INCO countries are grouped in the following regions:

- Developing Countries (Africa, Caribbean and Pacific (ACP), Asia, Latin America)
- Mediterranean Partner Countries, mainly in North Africa
- Western Balkan Countries, mainly in the former Yugoslav states
- Russia and the other New Independent States (NIS), mainly Black Sea and Caucasus.

It will not be possible to have all countries involved in an equal way. A choice will therefore be made for a selection of "prima inter pares" that will be given a stronger involvement in the project. Since many existing organisations promote international cooperation (for instance, the Asian Development Bank) we will make use of these networks as much as possible.

"Research will in particular have the following specific objectives: improve European transport models and forecasts (refining the demand analysis, linking with energy models); define/measure the quality of service of the transport system (reliability, congestion, bottlenecks etc.); improve energy models and data sources to evaluate the effects of regulatory action, fiscal measures or other policy instruments on energy security, competitiveness and environment protection; improve appraisal methods and tools; determine sustainability indicators and targets (modal shares, decoupling, shares of renewables etc);

analyse, develop and disseminate innovative policy packages and best practices designed to reach the targets defined."

Particular attention will therefore be paid to the following:

- The refinement of the European transport network model system the Commission is currently developing, TRANSTOOLS; this implies extension of the database to cover the flows with the rest of the world and extension of the model system.

- The implementation of the maritime and air transport modes which are the key to successfully modelling the exchanges between the EU with the rest of the world; these are the "remaining" parts of TRANSTOOLS.

- The need to ensure compatibility and a successful interface between WORLDNET innovations and the system developed in parallel by Task 3 (iTREN Project).

- The facilitation of the use of the database and model system by the countries and regions involved, with a special emphasis on dissemination, building a bridge between the product and the users; the use of the TRANSFORUM network will aid this process but account needs to be taken of the wider scope of the task (Rest of the World).

- The ability of the system to produce forecasts based upon scenarios developed by the Commission.

- The ability to assess policy issues in close relation with task 3; this is a crucial point, bearing in mind the globalisation of the economy and the role of major trade partners such as India and China as well as countries like Brazil and South Africa.

- The need to update the ETIS freight flow database which is the key freight input for the TRANSTOOLS system; with the completion of this objective, the Commission will obtain an up-to-date resource measuring transport flows within the Community and with the rest of the world. Note that the original ETIS database covers year 2000; since 2000 important structural changes have taken place following the EU10 enlargement (2004) and the EU2 enlargement (2007).

- The relevant EU funding instruments (programs, large projects) involving the transport sector in non-EU countries (i.e. MEDA, EUN-STAT, REBIS).

The research objectives will be strengthened by considering the context of the transport industry and the financial institutions whose behaviour is likely to influence the implementation of the EU transport policy in the medium-long term. With a view towards providing such context, a dynamic communication strategy will be undertaken in Work Package 2 of this project, which will target the main transport-related international associations as well as international financing institutions which are particularly relevant for the global economy and that have significant impact on the functioning of the EU.

3.3 List of Participants

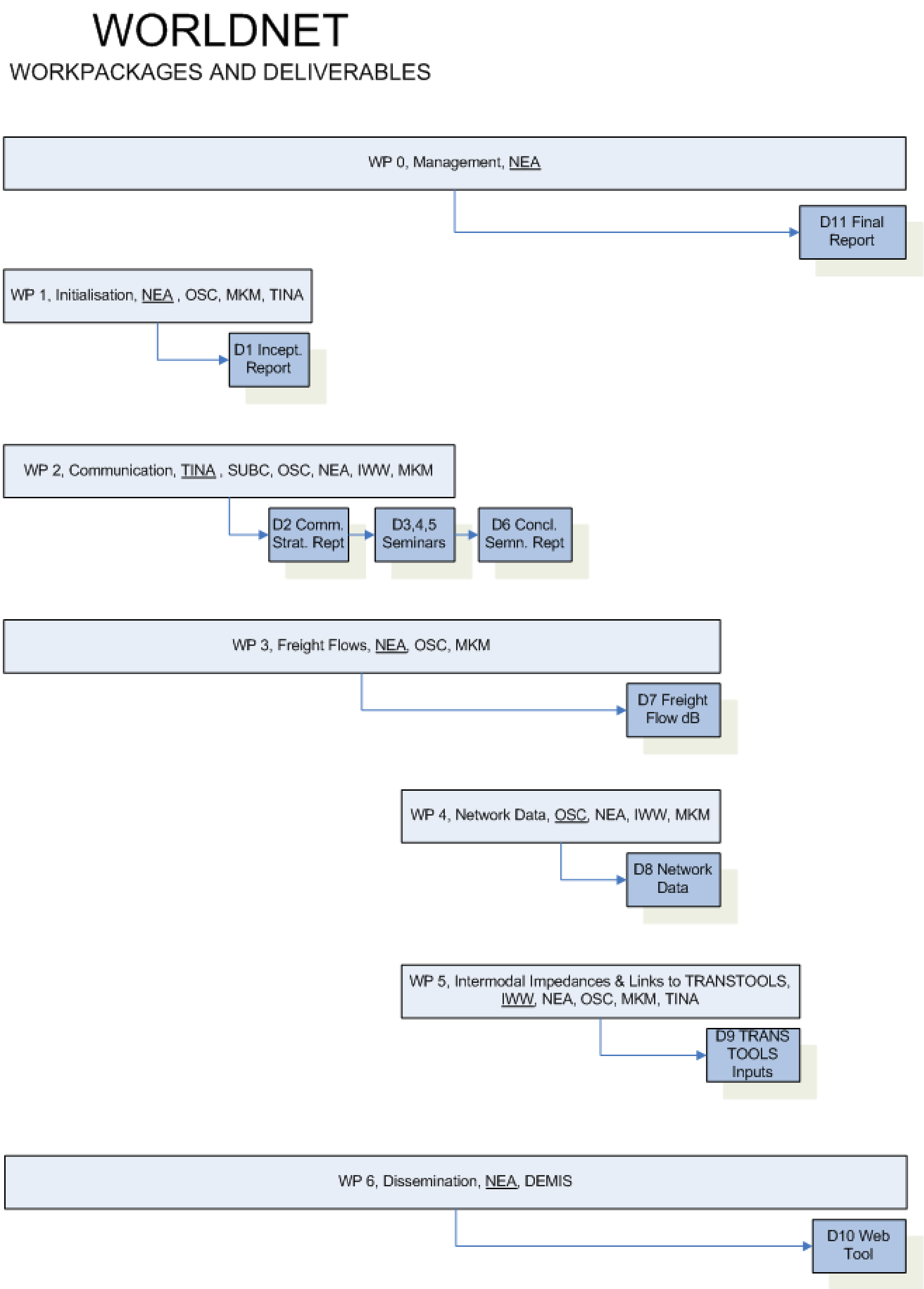
Table 2 List of Participants

Role	*No*	*Name*	*Short name*	*Country*
CO	1	NEA Transport research and training	NEA	NL
CR	2	Ocean Shipping Consultants Ltd	OSC	UK
CR	3	Institute for Economic Policy Research	IWW	GE
CR	4	MKmetric Gesellschaft für Systemplanung mbH	MKM	GE
CR	5	TINA Vienna	TINA Vienna	AT
CR	6	DEMIS bv	DEMIS	NL
SC		Fernando Aragon Morales		ES
SC		Emilio Arbos		ES

3.4 Work Packages

The main time-lines and project linkages are shown below:

Figure 2: WORLDNET WP Organisation



3.5 Deliverables

Table 3 WORLDNET Deliverables

Item	*Deliverable, Type and Timing*
D1	Inception Report/Dissemination Strategy (REPORT, Month 3)
D2	Communication Strategy/Policy & Institutional Dimension (REPORT, Month 6)
D3	EU Neighbours' Seminar (SEMINAR, before Month 9)
D4	Latin American Seminar (SEMINAR, before Month 9)
D5	Far East Seminar (SEMINAR, before Month 9)
D6	Conclusions of the Seminars (REPORT, Month 10)
D7	Freight Flow Database (REPORT/DVD, Month 15)
D8	Network Database (REPORT/DVD, Month 15)
D9	TRANSTOOLS Model Updates (REPORT/DVD, Month 19)
D10	Web-based Dissemination (REPORT/WEBSITE, Month 21)
D11	Final Report (REPORT, Month 22)

4 Communication Programme

One of the central tasks of WORLDNET has been a **communication strategy** in order to establish links with stakeholders in neighbouring countries and in the rest of the world. This has been the theme of Work Package 2.

This section summarises the outcome and conclusions of a series of seminars organised by WORLDNET in the spring of 2008. For copies of the seminar presentations please refer to the D3, D4, D5 reports or alternatively the WORLDNET website (www.worldnetproject.eu).

Communication plays an essential role and importance for the WORLDNET project. Its main objectives focus on items such as the identification of policies and practices that influence international movements of freight to and from Europe, provision of insight into major international routes, assessment of the major institutional, financial and commercial constraints for trade links with partner countries and definition of the major initiatives, by which the EU can maximise and integrate the use of the different modes of transport. To obtain the best possible results in these fields, the project has structured a concrete strategy that focuses on the interaction between the input that the team expects from major international actors in the field of freight transport and the results of the study's various phases that are presented to these actors.

One important part of the communication strategy (WP2) was the organisation of seminars in Istanbul, Beijing and Buenos Aires, which promoted the interaction between various stakeholders.

The main objectives of these seminars were:

- the provision of insight in routes used as well as the corresponding major flows of traffic by mode to be taken into account at the network design stage of the modelling process envisaged in this research exercise and the expected future developments;
- the provision of insight in and collection of data and networks needed and available;
- the identification of relevant policy and modelling aspects and needed indicators. In particular, provision of insight about major infrastructure planned projects (i.e. priority "corridors", or trans-national transport axes) and their financial constraints;
- the assessment of major institutional, financial and commercial constraints to trade links with the partners;
- the assessment of the interaction between modes;
- the identification of possibilities of (structural and on a permanent basis) cooperation on the relevant aspects in this project with EU partners operating both inside and outside the EU. Initiate this cooperation with the EU in the course of the implementation of this research project;
- the definition of major initiatives for the EU to maximise and integrate the use of the modes with these regions;
- the formulation of results into policy advise and concrete input to the modelling aspects;

- the dissemination of the results of the EU on network modelling on the European side.

The following sections discuss the progress as well as the findings of the three WORLDNET-Seminars.

4.1 Seminar 1 - Istanbul

The Istanbul-Seminar took place on 17 April 2008. This seminar focused on the regions of the Eastern Europe, MEDA and TRACECA countries, i.e. on a region where certain administrative links have already been established with the EU. For this reason, it was also useful to communicate information about the status of the project and to discuss how its deliverables and outputs might be shared with the seminar's participants. Thus, the seminar was dedicated mainly to policies and transport strategies, as well as the use of transport data in the planning of infrastructure.

The first seminar focused upon the investigation and elaboration of the project's objectives:

- Provision of insight into routes used by major traffic flows, and future developments
- Provision of insight into the collection of freight flow and network data
- Identification of relevant policies, modelling aspects and indicators; in particular, the priority corridors and trans-national axes and their financial constraints
- Assessment of the major institutional, financial and commercial constraints to trade links with partner countries
- Assessment of the interaction between transport modes
- Identification of possibilities for long term cooperation on the relevant aspects of this project with EU and non EU partners; initiate this cooperation with the EU in the course of the implementation of this research focusing on the Europe-Asia transport links (involving countries like Ukraine Russia, Turkey, and Kazakhstan), as well as on the region that includes other important neighbouring countries like Algeria, Libya, Morocco, Tunisia, Egypt, Israel, Saudi Arabia, Iran and UAE.

Its main scope was to address basic questions about existing policies and practices regarding freight movements to/from Europe as well as the status and perspective of the main connecting routes.

For this part of the world (Eastern Europe, MEDA, TRACECA countries, etc.) and for these questions there is an existing solid background, and Seminar 1 was based on this background.

In addition to the concrete elements of flows and network information, this seminar examined the perspective of the TEN-T extension to Neighbouring Countries.

To do that, it focused, both at the seminar level and during the bilateral contacts, on the following issues to:

- verify the status of the specific Transport Action Plans developed in the context of the various regional groups, where they exist;
- verify the status of development of the corridors and connections identified by the HLG and accepted by the European Commission;
- estimate the investment needs and the envisaged funding sources and mechanisms;
- estimate which could be the adequate institutional set up that could facilitate international freight transport, elimination of bottlenecks, and cross border operations.

The agenda of the first seminar in Istanbul dealing with Transport and Trade Development in Black Sea and the Mediterranean Sea regions is given below. The morning sessions dealt with the objectives of the project, and the transport policy context. In the afternoon, the methodology of WORLDNET was explained, leading into a discussion about actual and potential applications in the region. Finally the aspects of data access and communication via the internet were presented.

A location was chosen next to the Bosphorus Bridge at Ortakoy, in the Besiktas area of Istanbul. The bridge connects the European and Asian sides of the city, while the Turkish Straits link the Black Sea, now the South Eastern frontier of the European Community, to the Mediterranean.

Figure 3: Turkish Straits

Turkey has been a candidate for European Accession since 2005. It is the largest of the accession and pre-accession countries, and a long-standing member of the Council of Europe as well as NATO.

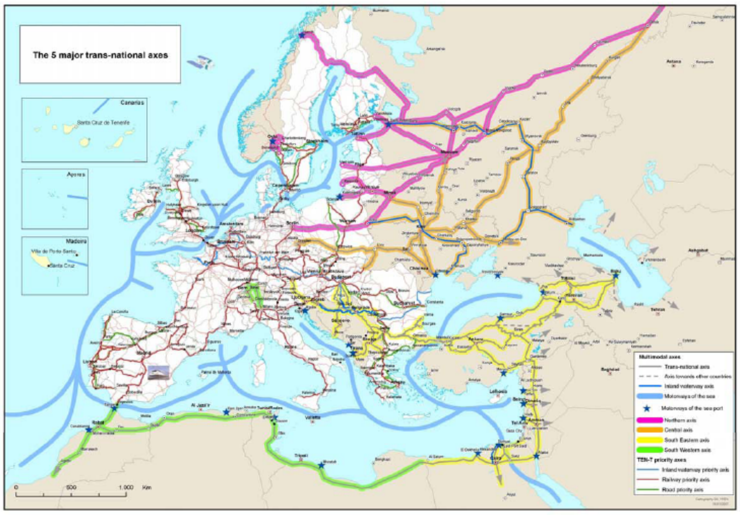
The outcome of the accession negotiations with Turkey will be a decisive moment for the European Union, potentially extending the territory by an area larger than any existing Member State and including a population larger than any other EU member except Germany. Combined with its strategic location in the Mediterranean, Aegean and Black Seas, with the prospect of opening up corridors towards the Gulf and Caspian states, it has a singular role to play in the development of trade and transport routes for the EU.

WORLDNET is attempting to build upon the links that already exist in the region, for example in relation to the TINA-Turkey (Transport Infrastructure Needs Assessment) project in 2006/2007, and the TRACECA Black Sea Maritime Links project (2008). There is an urgent need for infrastructure improvement in the region to keep pace with rapidly expanding economies in the region. Efforts are being made to co-ordinate the planning between the neighbouring countries and to discuss the options for addressing transport bottlenecks, for example in relation to the Turkish Straits and the construction of container terminals in the Black Sea countries.

The meeting was officially opened by Ms. Sedef Yavuz Noyan from the Turkish Prime Ministry State Planning Organization (SPO), representing the host country. The SPO is one of the top governmental agencies in Turkey, and the main policy formulation unit at the national level. It was founded in 1960 to accelerate the economic, social and cultural development of Turkey.

Following introductions, Mr. Frederik Rasmussen (scientific officer of the European Commission) outlined the Commission's expectations of WORLDNET as well as the European policy objectives.

Figure 4: The Five Major Trans National Axes



Referring to the inclusion of five "axes" connecting the EU to its neighbours, a map was presented showing the South Eastern axis, linking the EU with the Balkans and Turkey towards the southern Caucasus and the Middle East, a reflection of future strategic priorities and the basis for the selection of infrastructure projects.

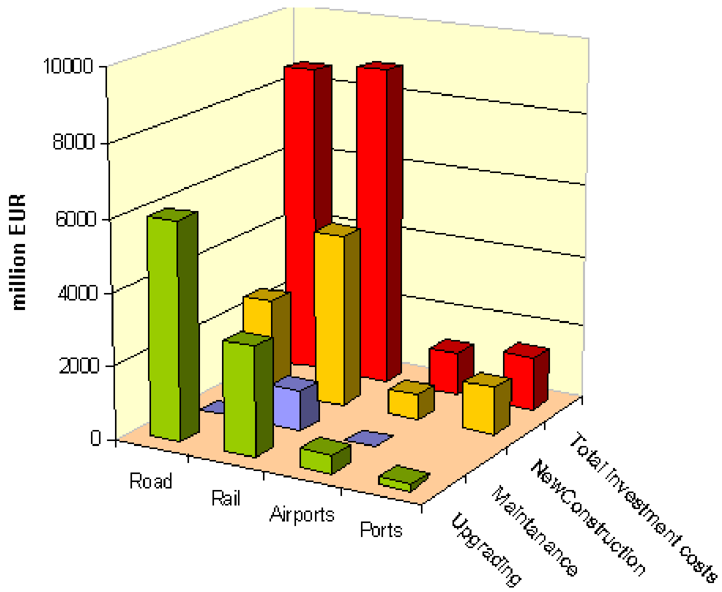
Returning to the role of WORLDNET, the Commission expected, on the one hand, the enhancement of TRANSTOOLS, a European transport network model with extensions to the rest of the world and a common modelling tool for the European Commission. On the other hand they wished to share information on policy, trade, transport, trends between EU and other world regions.

In detail TRANSTOOLS should be used for policy-making issues and infrastructure decisions and therefore it is essential to increase used data, forecasting and representation of sea and air transport to achieve a high quality tool, which allows assessing wider policy issues. Finally he pointed out, that WORLDNET is a research project in the area of the development of tools, indicators and operational parameters for assessing sustainable transport and energy systems and will not directly make recommendations for EU policies.

Concluding session 1 Mr. Göktug Kara (Sector Manager of the State Planning Organization) explained the role of the European Commission Delegation in Turkey. Thereby he outlined some characteristics of the Turkish transport system as well as future projects for the transport sector in the pre-accession of Turkey.

The three strategic priorities in the transport area were the rehabilitation of the railway network, the improvement and construction of ports, and technical assistance. A €20 billion plan was outlined for an enhanced core network, based on the findings of the TINA Turkey joint venture.

Figure 5: TINA Transport Infrastructure Investment Allocation



The plan included North-South and East-West rail links as well as port developments planned for Mersin, Candarli and Filyos along the South, West and North coasts respectively.

A discussion followed, in which the WORLDNET team outlined some of the additional data resources that were being used in relation to Turkey, including those contributed by Turkey to EUROSTAT, and those developed during the TINA-Turkey work. There was an obvious synergy in terms of harmonising data and modelling resources, given that until now, the evaluation of the transport axes outside the TRANSTOOLS region had required the development of specific models which were not necessarily consistent with their counterparts in other regions.

The second session was chaired by Mr Fernando Aragón Morales. This session focused on transport infrastructure priorities and on the financing of transport infrastructure. In his speech Mr. Aragón-Morales, gave a general overview mentioning that there are a number of relevant ongoing initiatives and policies at European level concerning the transport relations between the European Union and its neighbours.

For the purpose of the Istanbul-Seminar he focused on:

- the overall policy concerning external relations and particularly the European Neighbourhood Policy (ENP), which will be the framework where the transport relations with the neighbouring countries will be developed. In fact "transport" is just a thematic dimension of the ENP, along with many others (energy, environment, public health etc.).
- the Common Transport policy of the EU, which has developed a number of important instruments of important reference for the project, being the Trans-European Transport Networks (TEN-T) the most relevant of them.
- other sector policies like the EU Port and Maritime Policy that should be further developed.

In 2004 the European Commission established a High Level Group on the Extension of the major trans-European transport axes to the neighbouring countries and regions. As observers for the Group's meetings the European Investment Bank, the European Bank for Reconstruction and Development and the World Bank participated. Among others the main recommendations of this group are:

- to agree on the establishment of five major trans-national axes (named Northern, Southern, South-Eastern and South-Western Axis and Motorways of the Seas) that extend and complement the major axes of the trans-European transport network; South Eastern axis: to link the EU with the Balkans and Turkey and further with the Southern Caucasus and the Caspian Sea as well as with the Middle East up to Egypt and the Red Sea;
- to promote the development and the operating efficiency of the axes with the realisation of packages of measures including upgrade of infrastructure and adequate horizontal measures, aiming at eliminating infrastructure and operational bottlenecks;
- to establish a concrete cooperation framework in order to ensure the proper monitoring of the progress of the axes.

In addition to the network (set of corridors) layout, a number of projects and horizontal measures have been identified (45 billion, out of which € 35 billion are to be invested until 2020).

In comparison with North East Europe region the freight flows in the South East are for a larger share industrial products and consumer goods, which require high quality transport systems with short lead times. These flows can be transported either by road, rail or intermodal/ferry services. It is expected a growth in rail freight in the range of 15 – 30 % until 2020. However, a much stronger growth is considered feasible on rail freight between EU and Turkey.

Investments in Pan-European rail corridors are traditionally given high priority in the region, because rail systems can be very competitive on long distance traffic and there is strong potential for shifting freight transport from road to rail, particularly on Corridors IV and X (to Turkey).

Among other measures related to the investments needed in rolling stock and to streamline border procedures, the European rail industry considers that for the South East/Black Sea region, urgent and vast investments are needed to rehabilitate and modernise the railways systems in the region. This concerns investments in the national networks as well as in the Pan-European corridors, which connect the region with the EU.

Concerning the financing of infrastructure it was discussed that EIB has six priority objectives for its lending activities within the EU. One of them is the development of the trans-European Networks (TEN). In the context of the transport corridors in the countries of the wider European neighbourhood, there is also a focus on EU neighbours, notably Norway, Turkey, the Balkans, the Mediterranean Countries, Russia, Ukraine, Moldova and Belarus. In the period 2002 to 2006, loans for TEN projects have amounted to EUR 35.8 billion.

The EIB develops a remarkable activity in the immediate regions of the EU. Thus, in the Mediterranean area, following the Barcelona European Council in 2002, a reinforced investment mechanism, the Facility for Euro-Mediterranean Investment and Partnership (FEMIP), to stimulate the private sector in the Mediterranean partner countries, was also set up within the EIB. The facility has provided a total of EUR 6 billion between 2002 and 2006 with an increased share in favour of the private sector.

As an interesting experience on multilateral cooperation the EIB recently joined a partnership promoted by the International Finance Corporation, a member of the World Bank Group, comprising the European Investment Bank, the European Commission and the World Bank, to help create a favourable private sector environment in the Middle East and North Africa.

The EIB is also active in Turkey and in all of the Western Balkan countries and there is an increasing attention to enlarge EIB’s lending mandate in more distant regions, notably the Eastern Europe and Central Asia countries. In effect, up to July 2007, Russia as well as Belarus, Ukraine and Moldova received EUR 500 million for financing projects of key common interests for the EU/respective country, among them, on along the priority axes having cross border implications for a Member State of the EU.

In the second part of Session 2 Mr. Francesco Falco gave an overview of activities and infrastructure priorities in accession and neighbouring countries of the European Road Federation (ERF). Mr Falco highlighted the important role of the road network within the TEN strategy, particularly in the new members, accession and neighbourhood states. There was a funding gap up to 2020, and limits placed on the funding that could be derived from public sources. Therefore innovative financing solutions were needed, such as public-private partnerships and road user charging.

He argued that well designed road infrastructure could contribute significantly to social welfare, particularly through the reduction of road accidents, and this was a key message in South East Europe where road quality was at least as important as network size. A second important contribution relating to the road sector would be the use of intelligent transport systems to improve the efficiency of the networks. Again, in a situation where large-scale road infrastructure is being implemented, the countries in the Black Sea region have the opportunity to adopt best-practices and take advantage of the experience in other regions.

The presentation highlighted the fact that despite a preference at EU level for the development of multimodal networks, the economic growth and increasing affluence in the Black Sea region would inevitably place high demands upon the road transport networks and there was an opportunity to invest in measures to reduce externalities, beyond that which could be achieved through rail and maritime measures.

The 3rd Session, which was chaired by Jan Kiel from NEA provided information on methodology used for WORLDNET enabling the participants to become familiar with the approaches for the different modes of transport.

Origin-Destination Data

The first part of this session included a presentation by Sean Newton explaining the development of a freight flow database for the WORLDNET project, and the input data resources it was based upon. The defined data could be subdivided into the following categories:

- International flows (trade data)
- National flows (transport data specialised per mode) and
- Regional economic data (production consumption data).

The transport model itself is based on origin-destination data on NUTS3 level. The outputs are:

- Origin and destination region (NUTS2)
- Product (NST1)
- Mode at Origin
- Mode at Destination
- Mode between Transhipment Points
- Transhipment Point 1 (NUTS2)
- Transhipment Point 2 (NUTS2)
- Tonnage (year 2005).

The question of obtaining more detailed data for the East Mediterranean and Black Sea regions was discussed.

Previous O/D estimations have not collected data concerning the Eurasian countries with the exception of Turkey which is covered through certain EU projects at a national level. Data for accession countries is not collected comprehensively within EUROSTAT, and not at all for many other neighbouring countries e.g. Ukraine and Russia.

It was underlined that one goal of the project is to create win-win situation between the project team and stakeholders in the sense of providing data and receiving data as well as a transport model, which could improve the efficiency of long term transport and infrastructure planning.

Road and Rail Networks

After the presentation of Sean Newton, Eckhard Szimba gave an overview of the road and rail database, which was being developed within WORLDNET. One goal of the project is the extension of different network models to neighbouring countries of the EU. Thereby the demand dimensions and network planning as well as corridor planning data in the certain countries are crucial criteria for a network extension.

Figure 6: WORLDNET Road Network Model

Within the WORLDNET rail/road network models, TRANS-TOOLS, the VACLAV network models as well as further sources like UNESCAP are combined. By extending the networks further into Asia it becomes possible to consider the Black Sea transport network as a whole.

Air Transport

A further essential part of the WORLDNET project is air transport. Mr. Benedikt Mandel (MKM) gave an overview of the progress in building freight flows and networks for air cargo.

During his presentation he pointed out the need for several data as:

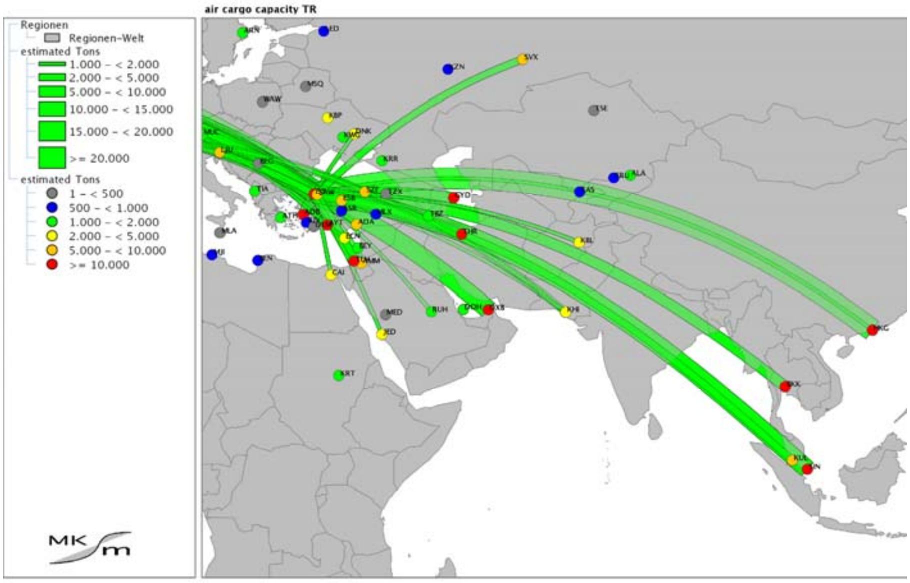
- air cargo & passenger statistics (by type, destination and direction),

- socio economic data on given regionalisation,
- road feeder impedances between region and airport and
- volumes and shares of commodity groups

to achieve good results, covering the whole intercontinental air cargo flows.

Mr Mandel pointed out that Istanbul airport had become the dominant air cargo centre in the region, with important trans-continental linkages to the Middle East and South East Asia.

Figure 7: Air Cargo Flows from Turkish Airports



He argued that Istanbul could compete with centres like Dubai, and demonstrated the advantage it had over competing European airports in Greece, Romania and Bulgaria. Turkey's air cargo volumes were already higher than those of the EU neighbours combined.

Table 4 EU Air Cargo Tonnes for Selected Mediterranean and Black Sea Countries

Air Cargo reported by EUROSTAT 2006 for distinct routes

Country	Shipped	Received	Total
Turkey	89.322	97.820	187.142
Greece	50.508	77.866	128.374
Romania	5.542	14.277	19.819
Bulgaria	4.429	4.518	8.947
Cyprus	19.754	19.349	39.103
Syria	209	7.250	7.459

values for Turkey and Syria only to/from EU destinations/origins

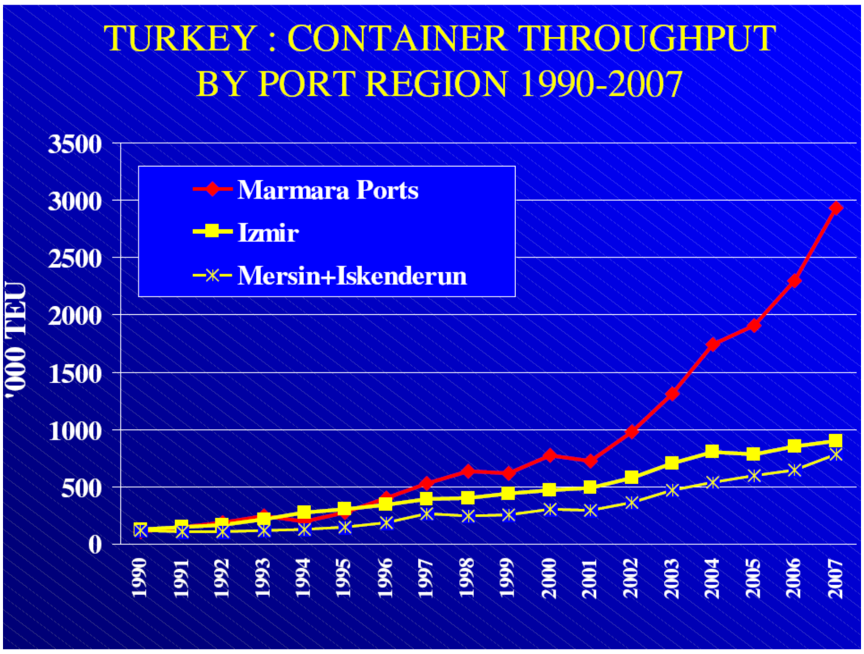
Istanbul and Antalya airports dominated the Turkish air cargo market, but even Istanbul with 600,000 tonnes per annum (to and from all origins and destinations) would need to double its volumes to achieve a position in the world top 30.

Maritime Transport

Concluding this session Mr. Steve Hanrahan (OSC) provided a review of container trade and port traffic in the East Mediterranean and Black Sea region, and a forecast of container traffics for the region as a whole as well as for Turkey itself. The market had been growing fast between 2001 and 2007, with container traffic at ports increasing from approximately 8m TEU to 17m TEU in the space of six years. Within this figure, around 12m TEU was import/export traffic and 5m TEU was transhipment. The two dominant countries were now Turkey and Egypt, each with around 4.5 million TEU throughout, and high rates of growth were present throughout the region, principally in Romania and Ukraine.

Within Turkey, the most substantial growth area has been along the Marmara coast, mainly at the terminals comprising the port of Ambarli (e.g. Marport and Kumport). Izmir, and Mersin have experienced steady growth. (See below).

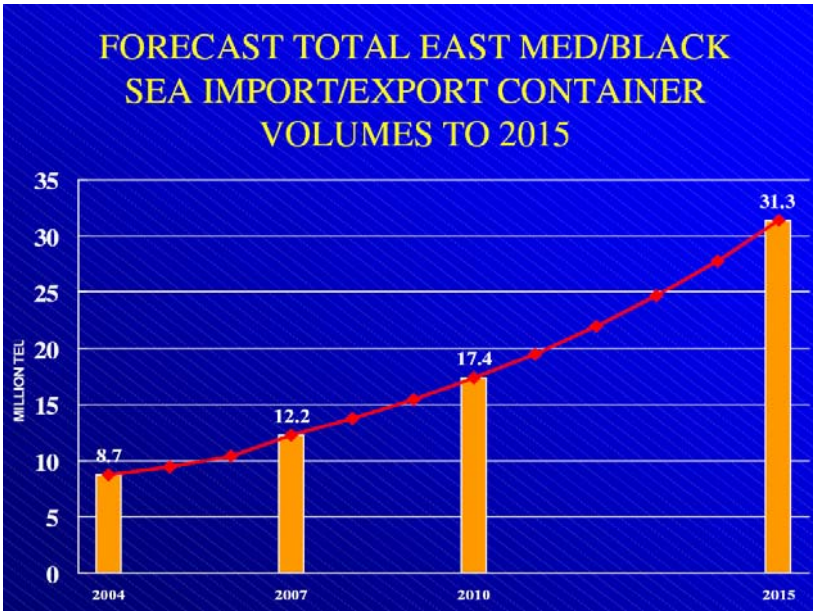
Figure 8: Turkish Container Traffic, 1990-2007



In comparison with other modes used for import an export traffic, the maritime sector was growing fastest and had the largest market share. There was a trade imbalance in favour of imports.

Looking at the distribution of container vessels calling at East Mediterranean ports, the majority were between 500 and 1500 TEU in capacity. Changes in this pattern were expected in future due to the increased presence of ships over 3000 TEU in the world fleet. By looking ahead to the order books it was clear that within the next decade the main container ports would need to be able to handle ships in the 4000+ TEU range.

Figure 9: Forecast Total EMED/BSEA Imp/Export Container Volumes to 2015



OSC's forecast of containerised import/export traffic indicated that the East Mediterranean/Black Sea market would rise from 12m TEU in 2007 to 17m in 2010 and 31m in 2015. Within Turkey alone, volumes would rise from 5m in 2007 to 7m by 2010 to 14m in 2015.

In the 4th Session, which was chaired by Sean Newton the TINA-Turkey and other projects and activities of the region were presented. The objective was to examine some recent projects from the region in which data of the kind being developed by WORLDNET was being used.

Turkey

The first presentation by Mr. Mete Orer (CEO of RMT Co. Ltd) dealt with the Transport Infrastructure Needs Assessment and the development of a Core Network for Turkey candidate for the extension of the TEN-T with in the European Union. He highlighted the fact that Turkey has a unique strategic location, and that there is an urgent need to take advantage of the ongoing modernisation of Turkish transport networks in order to realise the multi-modal transport opportunities. Priority should be given to:

- Development of both North-South and East-West axes, and integration into international transport networks.
- Improvement of container-related transport facilities in order to develop intermodal networks.
- Improvement of maritime facilities and the related development of industrial facilities and logistic platforms.

He then set out the main conclusions of the TINA study, including a projection of Turkish freight traffic by mode. These indicate an increase of more than 100% for freight traffic by 2020, with road transport accounting for an 85%.

Beside the implementation of the Core Network the key strategic aims of Turkish Transport Policy should be:

- to strengthen the political, social and economic status of the country by developing adequate transport networks
- to ensure an efficient and appropriate extension of existing networks. A step-by-step modernisation is necessary, affecting not only the infrastructures but also the system's function and services structures
- to increase transport safety
- to ensure the financing of projects, that is to co-ordinate short-term investments with long-term financial planning
- to simplify implementation. To create a dynamic project management between the conceptual and the project level.

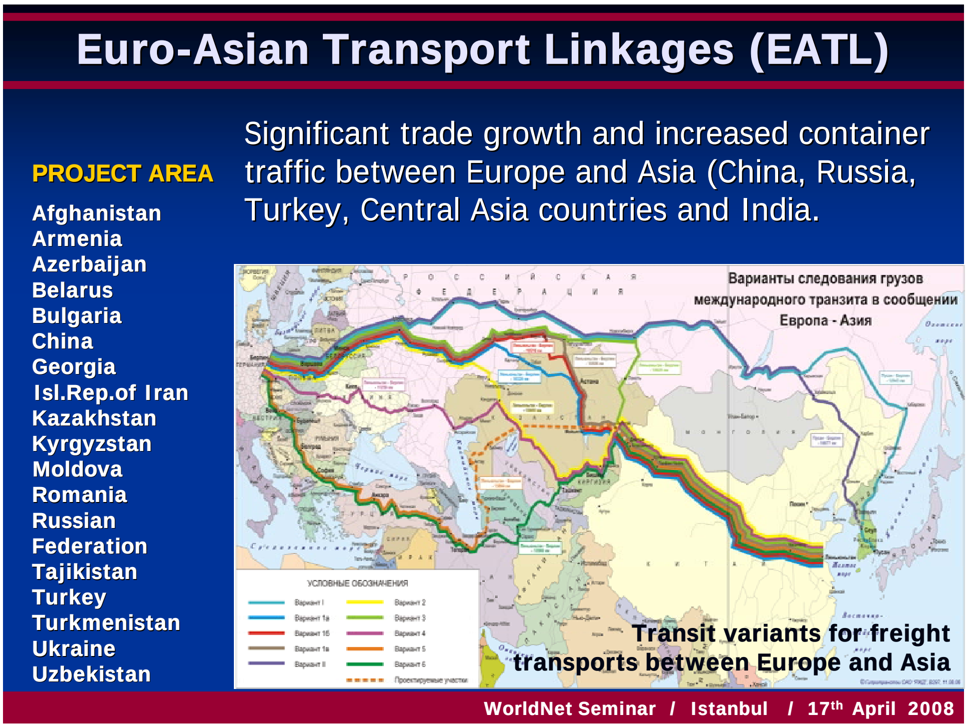
MEDA TEN-T

The second topic "MEDA-TEN-T Experience and Data Needs" in this session was presented by Dr. Athanasios Ballis of the National Technical University of Athens. In his presentation he mentioned and explained some projects in the MEDA programme:

- TEM and TER master plans
- Euro-Asia Transport Linkages
- The intermodal corridor Novorosysk – Black Sea – Varna
- MoS (Motorways of the Sea) for Eastern Mediterranean and MEDA
- ASTAN project.

These projects, like the TINA study, are assisting with the evaluation and prioritization of transport networks and multi-national corridors at a strategic level. There was a strong synergy with WORLDNET in terms of the regional coverage, the strategic themes and the data requirements.

Figure 10: Euro-Asian Transport Linkages (EATL)



On the basis of this experience, he outlined the data requirements for road, rail and maritime transport. He pointed out the difficulties they had experienced in collecting high quality data. One possible solution to deal with the problem of data collection would be centralisation of data. Regarding a possible share of data with the WORLDNET project he would need the agreement of his project owner but in general the methodology as well as the quality of the source is important for data collection.

BSEC Perspective

The importance of the Black Sea and Caspian Sea area and the main ongoing activities were underlined by Mr. Altai Efendiev in his presentation. BSEC was established in 1992 to promote peace, stability, and sustainable development through means of economic cooperation. Transport and trade development played an important role in this process of economic cooperation. On one hand the region faced opportunities for greater internal and external integration, and contained some the most dynamic development areas. On the other hand the asymmetries and protracted conflicts within the region were pointed out. However, important initiatives had been set up to simplify and coordinate the administrative processes in relation to transport services, and areas of cooperation were set out. Support was offered to WORLDNET through regional contacts.

TRACECA Perspective

Concluding this session Klaas Westerkamp from NEA talked about the ongoing TRACECA project focusing upon the improvement of maritime links between TRACECA and TEN Corridors. The project had also helped to develop the databases and methodologies for WORLDNET within the TRACECA region. It was therefore a useful indication of how the WORLDNET systems might be employed within a multi-country transport plan.

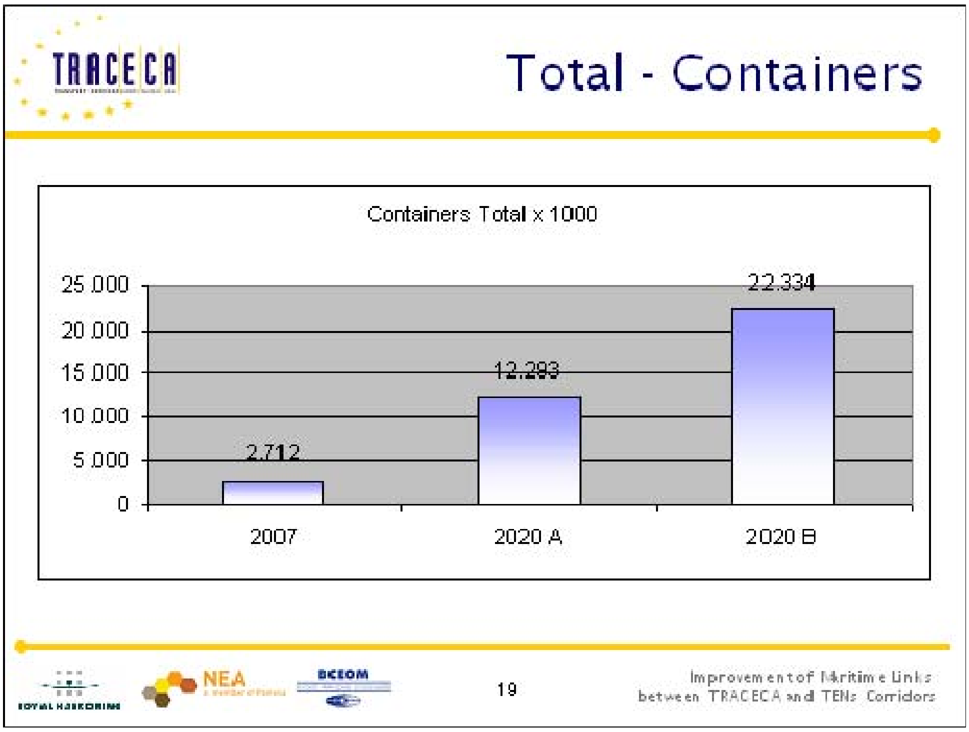
Thereby he outlined a high trade growth between the 15 countries in the study region and the rest of the world. The most important commodity in this area is liquid bulk. In general he mentioned that the Black Sea region has a high growth potential for sea transport due to:

- Substantial economic and trade growth in the black sea countries
- Ongoing integration of this region in world economy and its trade routes
- Currently relatively low trade volumes and underinvestment in port infrastructure
- Potentially large hinterland for black sea ports.

Further he outlined that there are very high growth rates for containerised transport due to:

- High overall trade growth
- Even higher growth in commodity types than can be containerised
- Low current levels of containerisation – strong catching up effects.

Figure 11: Forecast of Container Traffic in the Black Sea Region, 2020



For the group of Black Sea ports considered by the study, substantial growth was expected in the container market, and there was a clear need to add capacity in order to meet the needs of the economies in the region.

In this session the importance of the Black Sea region was underlined as well as the importance of high quality data for efficient future planning.

At the last session of the seminar the benefit of the project was further described. One goal of the seminar was to create a two-way-communication and therefore it was necessary to explain how the participants of the meeting could can use or share data with the WORLDNET-Project. Two aspects were discussed: the use and development of the TRANSTOOLS model, and the access to data via WORLDNET.

The first presentation in this closing session was held by Jan Kiel (NEA) on TRANSTOOLS, the European IPR free network model. In his speech he explained the background of TRANSTOOLS as well as the components, dimensions and characteristics.

Finally Sean Newton presented the dissemination of the WORLDNET-Project. Thereby he gave an insight into the WORLDNET web tool, which is a site where users can look at and access the data (both data collected and model results) in the form of thematic maps or graphs.

It allows users to download data, it acts as a repository for project documents and provide network data collection "WorldNetter", which is a sort of Wiki for network data. The tool is available at www.worldnetproject.eu.

The Istanbul-Seminar was the first of three WORLDNET seminar to be held during the project implementation, and therefore the first time the concept had been attempted. Consequently it played an important role regarding the preparation of the upcoming seminars.

Given a background of difficulties in the seminar planning process, this first seminar suffered most from the initially slow progress, and it was fortunate that support from the host country organisations was enthusiastic. On balance it covered most of the key subject areas, although most of the discussion related specifically to Turkey rather than the diverse range of countries in the region.

Considering the whole seminar and the list of participants and their organisations as well as the upcoming questions, one main finding which characterizes the whole seminar could be identified. Although the freight transport market has been active in developing regional hubs and transport corridors in the East Mediterranean area, the planning processes to coordinate development in the region are still at an early stage. The data and modelling resources supporting the planning processes are not yet suitable for satisfactory multi-country analyses of freight movements. Furthermore, the frameworks within which data and models can be exchanged and harmonised are not fully developed. WORLDNET is already contributing to these activities, but these are not yet sufficient.

Certain deficiencies exist in the widespread understanding of the urgency of the planning process in the region. Countries such as Turkey are eager to optimise the outcome of their substantial investment plans and to reinforce the processes of economic integration. In this sense Turkey's progress in this sector is a useful benchmark for the dynamics of the region as a whole, and for that reason the focus upon Turkey for the first seminar was advantageous.

However, it was noticeable that despite efforts to involve other countries within the region, including Ukraine, Caucasus, Middle East and North Africa, the participants for the seminar were mainly from Turkish or Turkish-based institutions. As a consequence, it would be emphasized that in future seminars there would be more diversification regarding the participants, which meant focusing upon achieving a balance between the origin of the participants to achieve a better range of outputs from the seminar.

Regarding the goal to create a two-way communication it should be noted that many linkages had already been made in advance of the seminar, so it was possible to reinforce this by introducing the contribution of WORLDNET. Given limited time, the presentations have focused upon a few selected topics in detail.

Concerning the search for data, the seminar discussions indicated that identifying the data sources is not sufficient. Administrative barriers exist, which prevent the free exchange of data. This was broadly to be expected, but it was felt that the benefit for the participants or third parties should be outlined in future seminars to help create a win-win situation.

In general it could be said that the meeting in Istanbul sparked the participants interest in the WORLDNET project. The exchange of contact details as well as some discussions during the breaks and at the end of the seminar underlines the interest.

As might be expected, discussions about WORLDNET subjects, freight flows and network performance, are dominated in this region by political as much as technical considerations. Given relative stability, the region has demonstrated the potential to re-integrate very quickly, and once this process is initiated, the planning and the financing agencies need to respond urgently to market-led changes.

The speed of change is a key consideration, and something that requires an re-calibration of the West European mindset. In a complex and dynamic environment, timely data collection and dissemination activities have an important role to play. WORLDNET can contribute to this in the specified domains of freight transport and trade, particularly with respect to international corridors, provided it can keep pace and be responsive.

4.2 Seminar 2 – Beijing

The Beijing-Seminar took place on 8 May 2008. It was officially designated as the seminar for the "Rest of the World". Given this rather broad objective, the seminar focused upon Asian markets – with specific reference to China, North East Asia, ASEAN, the Central Asian markets (critical markets for oil, gas and similar products and also as export markets for EU products) and Russia, whose economic expansion and integration into the world trading system is crucial. To establish effective contacts in this part of the world, the consortium based its work on the experience, which was established throughout the affiliate of the consortium leader and further use its contacts in the world shipping and port markets to develop and review commercial trading links with the major trading partners in these regions.

It should be also underlined that seminars 2 and 3 needed a different approach even if both had a predominantly maritime character. This was mainly because during seminar 2 the project had to deal with the identification of a network of important private or public operators (most of them in the maritime sector) and export/ import industries, whose opinion can be of crucial importance for the EU external trade.

The main task of the seminar 2 was a reflection on the extent and quality of the trade relations, their perspectives, and their possible impacts on the European transport system (mainly ports and hinterland). It was expected that in the framework of WORLDNET, the brain storming between the seminar participants and the selected individual organisations, the project team, national officials and the European Commission could have fruitful results. Important output should be the reliable estimations about the level and quality of the maritime trade between the various external blocks and the European main regions, its problems, perspectives and the way forward. Of importance, for example, is to estimate the levels of present and future container traffic, which will have an immediate effect on the intermodal systems of European ports and hinterlands.

Beijing was a natural choice of location for the second seminar. On one hand China has been the most dynamic trading partner for Europe in the last decade, and on the other, it has been somewhat neglected from the point of view of European transport research. By contrast, linkages between North America, for example, and the European research community are often more firmly established through long-standing academic and business connections.

Understanding the development of China has direct relevance for port and airport investments in Europe, and the development of Eurasian overland linkages are already on the agenda. Planners in Europe wish to know how changes in China will affect them, and they also wish to understand how such rapid progress in the development of these transport networks has been made in such a short time.

Whereas the Istanbul seminar concentrated upon reinforcing existing linkages, and looking for roles WORLDNET could play, this seminar focused upon initiating contacts. As before, efforts were made to broaden the geographical scope of the seminar beyond the host country, and to focus upon subjects where the main knowledge gaps exist.

The meeting was officially opened by Dr. Ji Ma from the Department of Comprehensive Planning of the Ministry of Communications China. In her welcome speech she underlined three main issues:

- Growth of trade volumes between China and the European Union
- Importance of maritime transport (95% of trade to EU is operated by sea)
- Bilateral maritime agreement on transport between China and EU.

Dr. Ji Ma welcomed the initiative having such a seminar in Beijing to share the experiences in transport to further promote (transport) relations between China and the EU. Since the EU is China's largest export market, many of the WORLDNET objectives are clearly understood and shared within China.

During the first session, the WORLDNET project was introduced to the participants. After the opening and welcome speech Sean Newton gave an overview and outlined the objectives of the project with special focus on the scheduled seminars and he emphasised the importance of Far East - EU trade statistics, and the dynamism of this trade figures as compared with other regions of the World.

Following to the explanations of Mr. Newton, Mr. Ignacio Asenjo Ruiz from the European Union Delegation in Beijing focused his presentation on European funding activities and opportunities in China. He explained the role of the FP6 research programme and its consequences for China, which is an active partner country, particularly in technological areas. Following his speech below main issues could be stressed:

- The importance of FP6 (2002-2006) which was a strong tool for EU-China research cooperation.
- The interest in having a network of active partners in FP6 (Research Institutes and Universities in China) that could be a good reference of information and transport expertise for WORLDNET.
- Unfortunately it doesn't appear that the transport relations between EU and China have been the subject of research in any of the projects under FP6. However, there is scope for stronger collaboration in the area of transport research, particularly in FP7.
- Research funded by FP7 in the area of transport will contribute to European Policy Objectives, thus the Commission should be encouraged to take the transport relations between EU and China on board under the next FP programming.

The 2nd session was dedicated to rail transport links between Europe and Asia focusing on:

- The Trans-Siberian Railway Route: Connecting East Asia and Europe by Rail
- Development of Eurasian Land Routes.

Railway Linkages – Japanese and Chinese Perspectives

The first presentation of this session was made by Ms. Hisako Tsuji on the latest developments along the Trans-Siberian Railway Route. Ms. Tsuji is an expert from the Economic Research Institute for Northeast Asia (ERINA), based in Niigata, Japan, and the author of an authoritative book[1] on this subject.

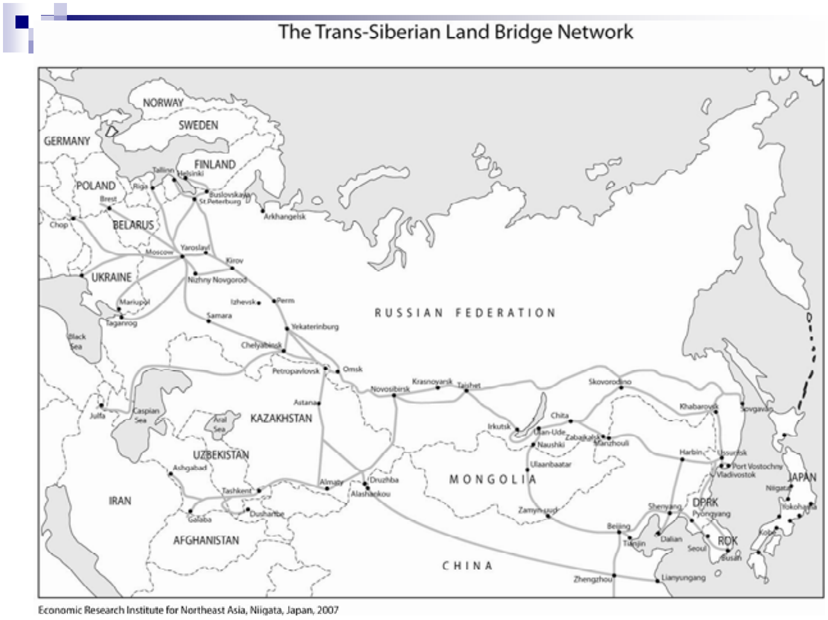
Ms. Tsuji provided a detailed analysis of the issues related to the Trans-Siberian Railway route, the main rail artery linking European Russia and Vladivostok (10.000 km) with branch lines to DPRK, China, Mongolia, Kazakhstan.

The performance of the line at present (2006) can be summarized as follows: it transported more than 72.2 million tons and 425,000 TEUs. The journey time

[1] Hisako Tsuji, 2007, The Trans-Siberian Land Bridge: The Main Artery of Japan-Russia Business. Seizando Publishers.

from Vladivostok to Moscow is 7 days by a passenger train, 11 days by a container block train. It will be double tracked from 2009.

Figure 12: The Trans-Siberian Land Bridge Network



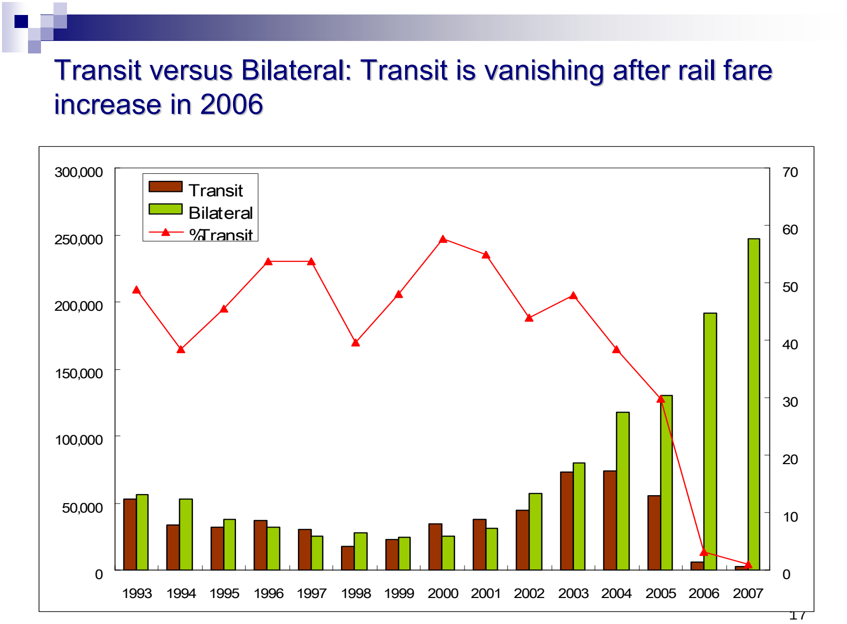
The present traffic has only a small share compared to the maritime flows EU-Far East, but the advantage is the travel time: it corresponds to half of the deep sea route from Japan to Moscow and is faster than the deep-sea route for transport from Japan/ROK to Finland, and East Europe.

The history of the TSR International Container Transport (TSRICT) is quite relevant to understand its potential for the future years. The TSRICT started in 1971 to transport cargo from Japan to Europe and Middle East, and already in 1983 the container volume reached 110,683 TEU. Following the collapse of the Soviet Union the route service deteriorated and lost its economic competitiveness versus the Deep Sea route. In particular, transit cargo originating in or destined from Japan reached a peak in the early 1980's (more than 100.000 TEUs) and is almost nil at present.

From 2000 onwards the booming Russian economy and its active demand for imports together with poor competing conditions of other routes (outdated Port of St. Petersburg and crowded Finnish route) constituted a recovery opportunity for the TSR. Finally from 2006 onwards it become an import / export route for Russia.

Today transit role is vanishing in favour of bilateral (Russian) and the use of the TSR is clearly imbalanced (88 % of the traffic is West Bound) with the problems inherent to the effective use and return of empty containers.

Figure 13: Transit vs. Bilateral Traffic on the TSR



Ms. Tsuji explained a New Business Model of the TSR Transportation focused on production parts delivery of FDI companies (trade between Europe and Japan, Korea) with fast and on-time delivery by block trains run by Russian operators and smooth customs clearance.

Presently the main problems are related to price competitiveness. For example, since 2005 for transit traffic high charges in Russia are in force, thus the TSR tariff is higher than the Deep Sea from Japan to St. Petersburg and Moscow. It is pointed out that a competitive rate will be the key for reviving a transit transportation, connecting East Asia and Europe. It was also pointed out the need to simplify customs clearances and introduce EDI as well as the upgrading and adaptation of port facilities, and associated capacities of forming block trains.

The TSR now attracts a niche market. In recent years the most important sectors have been the transportation of project cargo (e.g. mining equipment) and automobiles into Russia. These are likely to be the most profitable for the rail operators since they are high volume shipments. Future developments are likely to involve more activity on the links between China and Russia, and from Japan and Korea to Russia and Kazakhstan.

Although a promising route from the technical potential, there seem to be serious barriers to the free flow East West on the TSR mainly due to the lack of a joint perspective of all interested parties. This This problem was apparent during the following debate, where it was explained that the Russian strategy to discourage transit traffic to Europe is not transparent and has an important political connotation. Russian lack of transparency is also extended to the participation in funding from IFIs, the aspects of Coordination with the CAREC Central Asia projects. It appears that CCCT coordinating IFIs and Russia is taking an active part.

Furthermore no studies have been made comparing the environmental benefit of TSR against the deep sea routes.

Note that no representatives of the Russian railways were available at the seminar to elaborate these points.

The explanations on the Trans-Siberian Railway was followed by the presentation of Mr. Jian Hong Wu from the Ministry of Railways in China on the development of Eurasian Land Routes, and in particular the New Eurasia Land Bridge, a complementary route to the TSR.

Mr. Jian Hong Wu started the presentation with an introduction of the organization of the Railways in China.

The magnitude of the railway system in China can be grasped by considering that in 2006, the total passenger transportation volume was 1.26 billion people; the freight transportation volume was about 2.87 billion tonnes and these figures have shown a remarkable rate of growth over the past years.

He reported about a second Asian European land bridge with two corridors, North and South and showed interesting maps and details.

Figure 14: Eurasian Rail Corridors

The evolution of traffic on the land bridge was:

2006: 13 million tons, 140.000 TEU.

2007: 11 million tons, 180.000 TEU, 2-3 trains per day.

From the institutional side, there have been agreements between China-Kazakhstan and later with Russia to jointly promote the TSR.

The traffic between China and Central Asia has increased rapidly in recent years and the containerised traffic between China and Kazakhstan increased to 140.000 TEU in 2007.

A number of projects are being considered in order to improve the overall efficiency of the land bridge and the maps, which were presented showed new alternative routes being considered:

- One goes South of Mongolia and is expected to shorten considerably the whole transit time.
- In addition, a new advantageous route through central Asia and Turkey has been put on the table, but it is stopped for the moment. It goes South of the Caspian Sea.

During the debate it appeared that today the rail system is coping with various difficulties:

- Missing capacities
- Lack of coordination between partners involved (e.g. missing one-stop shops)
- Unreliability of services
- Missing harmonisation of customs services
- Not unified tariffs – especially on the European side that are too high (0.5.$ /TEU km; more than double than the Asian side).

Another possibility being considered is related to the Combined rail - air transport (lowering the tariffs and improving the service, specially for long distance transport).

The 3rd session was dedicated to air transport links between Europe and Asia focusing on:

- Market Outlook of Air Cargo between Asia and Europe
- Outlook of the Sino-Europe Air Cargo Market.

Air France/KLM Perspective

The first presentation of this session was made by Mr. John Engelaan, representing Air France/KLM Cargo.

The company is the result of the merger of Air France Cargo and KLM Cargo in 2005 and is the Nr.1 European carrier of international airfreight with a strong position on all relevant routes to/from Europe. Freight is based in Amsterdam. Schiphol and Charles de Gaulle are the hubs in Europe. Today it operates in 5 major areas in the world, 2 of them Europe and Asia. Within Asia it operates in 6 markets, which use some 15 hub airports in the region.

Asia represents 30-35 % of the total traffic and the so-called “Greater China” is the fastest growing market, with Japan being the number 2 market.

Most of cargo capacity is concentrated in China, where cargo revenues are higher than passenger revenues (Shanghai has the largest increase of all airports and Beijing is also growing fast; it will be in top-15 after 2008).

Figure 15: Market Opportunities for Airfreight

Within the next 20 years, China's airfreight traffic is expected to rise six-fold and its dedicated freighter fleet will grow eleven-fold. This rapid growth will certainly put the current infrastructure under pressure. The lack of trained staff might have an impact on safety and security.

Concerning Chinese infrastructure, there are 133 airports with cargo activity (5.6 million tons) but 77% of total traffic is concentrated on 10 airports and 44% of all domestic air tonnage moves between the top 10 city pairs.

The challenges for air traffic are:

- Increase of fuel prices impacts
- Custom regulations in China differ per station and there is no clear solution for the return cargo given the imbalanced import – export flows.

Among the future company's prospects it is envisaged that a new carrier AF / KLM / China Southern will also allow direct flights to Frankfurt.

Chinese Civil Aviation Development Institute Perspective

The second presentation of this session was made by Ms. Xingli Fan from the Civil Aviation Development Institute, who gave a general overview of the air cargo market in China.

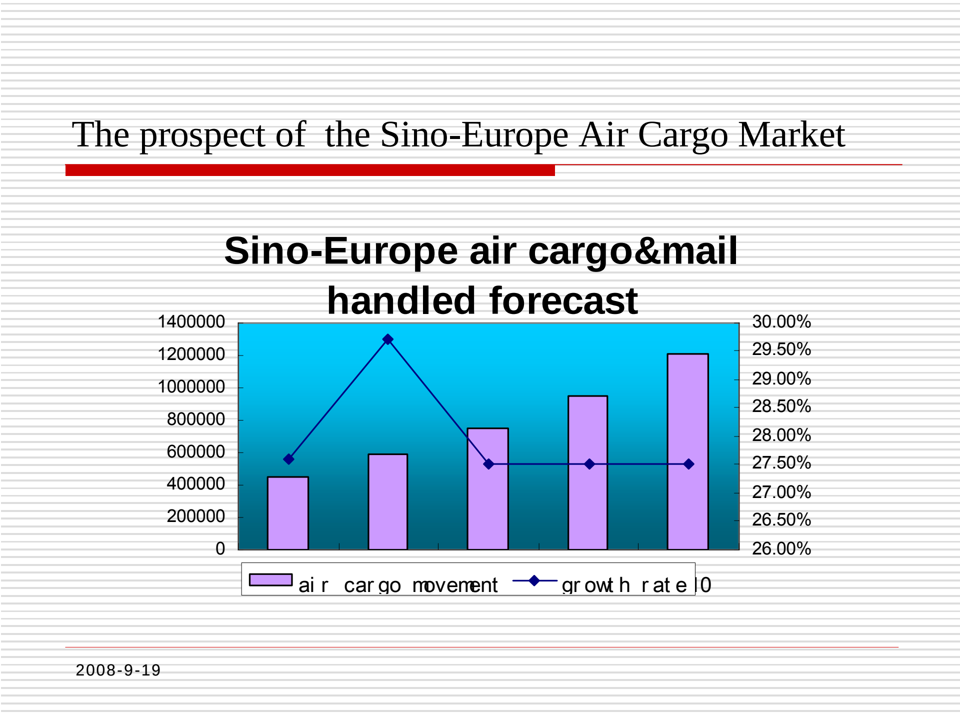
The air cargo market in China is highly dynamic with 16.5% annual growth rate from 2000 to 2007, and even higher for the international routes (23.3%). These routes represent 35.7% of the total volume and the traffic is highly concentrated in ten Chinese airports, the most dynamic being Shanghai and Beijing.

The top three routes from China to Europe are from Beijing to Frankfurt, Paris and Amsterdam and from Europe to China from Paris and Madrid to Beijing and Shanghai.

The carriers in this trade are 5 Chinese airlines (36%) and 8 foreign airlines (64%).

Given the extraordinary growth of this Sino-European traffic, it is expected to increase at a rate of 27.5% from 2007 to 2010. (meaning 1.28 million Tons in 2010).

Figure 16: The Prospects of the Sino-Europe Air Cargo Market



Summarising the two presentations on the air cargo market it became evident that there are expectations of continued high growth for the coming decades. However, the prognosis needs to be viewed in the context of certain risk factors affecting Euro- Chinese trade such as the increasing price of energy, and probable changes in the future pattern of western industrial delocalisation.

During the debate following these two interventions, the WORLDNET team raised the question that, in view of the huge speed of growth in this mode of transport, we need to provide for sufficient capacities (infrastructure capacity at both ends) as well as the correct service structures (well trained personnel) and the elimination of barriers (open sky agreements), which allow for competition (currently the airspace in China is controlled by the military).

Both Ms. Fan's answer (no problem in China about increasing of capacities) and Mr. Engelaan's (we can manage with the services issues as well) presented an optimistic outlook. However, there was a question mark about the rate of capacity growth at European hubs.

Sea Transport – Chinese Perspective

The presentation of this session made by Mr. Wei Li tackled the strategy of ports layout and port logistics development in China. Mr. Li is senior engineer of the Transport Planning and Research Institute (TPRI) of the Ministry of Communications, which was founded in March 4, 1998. The TPRI is responsible for the development of strategic research planning, policies and regulations, brainpower for decision-making, etc. on Highway and Waterway Planning & Design.

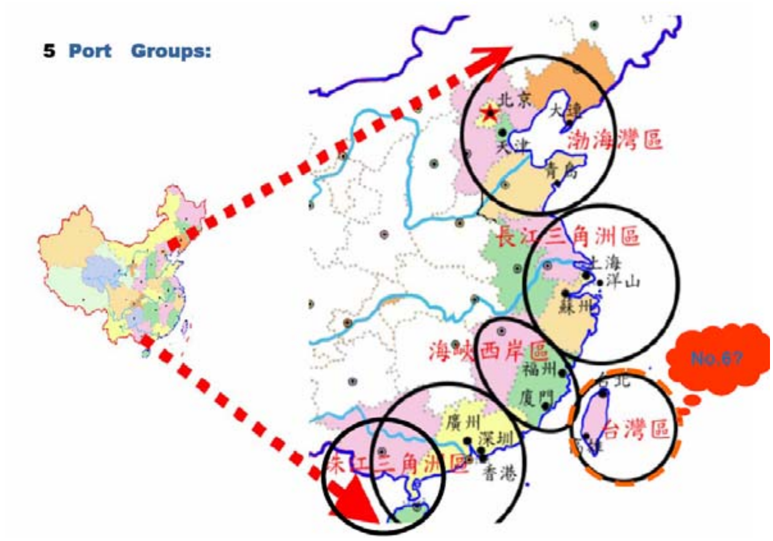
He explained in detail the legal framework, of which the "Port Law" was promulgated at Jan. 1, 2004 and the detailed contents.

At present, the EU has become China's largest trading partner. In 2007, the bilateral trade volume between China and the EU reached 356.1 billion US dollars, and ***95% of trade in cargo was transported by sea***.

He explained the key principles established in the Agreement and the Chinese trade figures by world block, including the EU.

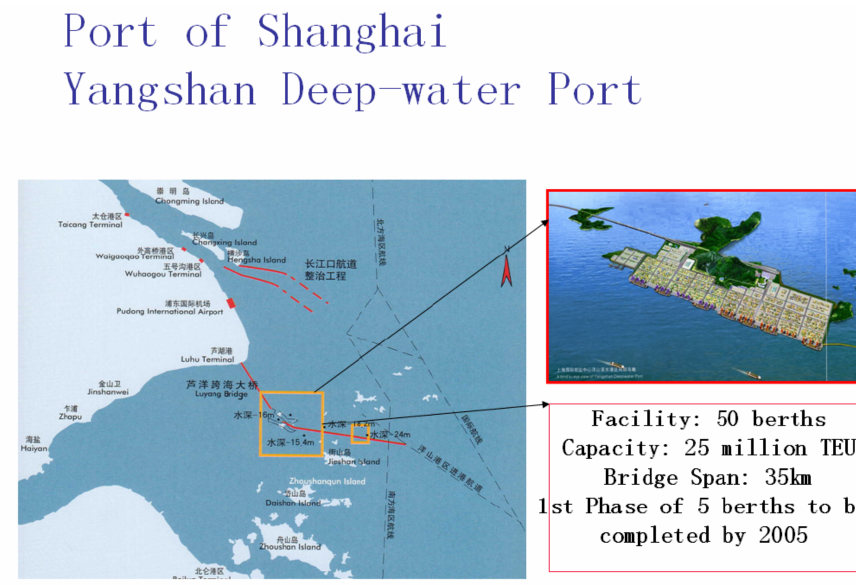
The Chinese port system consists of more than 150 coastal ports distributed by the Port Plan of 2006 in 5 main Port Groups. The "Distribution Plan of National Coastal Ports", approved in 2006 indicated a new development period of coastal plans in China.

Figure 17: Distribution Plan of National Coastal Ports (China)



In the plan, complementary port groups (in terms of function) would be established, certain key ports would be expanded into world class hub ports, and the integrated development of port-city linkages would increasingly appear. An example of port development at Shanghai (Yangshan deep water port) in which offshore islands have been extended by land reclamation and connected to the mainland by the 35km Donghai Bridge.

Figure 18: Yangshan Deep Water Port



Five of the top 10 biggest ports in the world are located in Northeast Asia, including Hong Kong, Shanghai, Shenzhen, Pusan, and Kaohsiung.

The cargo throughput in 2005 reached at 3.38 billion tons, which is more than double of that in 2000.

Its economic hinterland is a population of more than 1.5 billion. Northeast Asia is the economic core of Asia, with the present total GDP accounting for 1/ 5 of the whole world. The quantity of containers accounts for 30% of the whole world, which is expected to grow to 0.13 billion TEU in 2011.

Furthermore he explained the trade liberalization process in Northeast Asia from a global perspective and on that basis the Port logistics evolution.

The scale of the Chinese port system is in proportion with its huge hinterland population and the traffic through its ports has probably experienced the highest rate of growth in the world in recent years.

The Agreement recently signed with the EU should allow, in principle, unrestricted access to the international maritime market, as well as right of establishment of European shipping companies including door to-door multimodal transport operations. This appears to be a good institutional step, given the preferential position of the EU trade in China, but the realization of these potentials remains open.

In any case, some doubts could be raised as to the efficient functioning of this port system in the next few years. In this respect, one of the questions put in the debate to Mr. Wei Li, was about the existence and status of the coordination between the ports planning and the railways planning giving access to ports. The answer provided was that officially this issue should not pose problems.

Other questions raised included:

- The establishment and functioning of the logistic platforms in ports, and
- The present situation of the port access to their hinterland, railways, inland waterways as well as the modal split in the hinterlands traffic.

The 5th session could be summarised as activities in the field of research and data collection.

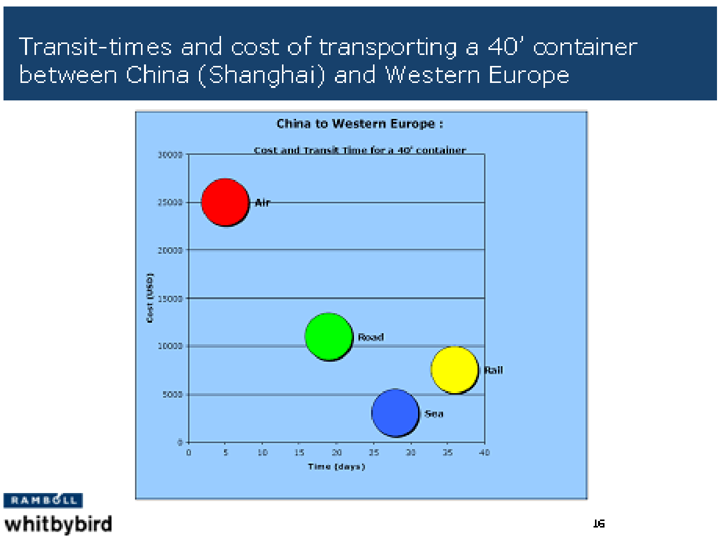
Eurasian Linkages – European perspective

The first presentation in this context was made by Mr. Arman Farahmand-Razavi introducing a feasibility study on Trans-Eurasia Transport, looking at the competition between maritime freight and overland options between Europe and Asia.

The US Chamber of Commerce had commissioned a study of “Land Transport Options between Europe and Asia”, focusing on the feasibility of land transport, particularly trucking. At present road and rail traffic (0.36 million TEUs) is negligible compared with sea transport (7 million TEUs).

The study considered competition on a particular route between Shanghai and Berlin.

Figure 19: Transit Times and Costs between Shanghai and Berlin



Following the initial analysis, sea transport is the cheapest and quickest way and rail is cheaper than road but slower (35 days). Eurasian trucking is not yet mass marketed to shippers and there is potential interest in developing capacity in order to open up trade relations with Central Asian economies. Furthermore, in cost terms, road transport is 3-4 times higher than sea transport and the regulatory framework lacks important elements. It should be pointed out that the road transport faces long delays in border crossing, particularly in the two borders of Kazakhstan.

It was noted that the results concerning rail transit time and costs do not match with the information provided by Ms. Tsuji Hisako in her morning presentation and this aspect is crucial for the purposes of the competitiveness of the rail alternative. However, it was pointed out that competition on a single route between Shanghai and Berlin is not necessarily indicative of all possible Eurasian linkages. Ms. Tsuji Hisako argued that there are big differences depending on the point chosen in China for the measuring of transit time.

During the debate following this intervention, the WORLDNET team questioned the relatively long transit times calculated for rail and the air cargo rates provided in the presentation.

A discussion took place on the prices of the different modes. In the case of maritime, the average hinterland leg at each end was considered to be 100 km.

While it was clear that the sea and air modes would dominate the core Eastern China-Western Europe market, with their relative strengths in the volume sector and high value sectors respectively, it was agreed that as the origin and destination points moved further inland, these advantages would diminish.

World Freight Flows – Singaporean Perspective

The second presentation of this session was made by Mr. Raguraman from the Centre for Maritime Studies in Singapore, part of the National University of Singapore (NUS). He focused upon data needs and considerations, and demonstrated a set of international freight data sources relevant for WORLDNET, and the likely problems that might be found.

An introduction was made to the "Maritime Asia-Pacific Research Network (MARNET)" [1], officially: "*Seeking to promote opportunities for better understanding, knowledge building, networking and collaboration between researchers and analysts of maritime and intermodal issues of the Asia-Pacific region*". MARNET has, therefore, somewhat complementary objectives to WORLDNET in the maritime field.

The purpose of the presentation was to give a picture of the demand (shippers), and supply (carriers and terminals) for transport services including a comprehensive review of traffic statistics covering Asia and Europe, much of it sourced from Eurostat and UNCTAD. Experiences on data needs for transport supply, demand as well as costs for intermodal transport options were outlined.

Very interesting presentations about alternative route and mode combinations were made and very instructive diagrams were presented (functioning of hubs) which help to understand the cargo movements between both ends. These

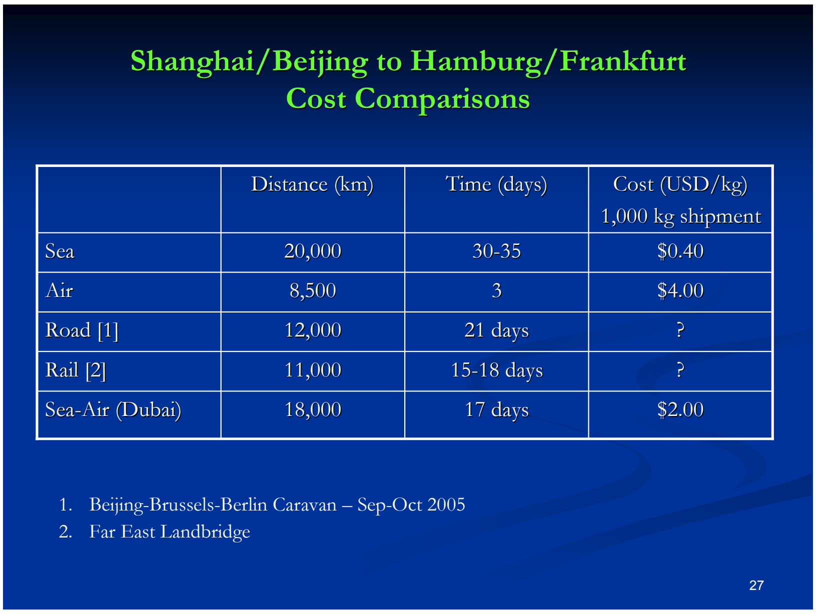
[1] See: http://www.nus.edu.sg/maritime/MARNET_Website/CMS_marnet.html

included examples of sea-air intermodal options between Hong Kong and Frankfurt via Dubai (by sea to Dubai, and by air to Frankfurt).

He presented a forecast of Asia-Europe container trade in which volumes were expected to increase from 15.8 million TEU in 2006 to 34.9 million by 2016. The Eastern European segment, currently the smallest, would increase five fold.

Transit time and costs for different modes were presented. Here, the rail transit time was consistent with the information provided by ERINA.

Figure 20: Asia-Europe Cost Comparisons



Shanghai/Beijing to Hamburg/Frankfurt
Cost Comparisons

	Distance (km)	Time (days)	Cost (USD/kg) 1,000 kg shipment
Sea	20,000	30-35	$0.40
Air	8,500	3	$4.00
Road [1]	12,000	21 days	?
Rail [2]	11,000	15-18 days	?
Sea-Air (Dubai)	18,000	17 days	$2.00

1. Beijing-Brussels-Berlin Caravan – Sep-Oct 2005
2. Far East Landbridge

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Within the presentation of Mr. Raguraman, certain interesting points can be summarised:

- Combinations sea-air (for example, Hong Kong – Dubai (sea), Dubai - Frankfurt (air) – subsidies by Dubai). In this case, for the success of the operation, the airlines should ensure the return trip from Dubai.
- The concept of “re-export” (which is not the same as transhipment).
- It appears to be safer to calibrate with trade statistics rather than transport statistics, which could create same problem with TRANSTOOLS.
- People from the industry sector should be included to verify transport and trade statistics.

There was a close relationship between the objectives of the NUS (National University of Singapore) research and the work of WORLDNET, and he provided useful data sources and advice concerning the methodology.

Modelling Maritime Networks – Japanese Perspective

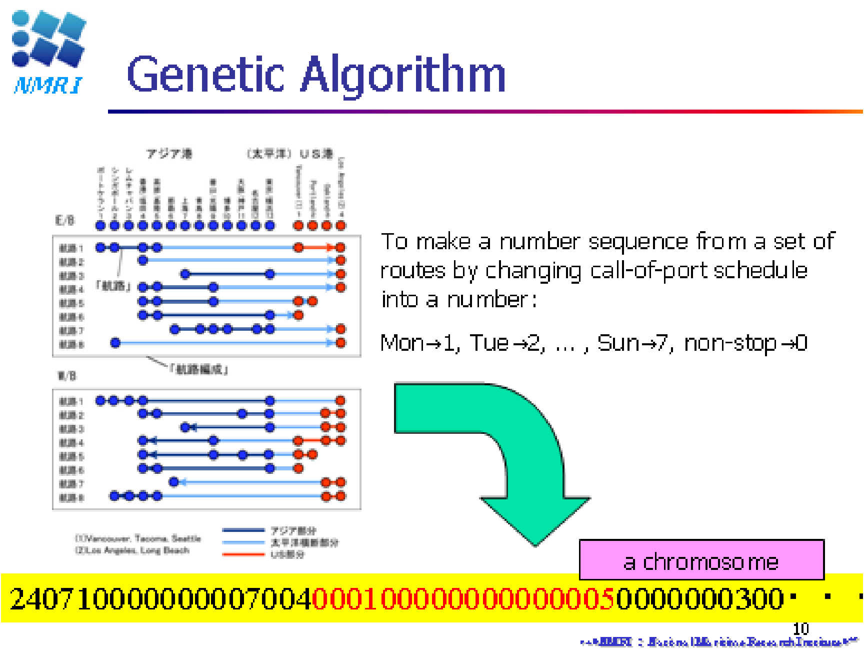
The last presentation of this session was made by Mr. Takahiro Majima from the National Maritime Research Institute in Japan.

The presentation was about a Study on Automatic Scheduling System for Pacific Liners with genetic algorithms for generating routes and schedules for the Pacific container liners.

One of the tasks within WORLDNET is to develop a model of maritime networks. So far, maritime networks are handled in a minimal way in the European models. The NMRI model offers possibilities in terms of extending the capabilities in this area.

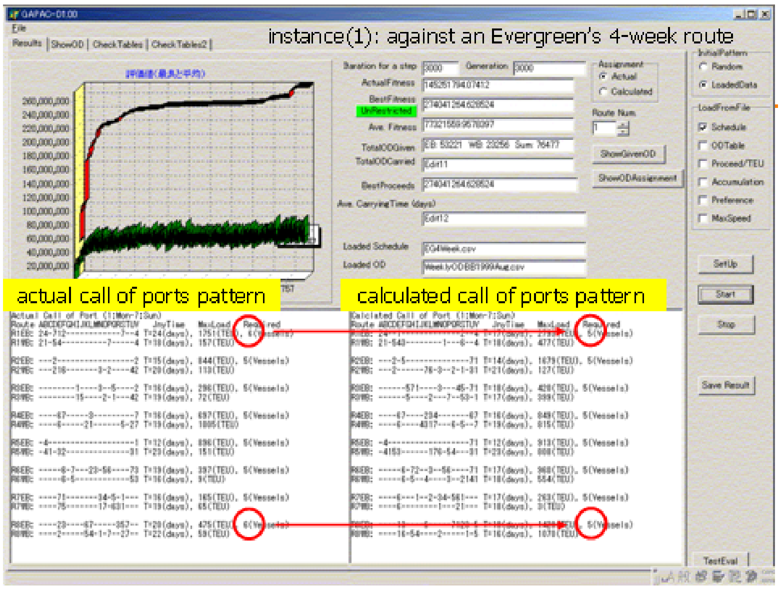
The problem of designing a shipping schedule is complex. Whereas land journeys can be represented as link flows within a network, and routes optimised through a path search, maritime networks offer many more degrees of freedom. The NMRI model interprets sequences of port calls as chromosomes and by simulating the genetic processes of evaluation, selection, crossover and mutation, "fit" sequences can be identified relatively quickly.

Figure 21: Genetic Algorithms to solve Ship Scheduling Problems



The model can be set up to generate optimised networks of shipping schedules and compared against actual performance.

Figure 22: Modelled Ship Rotations (NMRI Model)



Although it seems that there is some room for further model development, presently the system makes it possible:

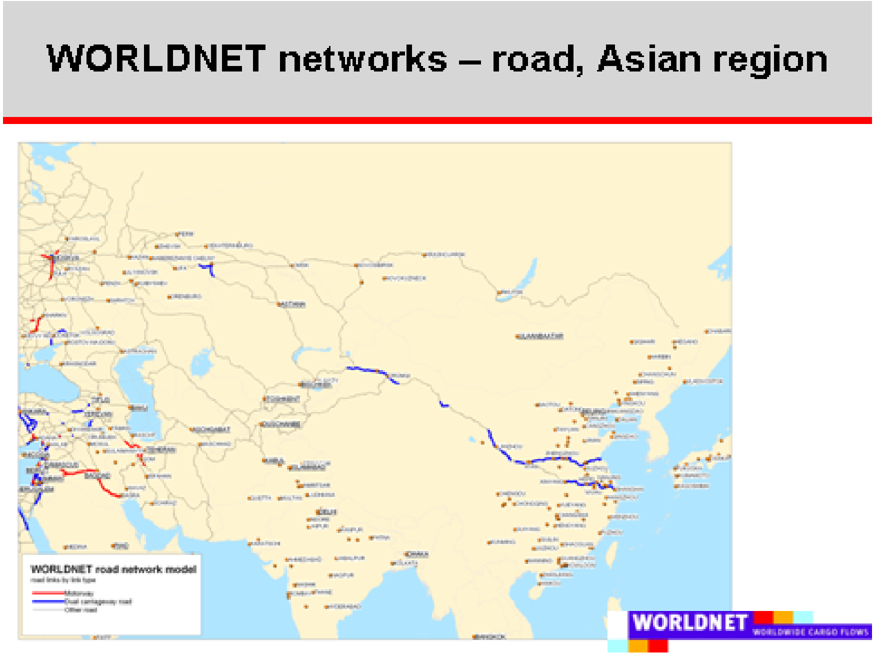
- to examine a quick modification for change of cargo amount or circumstances for a container shipping company.
- to generate a countermeasure against other container shipping companies.
- to discuss the management or operation of the container shipping company.

The WORLDNET team proposed a number of possibilities to adapt this model, since it appears to fill certain gaps on the supply side.

The last session provided comprehensive information on the methodology used for WORLDNET enabling the participants to become familiar with the approaches for the different modes of transport and the tools for dissemination. Their contents are similar to the Istanbul Seminar, but they made explicit reference to the Euro-Asian relations.

The first part of this session included a presentation of Mr. Eckhard Szimba giving an overview of the road and rail database, which was developed within WORLDNET. One goal of the project is the extension of different network models to neighbouring countries of the EU.

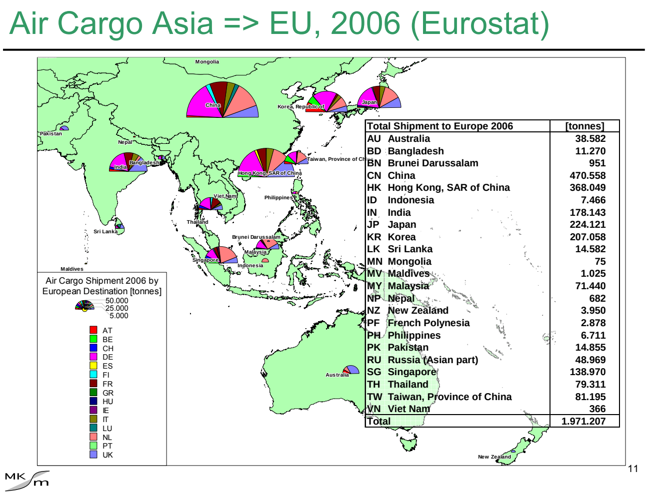
Figure 23: WORLDNET road network, Asian region



Thereby the demand dimensions and network planning as well as corridor planning data in the certain countries are a crucial criteria for a network extension, within the WORLDNET rail/road network models, TRANSTOOLS, the VACLAV network models as well as further sources.

A further essential part of the WORLDNET-Project is air transport. Mr. Benedikt Mandel gave an overview of the progress in building freight flows and networks for air cargo.

Figure 24: Air Cargo Asia-EU, 2006



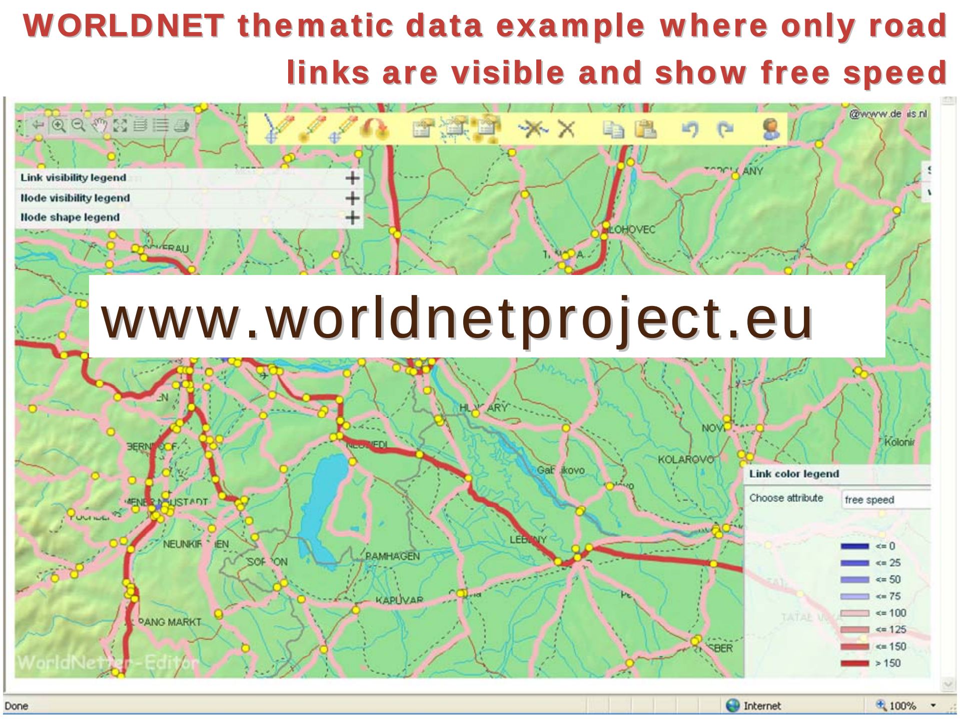
During his presentation he pointed out the need for several data including:

- Air cargo & passenger statistics (by type, destination and direction)
- Socio economic data on given regionalisation

- Road feeder impedances between region and airport and
- Volumes and shares of commodity groups.

Concluding this session Mr. Poul Grashoff presented the dissemination of the WORLDNET project.

Figure 25: WORLDNET web tool



Thereby he gave an insight into the WORLDNET web tool, which is a site where users can look at and access the data (both data collected and model results) in the form of thematic maps or graphs. It allows users to download data, it acts as a repository for project documents and provide network data collection “WorldNetter”, which is a sort of Wiki for network data.

This Seminar has covered a very wide set of topics and has offered a range of different national perspectives. In general the lessons learned in Istanbul have been applied and the planning for Beijing was improved. As before the response was highest from the host country, but high quality inputs were also obtained from Japan and Singapore.

Although certain aspects of the role to be played in future by Russia have been covered, the team has been advised by the ERINA expert to seek further contacts from the Russian railways. During the planning, several Russian institutions have been contacted, and although they have offered help, it has not been possible to attract them to Beijing.

One of the main impressions has been the strong consensus for continued growth in Euro-Asian trade – even at a time when several Western economies are entering periods of slow-down and recession. Chinese investment in port facilities, air cargo networks and inland rail are continuing at a high level, and confidence in these sectors is high. Particular attention is focused upon markets in the South and East of Europe. So whilst attention in the West turns towards financial and energy-related crises, it is important to stress that the process of East-West global integration through trade is expected to continue.

As economic linkages and market inter-dependencies develop, the need to monitor and analyse these connections at an international level increases. For example, it is impressive that a relatively small country such as Singapore, has made advances in this area, anticipating many of the objectives of WORLDNET. Today Singapore is highly influential in Europe's transport market through container shipping, air cargo, and terminal operations (NOL, SIA and PSA respectively), so the perception of Singapore's relevance should not be understated.

In the two most developed sectors, maritime containers and air cargo, further growth is expected, with greater emphasis on the Chinese market. China is acting faster than Europe in terms of investing in new capacity for these trades. Hybrid sea/air combinations are starting to appear.

Rail transport links are undergoing high levels of investment in China, with ambitious plans for new Sino-European routes. The Trans Siberian railway is also developing, but with the emphasis towards serving Russian trade routes with respect to Eastern and North-East Asia. Niche markets such as trade cars and project cargo are the main focus, so competition with maritime cargo is as yet limited. The prospects exist to improve transit times by rail towards the EU, but rail costs in Europe are seen as prohibitive, so the potential for rail linkages that can compete with maritime links in terms of either cost or capacity is limited.

Eurasian road links are as yet under-developed. Trucking is not seen as a viable competitor to other options, but simplified regulations could help to open up trade links towards the land-locked countries of Central Asia from both Europe and Eastern Asia.

From a research perspective, the contacts have been positive, particularly in terms of the content synergies. Several opportunities exist for countries such as China to participate in EC research frameworks, but so far this is not directed towards the subject matter of WORLDNET. In that context, the work being carried out in Singapore and Japan fits closely.

In any case, one very positive aspect of the seminar was the network of qualified persons which has been created. The maintenance of this network will be developed further within WORLDNET.

4.3 Seminar 3 – Buenos Aires

The Buenos Aires-Seminar took place on 26 June 2008. This seminar focused on trade and transport relations between the EU and the countries in Central and South America, with the maritime sector as the natural centre of attention. In preparing this seminar, the active participation of senior officials and experts from maritime authorities of the region was sought, along with officials from the main IFIs acting in the region i.e. the World Bank and the Inter American Bank of Development as well as main consultants in the maritime transport sector of the region.

It should be also underlined that seminar 3 needed a different approach from seminar 2, even though both had a predominantly maritime character. This was mainly because during seminar 3 the project dealt with a set of transport (port) institutions of relevance, whose areas of interest should be investigated during the project, together with possible issues of common interest that could build better future cooperation, including the identification of a network of important private or public operators and export/ import industries, whose opinion can be of crucial importance for the EU external trade.

An important objective of this seminar was to deal with basic issues and practical experiences concerning ongoing major transport projects in the Latin American Region, which could have an impact on the transport relations between the two regions. It was expected that in the framework of WORLDNET, the brain storming between the seminar participants and the selected individual organisations, the project team, national officials and the European Commission could have fruitful results. Important outputs should be the reliable estimations about the level and quality of the maritime trade between the various external blocks and the European main regions, its problems, perspectives and the way forward. Of importance, for example, is to estimate the levels of present and future container traffic, which will have an immediate effect on the intermodal systems of European ports and hinterlands.

For this part of the world, there are neither a solid information background nor a network of experts familiar with these relations and therefore the seminar had also the purpose of establishing an initial network of communication for exchange of information and future contacts among experts both sides of the Atlantic.

From the beginning, the intention was to use the third seminar to develop linkages with the Spanish-speaking countries in Central and South America, bearing in mind the network of contacts within the WORLDNET consortium. Therefore the choice was made to base the seminar in Argentina rather than Brazil.

The context for the seminar was that (according to IMF estimates), growth in South America had been relatively strong, with the best four-year performance since the 1970s. Argentina was at the top end of the scale, achieving rates of 8.5 per cent annual GDP growth since 2006. As an important commodity producer, an emerging market, and a country with strong cultural ties to South West Europe, Argentina offered the WORLDNET team an opportunity to examine a different set of issues related to economic development, globalisation and the effects upon the transport sector.

The meeting was officially opened by Mr. S. Dorrego on behalf of Mr. R. Luján, Secretary of State for Ports and Inland navigation of the Government of Argentina, followed by a short introduction by Matthias Jorgensen, responsible for Trade and Economic relations of the Delegation of the European Commission in Argentina who recalled that the EU is the first investor and the second trade partner in the region and consequently stressed the importance of the

WORLDNET project within the overall framework of relations of Latin America and the EU.

During the first session the WORLDNET Project was introduced to the various participants.

Sean Newton gave an overview and outlined the objectives of the seminar along the lines followed in the two previous seminars.

Following the explanations of Mr. Newton, Mr. F. Aragón Morales, from the WORLDNET team, outlined the European Transport policy focusing on the objectives and instruments related to transport infrastructure. He summarized the chronology and milestones of the development of the Trans- European Transport Network, outlined the various instruments for selection and financing of projects of common interest and described the policy framework of the White Paper of 2001 and the new priority references of the Mid term policy review. Finally he stressed the importance of the initiative of extension of the TEN-T to the neighbouring countries. Apart from the five main trans-national axes, which are basically connecting with the Euro Asian countries by land links. In the case of the transport relations with Latin America, the crucial points will naturally concern the main European ports (and airports) and their connections with their hinterlands.

In this perspective, Mr. Aragón summarized the Commissions expectations of the WORLDNET project in the context of the enhancement of TRANS-TOOLS, along the line of the presentations in the two precedent Seminars. Given the importance of the EU as an investor and trade partner of Latin America, he launched a question to the Seminar: will the Latin American efforts in upgrading their transport networks be at the level of the challenge faced by a very dynamic increase of the trade between the two regional partners (LA and EU)?

Ports and the maritime sector play a fundamental role in the trade and transport relations between Latin America (LA) and the EU. One important issue to be explored in the seminar was the way in which the large ports on the LA continent are served by their hinterland links, the scale of the continental land network and its ability to connect production and consumption areas with the sea.

There is a recent ongoing initiative envisaging the development of a multimodal network in Latin America, known as "Initiative for the Integration of Regional Infrastructure in South America (IIRSA)". It was created as a result of the Summit of South American Presidents held in Brasilia in the year 2000 with the objective of the efficient coordination of the Multinational transport infrastructure (MTI) projects[1] on the continent.

IIRSA uses the concept of "Integration and Development Axes" to organize its vision of physical integration. Their deployment is expected "to improve access to areas of high productive potential that find themselves currently isolated or

[1] See the interesting paper "Coordination of public expenditure in transport infrastructure: analysis and policy perspectives for Latin America" by R. Cárcamo and J.G. Goddard, CEPAL, Santiago, Chile, January 2007.

under-used due to the deficient provision of basic transport, energy or telecommunication services".

Under this perspective three main large projects were presented in this session as follows:

The "Hidrovía Paraná – Paraguay" project

The project was presented by Mr. R. Escalante, Engineer in charge of the project's navigation and signalling system of the Company Hidrovía S.A.

It is a large maritime and inland navigation project, (one of the IIRSA's "Integration and Development Axes" in the continent) running from the South of Brazil through East Bolivia, Paraguay, Uruguay to the Northeast of Argentina. The total length of the waterways is more than 4.000 km, spread in the main two rivers Paraná and Paraguay and flowing into the Atlantic at Buenos Aires.

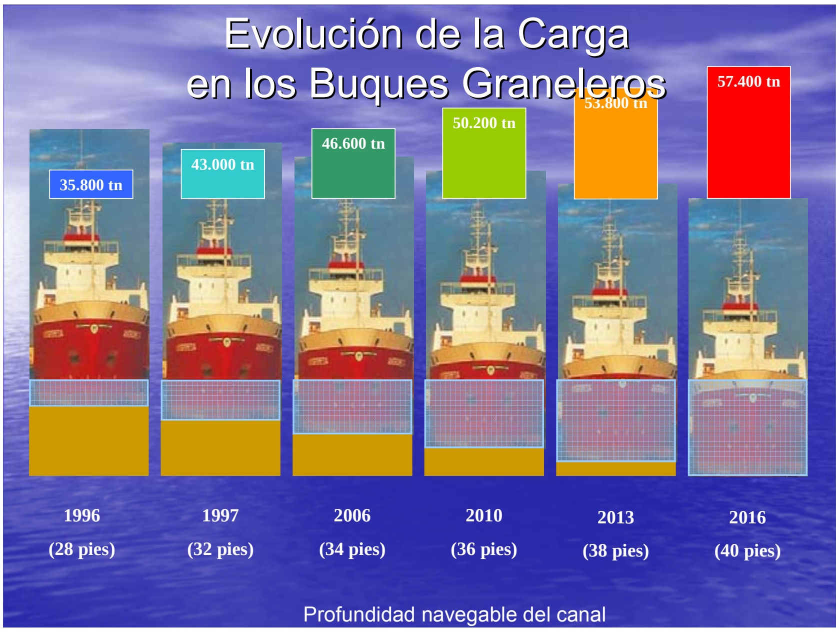
Figure 26: Hidrovia Parana-Paraguay

The navigability of this waterway is rather satisfactory, both in terms of the depths, vessel sizes as well as the total length. Only at the section of the Itaipú dam, it needs locks. It admits bulk as well as container vessels of the Post Panamax and Cape sizes (59 feet draught) whereas the last type is not frequent. Although, the canal width is only 100 m in average, it doesn't create problems for navigation in view of the present level of traffic. The depth of the container vessels using the waterway has been increasing steadily in recent years. Most of this traffic is international import and export.

Most of the traffic concerns dry and liquid bulks, and the rate of growth of the traffic has been impressive - more than doubling in the last ten years. Container traffic shows a strong evolution, too.

Concerning the future, there is a prevailing concept allowing for an increase of the size of the vessels that would produce clear economies of scale.

Figure 27: Evolution of Cargo and Ship Size



Consequently, there are important initiatives to enlarge and deepen the waterway in the upper sections of the projects as well as providing better conditions of access to a dozen ports in the hinterland. However, these projects require coordination between the various countries involved and there are evident problems and delays. Even at the level of a single country (Argentina) serious institutional problems appear, although the rate of return of most of the upgrading and enlargement projects along this waterway seem to be very satisfactory.

In view of the geographical scale of the project, the potential for multimodality and intermodality, in particular with the railway, is evident.

The consequences of the use of mega carriers on Ports and Trade between America and Europe

This subject was presented by Eng. Ricardo del Valle, Secretary of State of Port Activities Ministry of Agriculture Affairs and Production.

In his speech he described the regional port system focusing on the port of Buenos Aires, which handles 35 % of the overall country ports traffic. The use of mega carriers (up to 16.000 TEUs capacity, 300 m length, 18m draught) poses a challenge, which will have an impact on the port strategy at the national and continental level.

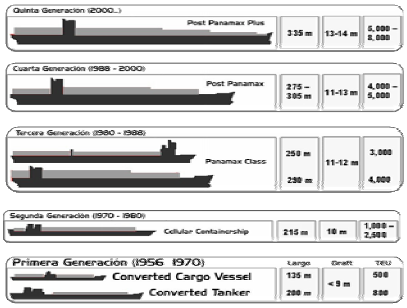
Figure 28: Ship Size and Port Strategy, Buenos Aires

Buenos Aires LA PROVINCIA

Ministerio de Asuntos Agrarios y Producción

El desarrollo de megacarriers impacta directamente en:

- el transporte y logística internacional
- la política portuaria y de vías navegables nacional/regional



Los buques de "sexta generación" - 11.000/12.000 TEUs-, no recalan en nuestros puertos pero impactan indirectamente al alterar la organización del tráfico mundial de cargas

Su desarrollo resalta la relevancia estratégica de los **puertos hub/regionales**

The ports of the LA continent, including the Caribbean, handled 28 million TEU in 2006, as a result of a very dynamic growth in recent years. One fourth of the overall ports traffic is concentrated in only 6 regional ports, of which Santos (Brazil) is the first and Buenos Aires the second. The container traffic in these ports has increased at an annual rate of 24% during the period 2001 – 2007, which means a rate well above the GDP growth in the region.

Figure 29: Principal Seaports in Latin America

Buenos Aires LA PROVINCIA

Ministerio de Asuntos Agrarios y Producción

Principales puertos de la Región

Latinoamércia y Caribe: movimiento portuario				
Países con movimiento > 1MM de TEUS				
	País	2005	2006	Var % 2001/2006
1	Brasil	5.302.242	7.122.056	142%
2	Panamá	2.731.705	2.949.073	85%
3	México	2.133.476	2.676.774	97%
4	Jamaica	1.670.800	2.150.409	119%
5	Argentina	1.501.120	1.748.830	32%
6	Chile	1.715.999	1.544.608	28%
7	Bahamas	1.121.285	1.390.000	144%
8	Colombia	953.331	1.333.764	86%
9	Venezuela	1.069.008	1.186.798	28%
16	*Uruguay*	*454.517*	*519.218*	*72%*
TOTAL LATAM + CARIBE		**23.607.352**	**27.997.105**	**74%**

Fuente: CEPAL

20 principales puertos de América Latina y el Caribe		
TEUs		
	2005	Variación 2005/2002
1) Santos, Brasil	2.267.921	84%
2) Colon, Panamá 1)	2.054.285	42%
3) Kingston, Jamaica	1.670.800	57%
4) Freeport, Bahamas	1.121.285	30%
5) Buenos Aires, Argentina 2)	1.375.173	84%
6) Callao, Perú	887.035	70%
7) Manzanillo, México	872.562	37%
8) San Antonio, Chile	773.048	76%
9) Puerto Cabello, Venezuela	746.810	48%
10) Puerto Limón-Moin, Costa Rica	688.563	22%
11) Rio Grande, Brasil	665.111	46%
12) Balboa, Panamá	664.185	76%
13) Itajaí, Brasil	644.000	92%
14) Veracruz, México	631.308	15%
15) Guayaquil, Ecuador	567.608	23%
16) Cartagena, Colombia 3)	549.860	134%
17) Puerto Cortes, Honduras	468.563	33%
18) Montevideo, Uruguay	454.517	55%
19) Paranaguá, Brasil	420.000	55%
20) Valparaíso, Chile	377.275	26%

Fuente: CEPAL

One of the most important challenges refers to the present inability of these ports, whose maximal draught is only 13m, to receive the large mega carriers in the immediate future.

In parallel to this, only the trade between the Atlantic façade of Mercosur (Brazil, Uruguay, Argentina) and the EU in 2008 will result in more than 2 million TEUs.

On the basis of the observed trends of both the Argentina's trade and containerised port traffic, as well as the level of population, its port system is expected to become a fundamental hub in the region. However the port of Buenos Aires has no possibility of expansion and will soon be saturated. It will not be in a position to respond to the challenge and for that reason the authorities are now gathering an old idea planning an important new container port down the river of La Plata in the mid term, which at the same time would become the first port of access to the above mentioned Hidrovía.

Figure 30: New Container Port Development Plans at La Plata

The new port would count on a 42 feet draught in 2016, and would combine rather satisfactorily with the enlargement and upgrading of Hidrovía. The new port would, at the same time, have an excellent connection with the hinterland, where the main production centres of the region are located.

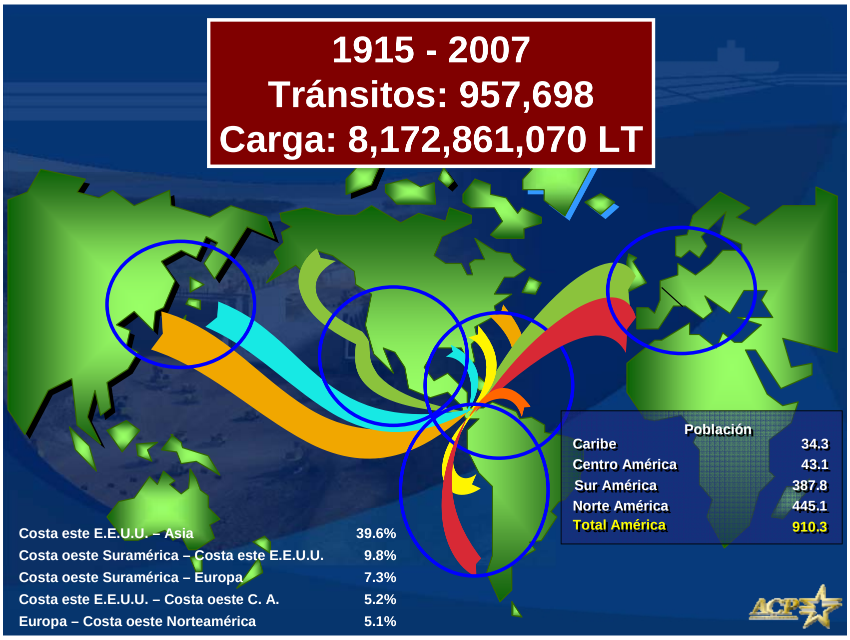
The project of enlargement of the Panama Canal and the alternative projects

This subject was presented by Mr. Eduardo Lugo head of the line services of the Bureau of Analysis of the Panama Canal Authority.

The traffic transiting the Canal affects a population of more than 900 million on the American Continent. Originally the Canal was used to transport bulk cargo (grains, oil, minerals…) but today, in parallel with the world trends, 59 % of the traffic is containerised cargo.

For the purpose of this seminar, it is relevant to say that the main markets for Europe via Panama are the West Coast of Latin America (7.3 % of the total traffic) and the West Coast of North America (5.1%).

Figure 31: origins and Destinations of Panama's Transit Traffic



The volume of traffic through the Canal has increased steadily nearly doubling during the last decade, which is however, not because of the number of vessels transiting the Canal but the vessels' increasing size, the Panamax being the predominant type of vessel. This fact led to the decision to enlarge the Canal and, in order to measure the scale and type of the enlargement project, the Canal Authority has undertaken a number of detailed econometric and traffic forecast studies, which anticipated relevant rates of growth for the future.

In presenting possible alternative routings to the Canal, Mr. Lugo stressed that Suez is not considered to be a competitor of Panama: both are inter-oceanic canals and their markets are separate, Suez dealing with Asia Europe trades and Panama basically Asia USA East Coast.

Only 7 % of the cargo transiting Panama is related to South East Asia – Europe trades and South East Asia is not a major area of trade for Panama. Only 7 % of the cargo transiting Suez is related to South East Asia – USA trades.

Figure 32: Extent of Competition Between Panama and Suez Routes

Movimiento de Carga Contenerizada en el Canal de Suez por Ruta: (2003 -2007) (1000 TEU LLENOS)

Ruta	2003	2004	2005	2006	2007
Europa – Lejano Oriente	12 793	15 537	17 483	19 343	21 502
Europa – Sur de Asia	1 263	1 061	957	1 445	1 550
CEEEUU – Sur de Asia	470	686	762	807	936
CEEEUU – Sur Este Asia	547	315	339	536	850
Europa – Australasia	371	420	394	371	390
Europa - Medio Oriente	137	350	381	200	210
Europa - Este de África	246	143	134	102	96
CESA – Medio Oriente	24	23	56	74	76
Total	15 851	18 535	20 506	22 878	25 610

Suez Canal Authority ACP

There are a number of possible projects which could be considered as partial alternatives to the Canal of Panama, generally consisting of enlarging or creating new ocean terminals in the West Coast of North America or Mexico, which would combine with rail networks connecting them with the East Coast of the USA. However, none of them appear to be a challenge for Panama's main market in the USA in the medium term.

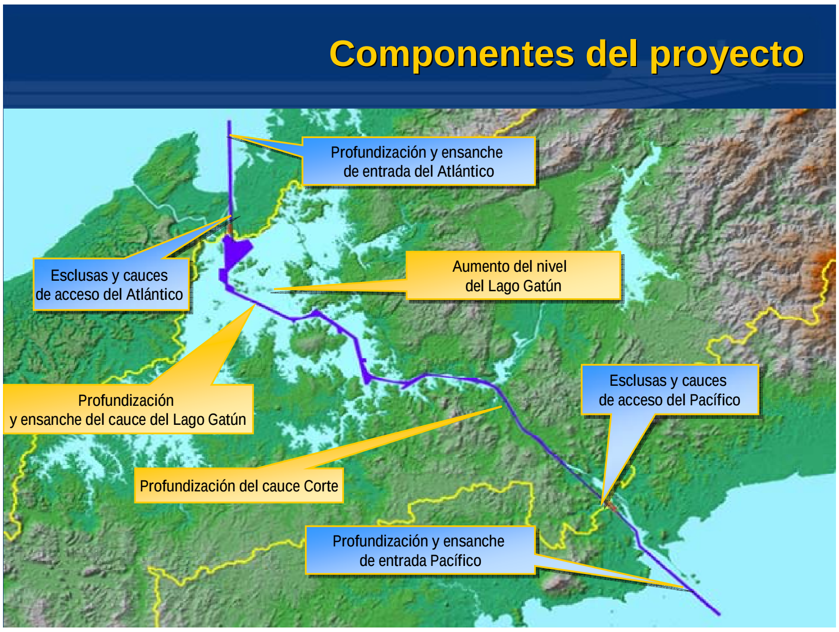
There are also inter- oceanic schemes of railways (around 100- 300 km length) cutting the isthmus of Central America, serving, for example, trades between the West Coast of Latin America and the Caribbean. These are considered to be complementary to Panama, rather than competitors.

Finally, in the context of the above mentioned "Initiative for the Integration of Regional Infrastructure in South America (IIRSA)" there are a number of the so-called Bi-Oceanic corridors being discussed, which run East West in the South American continent. However, they are considered to be very expensive and unable to be implemented in the short term.

In this context, Mr. Lugo pointed out the important deficiencies in the Latin American transport system, (such as missing links, geographic barriers, border crossings, lack of transport terminals, insufficient inland navigation infrastructures, lack of connectivity of the main consumption and production areas), coupled with the highly dispersed pattern of population, which is typical for many nations on the continent. One of the challenges for the rationalization of a multimodal network would be the ability to concentrate the cargo in well located logistic platforms.

As for the plans for enlargement of the Panama Canal, they consist basically in the construction of two sets of new locks (more than twice the size of the existing ones), one at each side of the Canal, to be able to serve the large vessels in the near future (up to 12.600 TEUs vessel capacity) as well as deepening of the waterway in between. It is expected that the majority of vessels transiting the new locks will have a size between 8.000 and 10.000 TEUs. This will have a clear impact on the hub- spoke system in the wide region, particularly concerning the Caribbean ports. Dredging works have already started on the Pacific side, and tenders are being launched for the construction of the locks which will be awarded in December this year.

Figure 33: Components of the Panama Canal Expansion Plan



The project is expected to be completed by 2014 and will help Panama to become a fundamental hub for the maritime transport in the whole continent.

Following the three presentations a vivid discussion started concentrating on the bellow questions:

1. *The potential of the Hidrovía is huge, but in order to realize it there should be some kind of strategy based on a marketing approach. What is being done in this respect?*

   The project is more than 20 years old, but has only been adopted by the 5 Mercosur countries for the period between 2001 and 2004. However, the political willingness to develop the necessary works was not clear at the beginning and the project execution was delayed. This was not hindering the growth of the traffic, and there are 600 orders placed for construction of barges at the moment, compared with the present fleet of 1600 proving the existence of a substantial demand. The "Hidrovía" is the backbone of the food production (agro-industry) being exported to the rest of the world.

   The example of the difficulties in financing the $80 million project for dredging and signalling works demonstrates well the situation. The amount could well be raised privately and would bring enormous benefits: the navigation time between the Mattogrosso and the port of S. Martin could be reduced from 20 to 12 days, if all the interior ports were duly upgraded.

2. *How is the situation of the access from the hinterland to Hidrovía? Which intermodal solutions are in place?*

Hidrovía can be split in two different sections:

- In the lower section, with ocean traffic, its draught was deepened in recent years and signalling was improved, large private investments took place (around $ 2.500 millions). The terminals on the banks of the waterway showing a very positive response to this actions. However, there was no accompanying public action to provide adequate road or rail access to the hinterland.

- In the upper section, dominated by the traffic of barges, the situation is even worse, due to the project paralysis and the bad conditions of navigation (e.g. safety problems). Furthermore, there are serious problems of intermodality. During the last decade the rail freight network feeding the waterway hinterlands (10.000 km) has suffered from important difficulties to keep an adequate degree of operability. Everyone knows what has to be done, but the works are not implemented.

3. *What is the ecological impact of the Hidrovía?*

There has been precaution in the places, where the waste materials have been deposited, trying to avoid any sensitive location. Studies have been conducted on the water quality and the dredging, and it has been concluded that the most important impacts are due to the vessels and barges navigating on the waterway.

Nevertheless, no environmental complaints have been raised in the last 14 years in the lower section of the waterway. However, in the upper Northern section (region El Pantanal) there is opposition by ecologists.

4. *There is a World Bank report showing its concern about the infrastructure system. Are there any synergies of Hidrovía with other regional projects?*

There are problems in four different areas:

- Export areas of grains - Good response from terminals, which were constructed and upgraded as they were needed. However, serious problem of access to hinterland.
- Containers - Big initial delays in upgrading access in the port of Buenos Aires both from the sea and from the land. Everything was managed by the public authorities, but it did not work.
- 20 % of the Argentina’s external trade is made by truck and this is a common trend in the countries of the region.
- Problems in freight logistics - as economy grows, trades grows even more, and transport trends to concentrate in congested nodes and a few links, creating real deficits of capacity. In the 1990’s there was an effort of infrastructural reform, focusing on the better use of the existing

infrastructures, but today there is a need for new infrastructures (both road and rail) and terminal capacity.

- The existing regulation dealing with concessions is not adequate for enlargement of infrastructure capacity. The reform process of the 1990's encouraged a better use of existing infrastructures but there is a need to build new infrastructure at present and the existing concession rules are not valid for cases of capacity enlargement. They are therefore obsolete.

Recent trends of imbalance in favour of truck transport (90 % in Argentina and Brazil). In Mexico there is an ongoing recovery of rail transport basically because of trade with USA (Double stack container wagons). In the rest of LA, rail is successful for bulk (grain, minerals,..).

5. *How do you see the instrument IIRSA*[1] *by comparison to the TEN-T in Europe?*

IIRSA is in reality supported by two institutions: the Interamerican bank for Development and the Corporación Andina de Fomento.

IIRSA is starting to launch interesting projects aiming at the integration of the transport system in the LA. However, progress is very slow, not because of the lack of money, the private sector having a rather positive approach for investment. But due to the institutional framework: How to select projects? How to implement them? How to coordinate their execution and management?

The case referred to before, related to the failure to fund $80 million project for the Hidrovía project is difficult to understand. There seems to be a striking case of lack of coordination between member states in the region. The largest part of the dredging work is to be done in Paraguay, but the benefits will accrue to its neighbours. If the project is to be executed and managed by a private firm (including tolls), the administrative barriers to establish a contract are problematic.

6. *How the hub-spoke system in LA is going to be affected by the enlargement of the Panama Canal and what will be the impact on the Suez Canal?*

The predominant flow through the Canal is East – West - East. The port system which was generated by the Canal from the beginning, both sides, Atlantic and Pacific, handles a considerable amount of traffic going to LA, and traffic between LA and USA and Asia. For example, a big proportion of the traffic between Chile and Asia, is transhipped by the port of Balboa on the Panamanian Pacific. A similar role is played by the port of Lazaro Cárdenas in the Mexican Pacific coast. Both ports are receiving Post Panamax vessels and send feeders to South America.

Some of the Post Panamax vessels trading with Europe could use directly the canal in the future for connections with the Pacific coast ports, both in USA and in LA. LA ports will have to upgrade their infrastructures in order to adapt to the increasing size of vessels (draughts between 14m and 15m).

[1] IIRSA stands for "Initiative for the Integration of Regional Infrastructure in South America"

The relevant market for Panama Canal in Asia are the ports north of Hong Kong. For South East Asia, the Panama route is longer than the one through Suez. We cannot speak of competition between the two Canals. It is very unlikely that Panama takes any share of the Suez traffic for trades Asia- Europe. The latest designs of container vessels (Emma Maersk) can easily transit through Suez, which has no locks.

7. *Are there any intentions to form alliances Canal-ports to promote trade?*

The Panama Canal has already alliances with ports of the US East coast. It owns 4 terminals, being operated by global companies. There are also intentions to come to an agreement with some Spanish ports, but that will be the responsibility of the Panama Canal Authority. They are looking to promote the whole country as a logistic platform, extending their services to the region and coordinating all modes of transport. They also envisage agreements with ports all over LA.

8. *Is there a* competition *of the Canal with some rail projects proposed or established through the isthmus?*

Only the Panama inter-oceanic railway running close to the Canal has been realized. (80km operated by two US companies). For the other projects there are intentions but no money. In Panama the railway has a market niche. Unloading in Balboa and sending freight to Atlantic ports would take more than two weeks at an unacceptable tariff. Only for short distances the railway is used and could even feeder some of the ports in the region.

The last session provided comprehensive information on the methodology used for WORLDNET enabling the participants to become familiar with the approaches for the different modes of transport and the tools for dissemination.

These presentations received a lot of interest. Their contents are similar to the seminars in Istanbul and Beijing, but they made explicit reference to the Euro American relations.

The first part of this session included a presentation of Mr. Eckhard Szimba giving an overview of the methodology of the model, which will be developed within the WORLDNET Project. The modelling of freight flows is described with particular reference to the zoning system, which has been established for Latin America.

He showed how the model can be applied to different kinds of data basis (trade information or traffic information) and what are the main tasks i.e. to transform this traffic and trade information at the national level into more disaggregated zoning as well as the building of the relevant multimodal transport chains.

The structure of the model (various sub-models and their interrelationship) is then described including examples in order to visualize better the case for the LA-EU relations.

The second part of this afternoon session included a presentation of Sean Newton explaining the development of a freight flow database for the WORLDNET Project and proposing a number of examples of the usefulness of the data that are collected and the presentation of possible applications on the basis of the provisional results available at this moment. He encouraged the participants to look at these results critically and to propose modifications, if needed.

A top-down overview of the main parameters of the trade between the EU and LA is presented and the manner, in which these are integrated into a macroeconomic model in order to obtain country to country flows and region to region. He also underlined the way, in which ports and canals are integrated into the representation of traffic flows, being particularly relevant for the relations between LA and the EU. In this manner, the model should be able to translate economic changes into infrastructure requirements, being at the core of the transport planning.

This is illustrated by statistical material, which shows the excellent prospects for the future, in particular for countries like Brazil, and for segments like containerised cargo.

As explained in the D2 report, the European Union is Latin America's second most important trading partner - and the first trading partner for Mercosur and Chile. The European Union has gradually strengthened its economic and trade links with Latin America, resulting in trade figures that more than doubled between 1990 and 2005. European Union trade with Latin America has increased remarkable in that period and this positive trend is likely to improve with the enlargement of the European Union.

One central and general question raised in the seminar was whether the transport system in Latin America was going to be able to meet the challenge of coping successfully with the increasing trend in overseas trade volume.

The seminar has confirmed that there are a number of problems, which persist in the development of the transport infrastructure in the region starting with the physical constraints of a continent with huge chains of mountains and forests as well as numerous islands. From the areas of production to the points of distribution and shipping there are enormous distances.

There remain important bottlenecks and inefficiencies in the Latin American transport infrastructure which need to be addressed, if the pace of commercial growth has to be paralleled with an efficient transport system.

There is potential for development of large axes in the continent, such as the “Hidrovía” or the inter-oceanic corridors, and although the IIRSA seems to proceed only very slowly in the integration and coordination of large multinational corridors through the continent, there remains scope for future efficient action so that the main ports in the region could be able to feed their hinterlands with an intermodal approach. However, much effort is to be dedicated to the solution of the institutional instruments at hand. An instrument such as the TEN-T could be very useful in LA, but the Seminar showed that IIRSA will not be in the short term up to develop a similar task in LA.

On the other hand, the single major projects, such as the enlargement of the Panama Canal would probably have the effect of triggering transport innovation and institutional improvement since it will have an important impact on the present structure of the port system in the region, and the upgrading of terminals and access to the hinterlands of port will become a necessity.

The participants, who were invited and attended the last seminar showed a high degree of professionalism and interest in the issues presented and will certainly constitute a good starting point for future relations concerning the improvement of the execution of the WORLDNET project.

4.4 Seminar Conclusions

Following the intention of the WORLDNET Project and the communication strategy described in the D2 report, the three seminars have been conducted in Istanbul, Beijing and Buenos Aires aiming at providing a basic forum of expert discussion, enabling the consultant to collect new data, to validate existing data, to establish a clearer view for policies and practices regarding international freight transport and to learn about problems, obstacles and limitations. At the same time, the project team set out to present the WORLDNET content to major actors, stimulate interest, discuss the project's progress, validate the modelling ideas and disseminate the results from various project's stages.

In general this overall objective could be reached. Only the more ambitious aim of collecting new data could not be reached directly as the participants were not in the position to provide any information during the meetings. Nevertheless contacts for further exchange of data were established and it is expected that the network of contacts created will make possible to gather valuable information for the project at a later stage on ad-hoc selected issues. Through the presentations it has been possible to see which data sources have been used in related projects. In many cases similar data gaps and solutions have been found.

The content of the seminars depended very much on the participants and the location, and the quality in terms of the achievement of the objectives was affected by the planning approach. The extent to which the objectives were reached was also influenced by the different levels of institutional ties between the European Union and relevant regions of the world. Istanbul was oriented more towards public sector activities, Buenos Aires more commercial, and Beijing was more research and market research oriented.

All three seminars had a strong orientation towards the host countries, so the initial selection turned out to be critical. While this helped to provide depth to the discussions, the expected breadth of scope was not as forthcoming. Given the detailed nature of the WORLDNET project, the ability to discuss specific issues in depth was valuable. However it became clear that many important issues remained outside the scope of these seminars, e.g. European transport links with Russia, North Africa, and the Middle East/Suez.

In Turkey, the planning was most affected by the delays at the start of the project, and the content was oriented towards explaining potential applications of the WORLDNET material within existing international planning and research frameworks. It was demonstrated that results of WORLDNET are already being applied within studies relating to Turkish seaports as well as other countries in the Black Sea area. Opportunities exist for collaboration with respect to other EU-led Mediterranean initiatives.

The second seminar in Beijing has covered a much wider set of topics and has offered broader perspectives, and it has been useful to contrast different viewpoints and approaches to questions such as the development of initiatives to open up access to the Silk Road countries as well as the Russian interior. However, this wide range of issues limited the space for discussion between the project team and the participants. In this context, a day's discussion about the "Rest of the World" involved a degree of compromise. Nevertheless the project team could gather a lot of information concerning transport routes and developments between the Asian markets and Europe.

Finally the last seminar in Buenos Aires offered the project team the opportunity to learn about developments and projects in Central and Southern America, such as the Panama Canal enlargement and the commercialisation of the Hidrovia waterway corridors. These will be relevant elements to consider when estimating the necessary transport infrastructure and investments to be made in that continent, in order to face the challenge of a dynamic trade relations growth. It showed how transport infrastructure operators were having to adapt to the changes in the shipping market and the need to handle larger vessels in order to capture future growth potential. The removal of limitations such as the Panamax constraints will change Europe's trans-Atlantic linkages and have direct implications upon the vessels calling at Europe's ports. Particularly important should be the consideration of future port development plans and the proper dimensioning of the related hinterland connections.

Summarising the presentations and discussions at the three seminars following issues are relevant for the implementation of WORLDNET:

- The participants, who were invited and attended the seminars showed a high degree of professionalism and interest in the issues presented.
- The seminars sparked the participants interest in the WORLDNET Project, and in return underlined the need for European researchers in this field to adapt our thinking towards the new world view, which has instinctively been initiated by the commercial sector and planners from the emerging and "emerged" economic powers.
- In this context, the need for WORLDNET appeared overdue, and the reaction has been positive and encouraging.
- The identified knowledge gaps, targeted by WORLDNET are generally supported.
- Existing networks of experts could be further extended and constitute a good starting point for future relations improving the execution of the WORLDNET project.
- Unfortunately the seminars were attended by representatives of IFIs only at the Buenos Aires Seminar, thus it seems to be helpful to organise a dedicated meeting with them in Brussels to include their opinions/strategies for the development of scenarios.
- The knowledge on the European Transport Policy of the participants were partly limited (even in Turkey), but certain interest of some of the

participants has been expressed (e.g. introducing of a similar tool like the TEN-T in Latin America for better co-ordination of policies and activities/projects).

- Information on the EU neighbouring countries are already quite well represented within the traffic models, including main strategies (e.g. TINA Turkey, MEDA/TEN-T).
- The development of new/upgrading of existing land bridges in China (China – Kazakhstan and China – Central Asia) will have impact on European transport routes.
- The increase of traffic to and from Russia, including Russia-China has to be considered in the models and scenarios.
- The construction of new land routes, depending on political developments in the regions, from China through Afghanistan and Iran in the direction of Europe could have impact on the route choice (rail vs. sea), but more activity is being directed towards opening up access to land-locked regions.
- Serious competition with Suez is not currently evident; not from Eurasian land routes, nor trans-Atlantic routes.
- The rapid development and increase of air cargo in Asia (particularly with respect to China) will have serious impact on Europe, e.g. with respect to the landing points.
- Air capacity limits due to landing limitations (e.g. night landing restrictions) might affect the development of the European market. A mismatch may occur between Eastern and Western ambitions for air trade growth.
- New forms of intermodality should be further assessed (e.g. combination of sea and air transport).
- The development of air cargo hubs in Turkey can potentially compete with UAE airports as distribution centres for the European market.
- The increasing size of vessels has not only to be considered at the port sites, but also the capacity of the hinterland connections has to be improved adequately. Matching trade ambitions to port development ambitions and thence to hinterland capacity is a common problem faced in all the seminar countries.
- In particular, the development of intermodal solutions in the hinterland connections of the international ports, both in the Asian and Latin American continents, will be a key factor in the development of trade and traffic services with the EU.
- Rail transport between Asia and Europe, transiting Russia is currently at a very low level, despite important improvements and investments on the Asian side. Institutional bottlenecks and pricing policies have to be investigated further.
- Another aspect of land transport between Asia and Europe, in Central Asia and the Caucasus is the mix of political, technical and security issues. Regulatory difficulties, fair play of operators and administrative barriers at border crossings have come to light.
- The Chinese ports system seems to be a priority for the Chinese government and its open access to European operators looks promising. However, the way multimodal transport is operating is unclear, and the plans to provide ports with a adequate rail capacity to their hinterlands is still unclear.
- In Central and Southern America there are a number of problems, which persist in the development of the transport infrastructure in the region starting with the physical constraints of a continent with huge chains of mountains and forests as well as numerous islands. From the areas of

production to the points of distribution and shipping there are enormous distances.

- There remain important bottlenecks and inefficiencies in the Latin American transport infrastructure, which need to be addressed, if the pace of commercial growth has to be paralleled with an efficient transport system.
- There is potential for development of large axes in the continent, such as the “Hidrovía” or the interoceanic corridors, and although the IIRSA seems to proceed only very slowly in the integration and coordination of large multinational corridors through the continent, there remains scope for future efficient action so that the main ports in the region could be able to feed their hinterlands with an intermodal approach. However, much effort is to dedicated to the solution of the institutional instruments at hand.
- Projects like the enlargement of the Panama Canal would probably have the effect of triggering transport innovation and institutional improvement since it will have an important impact on the present structure of the port system in the region, and the upgrading of terminals and access to the hinterlands of port will become a necessity.

5 WORLDNET - Applications

Work package 5, **Intermodal Impedances and Links to TRANSTOOLS**, sets out to develop linkages between WORLDNET and the TRANSTOOLS model.

Specific objectives of this work package were:

- Enrichment of the maritime and air network models by the intermodal land-based modes
- Definition of interface requirements to TRANSTOOLS
- Update of TRANSTOOLS mode split model with WORLDNET modes and levels of service
- Test computation of TRANSTOOLS based on WORLDNET data and scenarios.

The WP5 consisted of three tasks:

- *Task 5.1* Updated intermodal impedance matrices
- *Task 5.2* WORLDNET interfaces to TRANSTOOLS
- *Task 5.3* Scenario definition, testing and analysis

The ports of the maritime network and the airports of the air network were integrated with the land based modes rail and road. To do so the detailed land-based network models were linked to the nodes defined in the maritime and air network. Seaports were connected to road, rail and inland waterway, whereas the air network was connected mainly to the road mode, since the airports access/egress mode for air freight is almost exclusively road. Therefore both WP4 airport-airport matrices would be enriched by road transport impedances where necessary. The same was undertaken for the maritime network but there were three feeder modes: inland waterway, rail and road. After connecting these different networks, intermodal impedances will be computed for the defined O/D relations.

A freight model has already been developed within TRANSTOOLS. It was developed originally for the V1 TRANSTOOLS, and then revised , expanded and updated for the V2 TRANSTOOLS, as delivered in December 2008.

This model works on an origin-destination basis. When the level of detail of the origins and destination is changed in this project the freight model can still be used although some changes are needed on the input and output files and software modules.

The key freight modules are the trade model, the modal split model, and the logistics module.

Demand

On the demand side, it was intended that WORLDNET would update the trade and mode split models, as ‘drag and drop’ replacements and provide input data on freight flows via WP3.

However, in practice it has been necessary to adapt to the changes contained in the new TRANSTOOLS version. Initially this has meant producing updated freight flow matrices at regular intervals between April 2008 and September 2008, and ensuring that zoning conventions are synchronised.

However, with the release of TRANSTOOLS V2, it has become apparent that the specification for the freight model is no longer valid, the data exchange relationships between the freight modules has changed, and even the foundation of the TRANSTOOLS base year matrix has been removed, creating a discontinuity between the processing stages.

Therefore, the results of this WP are simultaneously incompatible with both V1 and V2 of TRANSTOOLS. They agree with the new zoning conventions agreed between all parties, and implemented in TRANSTOOLS V2, but they cannot be directly input into either the V2 trade model or mode split model. However, since the discontinuities between the freight module stages need to be addressed urgently, the preferred approach has been to develop the data inputs according to the TRANSTOOLS specification, and to expect that some additional work is later required to either change the specification (and therefore update the results) or to bring the modules back to the original specification.

It remains the case, that none of the final outputs of WORLDNET have been tested within the V2 of TRANSTOOLS. It should also be noted that TRANSTOOLS V2 contains a provisional (uncalibrated) OD matrix produced in August 2008, which has since been subject to important revisions. Also, that this matrix was modified (substantially corrected) by the TEN-CONNECT team to reach accordance with the EC Pocketbook statistics, so no results are available using the new demand matrix in unaltered form.

Supply

On the supply side, the integration of the WORLDNET network extensions with the TRANSTOOLS V2 networks has been concluded successfully, so that the WORLDNET network contains the complete V2 road and rail freight networks, as well as the additional links from the WORLDNET project. The extended networks have been published according to the same technical specification, so they are indeed compatible. This allows future extension of the TRANSTOOLS network model, for freight traffic flows.

The implementation of the revised rail and road network models into the TRANSTOOLS model system will significantly extend their geographic scope e.g. to Turkey, toward the eastern neighbouring countries of the EU and towards the northern part of Africa.

Cost (level of service) calculation procedures implemented in TRANSTOOLS have (still) to be adapted to the new geographic scope covered by all modes. Therefore, the procedures developed for calculating freight mode chains in WP3 have been adapted to calculate network path levels of services, and to make rudimentary traffic assignments so that the demand and supply components can be linked and verified. This WORLDNET network model now provides impedances for the cost calculation procedure.

Full integration between TRANSTOOLS and WORLDNET will become clearer when the final deliverables and technical descriptions of TRANSTOOLS V2 are published and more experience with the working of the TRANSTOOLS model is available.

Until these linkages are improved and verified the new model elements produced by WORLDNET can be analysed using external tools, and by manual calculations.

Scenario definition, testing and analysis

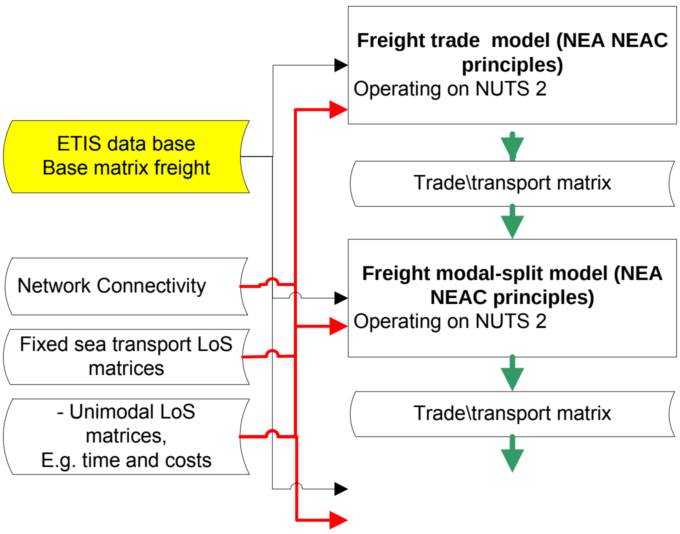
It has been intended to combine the outputs of WORLDNET with the new forecasting stages produced by ITREN, so that in effect the results can be combined into a more holistic model of the economy, energy demand and supply, transport and transport impacts. However, due to the incompatibilities between the model systems, as described above, it has not been possible to do this according to the proposed method. Instead, we focus upon the specific innovations contained in WORLDNET, demonstrating how these can provide insight for policy makers, going beyond the capabilities of previous model systems. We concentrate upon globalisation, motorways of the sea, and Transnational Corridors.

TRANSTOOLS

WORLDNET has created multi-purpose databases for transport modellers. In this section we set out examples demonstrating how WORLDNET outputs can be applied within TRANSTOOLS.

The specification for TRANSTOOLS V1 is as follows:

Figure 34: TRANSTOOLS Freight Models



TRANSTOOLS is currently in a transition phase, with many changes and additions following the TEN-CONNECT project in December 2008.

Key changes include:

- Addition of processing stages between Base Matrix and Trade Model
- New Trade Model methodology
- Change in zoning system in Base Matrix, Trade Model, and Mode Split Model.
- New linkage between Base Matrix and Mode Split Model
- Partial adoption of NUTS3 zoning in Base Matrix and Trade Model
- Geographical extension of Base Matrix.

Until a new specification is agreed, and all the modules updated to incorporate the changes, the WORLDNET updates cannot be tested in full. However, the data structures have been set up to allow the maximum level of detail to be used, i.e.

- NUTS3 Zoning in Europe, and (optionally) regionalisation in larger non-European countries
- NST (2 Digit) commodity sectors
- Inclusion of maritime and air cargo modes for freight
- Use of full, WORLDNET Euopean/Eurasian/North African network.

In the mean-time, WORLDNET has developed a set of provisional modelling tools, mainly based upon those used to construct the WORLDNET mode chain database. These have been used to provide examples of how the system would be implemented in an extended TRANSTOOLS. The system has been considerably simplified, with a network, a base year OD, a forecast model, a mode chain builder and a traffic assignment tool. There is no logistics model, and traffic assignment is freight-only and unconstrained.

Three policy topics have been selected.

5.1 Globalisation

Under globalisation, we attempt to demonstrate the impact of changes in worldwide trade patterns, upon transport demand within Europe. To illustrate the trend, the 2005 data is compared with trade date for 1995, and a forecast (originating from the work of the ITREN project) for 2025. The forecasts were based on data up to and including 2007.

Results are analysed by direction (imports and exports), by world region, and by product sector. Domestic traffic is not included, since the objective is to show changing patterns in overseas sourcing.

Table 5 EU 27 Exports by World Area, Tonnes(m)

Destination	*1995*	*2005*	*2025*	*CAGR 05/95*	*CAGR 25/05*
EU27	1,099	1,619	2,246	3.9%	1.6%
Other Europe	93	150	251	4.9%	2.6%
North Africa	29	42	123	3.6%	5.6%

Destination	*1995*	*2005*	*2025*	*CAGR 05/95*	*CAGR 25/05*
Other Africa	21	34	80	4.8%	4.3%
Middle East	30	38	70	2.4%	3.1%
Central Asia	5	11	26	8.1%	4.5%
Other Asia	47	71	145	4.2%	3.6%
Russian Federation	11	19	82	6.2%	7.5%
North America	79	157	163	7.1%	0.2%
Latin America	20	23	41	1.6%	2.9%
Oceania	4	5	6	3.2%	0.3%
TOTAL	1,438	2,169	3,233	2.0%	1.2%

Source: NEA

In Table 5 EU27 exports are subdivided by trading partner regions. Where the destination is EU27, this indicates intra-EU trade.

The regions are as follows:

- EU27
- Other Europe – includes Norway, Switzerland, and neighbouring European countries (mainly towards the South and East, including former Yugoslavia and Turkey)
- North Africa – Mediterranean African countries
- Other Africa – the rest of Africa
- Middle East – the region South East of Turkey, including the Arabian peninsula and Iraq
- Central Asia – including the countries bordering the East of the Caspian Sea, Iran, Pakistan and Afghanistan
- Other Asia – including China, India, ASEAN and Japan
- Russian Federation
- North America – USA, Canada and Mexico
- Latin America – the rest of the the Americas, including the Caribbean
- Oceania – including Australia, New Zealand and other Pacific countries.

Growth rates are calculated as compound annual growth rates (CAGR), for the periods 1995 to 2005 (ten years) and 2005 to 2025 (twenty years).

Volumes are measured in millions of tonnes per annum.

Shares of cargo destinations are shown below in Table 6. In 1995 for example 76% of European export volume was within the EU27 region. By 2005, this volume had grown substantially from 1,099 m tonnes to 1,619 m tonnes, but the share of total export volume had declined to 75%. This decline of 1.8 percentage points is expected to continue, so that by 2025 69% of EU27 exports will be intra European.

Table 6 EU 27 Export Shares by World Area, Share (%)

Destination	*1995*	*2005*	*2025*	*Change 05-95*	*Change 25-05*
EU27	76%	75%	69%	-1.8%	-5.2%
Other Europe	6%	7%	8%	0.4%	0.9%
North Africa	2%	2%	4%	-0.1%	1.9%
Other Africa	1%	2%	2%	0.1%	0.9%
Middle East	2%	2%	2%	-0.3%	0.4%
Central Asia	0%	0%	1%	0.2%	0.3%
Other Asia	3%	3%	4%	0.0%	1.2%
Russian Federation	1%	1%	3%	0.2%	1.7%
North America	6%	7%	5%	1.7%	-2.2%
Latin America	1%	1%	1%	-0.3%	0.2%
Oceania	0%	0%	0%	0.0%	-0.1%

Source: NEA

By 2025, it is expected that the North America and Oceania export markets will also decline in relative terms, at the expense of more rapidly growing regions such as North Africa, the Russian Federation and Other Asia.

Although the future picture appears more balanced, the structural changes are relatively small.

Table 7 EU 27 Export by Product Group, Tonnes (m)

Commodity (NST)	*1995*	*2005*	*2025*	*Change 05-95*	*Change 25-05*
Agricultural Products	135	184	265	3.1%	1.8%
Foodstuffs	138	202	289	3.9%	1.8%
Solid Fuels	50	61	83	2.0%	1.6%
Petroleum	305	561	897	6.3%	2.4%
Ores and Scrap	75	101	146	3.1%	1.8%
Metals	116	163	255	3.4%	2.3%
Crude Minerals	212	245	348	1.4%	1.8%
Fertilizers	36	39	49	0.6%	1.2%
Chemicals	150	248	366	5.2%	2.0%
Misc Manufactures	222	366	535	5.1%	1.9%
TOTAL	1,438	2,169	3,233	4.2%	2.0%

Source: NEA

Highest export growth sectors for the future are expected to be oil/petroleum, metals, chemicals and manufactures.

On the import side it is noticeable that the volumes are substantially larger, i.e. 3.4 billion tonnes in 2005 for imports and 2.1 billion for exports. However, growth rates are lower, implying that the gap is being narrowed.

Table 8 EU 27 Imports by World Area, Tonnes(m)

Destination	*1995*	*2005*	*2025*	*CAGR 05/95*	*CAGR 25/05*
EU27	1,099	1,619	2,246	3.9%	1.6%
Other Europe	226	335	414	4.0%	1.1%
North Africa	145	185	228	2.5%	1.0%
Other Africa	109	146	202	2.9%	1.6%
Middle East	141	127	116	-1.0%	-0.5%
Central Asia	48	75	185	4.6%	4.6%
Other Asia	58	128	292	8.1%	4.2%
Russian Federation	254	433	796	5.5%	3.1%
North America	141	112	191	-2.3%	2.7%
Latin America	148	213	234	3.7%	0.5%
Oceania	49	49	40	0.0%	-1.0%
TOTAL	2,419	3,421	4,944	3.5%	1.9%

Source: NEA

Intra EU27 imports represent only 47% of total EU27 imports, compared to 75% in the export direction. Rates of change within the import analysis are relatively small, but raw material producing regions such as Russia are prominent.

Table 9 EU 27 Import Shares by World Area, Share (%)

Destination	*1995*	*2005*	*2025*	*Change 05-95*	*Change 25-05*
EU27	45%	47%	45%	1.9%	-1.9%
Other Europe	9%	10%	8%	0.4%	-1.4%
North Africa	6%	5%	5%	-0.6%	-0.8%
Other Africa	5%	4%	4%	-0.3%	-0.2%
Middle East	6%	4%	2%	-2.1%	-1.4%
Central Asia	2%	2%	4%	0.2%	1.6%
Other Asia	2%	4%	6%	1.3%	2.2%
Russian Federation	10%	13%	16%	2.1%	3.5%
North America	6%	3%	4%	-2.6%	0.6%
Latin America	6%	6%	5%	0.1%	-1.5%
Oceania	2%	1%	1%	-0.6%	-0.6%

Source: NEA

The two most dynamic import markets are the Russian Federation and Other Asia (includes China). Both of these are expected to increase into the medium term.

Table 10 EU 27 Imports by product Group, Tonnes (m)

Commodity (NST)	*1995*	*2005*	*2025*	*Change 05-95*	*Change 25-05*
Agr. Products	149	210	291	3.5%	1.6%
Foodstuffs	189	253	331	3.0%	1.4%
Solid Fuels	167	272	405	5.0%	2.0%
Petroleum	924	1,313	1,962	3.6%	2.0%
Ores	238	264	314	1.0%	0.9%
Metals	114	176	292	4.5%	2.6%
Crude Minerals	205	266	369	2.6%	1.6%
Fertilizers	50	48	65	-0.3%	1.5%
Chemicals	154	242	334	4.6%	1.6%
Misc Manuf.	229	376	580	5.1%	2.2%
TOTAL	2,419	3,421	4,944	3.5%	1.9%

Source: NEA

If the commodity information is summarised into three groups, based on their likely cargo handling characteristics, the following results are obtained:

Table 11 EU 27 Imports by Mode of Appearance, Tonnes (m)

Commodity (NST)	*1995*	*2005*	*2025*	*Change 05-95*	*Change 25-05*
Non Bulk	885	1,306	1,894	4.0%	1.9%
Dry Bulk	610	802	1,088	2.8%	1.5%
Liquid Bulk	924	1,313	1,962	3.6%	2.0%
TOTAL	2,419	3,421	4,944	3.5%	1.9%

Source: NEA

The non-bulk sector contributes most significantly towards the demand for containerised transport services. It is noticeable that the highest historical growth rates are to be found in this group. Although future year-on-year growth are expected to be lower than those observed in the previous decade, absolute increases are still high. An additional 588 million tonnes of non-bulk cargo between 2005 and 2025 represents in the region of 75 million TEU container loads.

Dry bulks, principally, coal, ores, and construction materials have grown the least of the three categories, and are expected to contribute the least towards future absolute growth.

Liquid bulks have risen more quickly, and this is also forecast to continue, again at lower rates than observed in the last decade.

In the final example of this globalisation section, Latin American export trade is analysed by world region. In this way it is possible to see the share of total Latin American export cargo by destination region.

The table indicates that exports to EU (by weight) declines relative to other markets from 28% in 1995 to 22% in 2005. During the same period, relative volumes to Other Asia and North America increased, and intra-Latin American trade remained constant.

Table 12 Latin American Trade by Export Region, Share of Volume (%)

Destination	*1995*	*2005*	*2025*	*Change 05-95*	*Change 25-05*
EU27	28%	22%	16%	-6.3%	-5.4%
Other Europe	1%	2%	1%	0.2%	-0.3%
North Africa	1%	2%	2%	0.5%	0.3%
Other Africa	1%	1%	1%	0.4%	0.1%
Middle East	2%	3%	2%	1.1%	-0.6%
Central Asia	1%	1%	1%	-0.2%	0.5%
Other Asia	18%	21%	25%	2.6%	4.5%
Russian Federation	1%	1%	2%	-0.2%	0.8%
North America	28%	31%	23%	3.1%	-8.2%
Latin America	18%	17%	25%	-1.2%	8.2%
Oceania	0%	0%	0%	0.0%	-0.1%

Source: NEA

In future, the forecasting model predicts that intra Latin American trade will grow, along with trade to Other Asia, whereas the shares of the EU and North America will decline.

Implications are as follows:

- EU27 trade growth, which has been strong in both import export directions over the last decade is expected to continue, but at lower than historical rates.
- The structure of EU27 is changing relatively slowly, with the breakdown by product and trading partner region remaining constant. Emerging markets are clearly visible, but their impact upon the overall pattern is gradual.

- Where the structure is changing, the main growth areas are towards the East and South East of Europe, rather than towards the Atlantic.
- On the export side, intra EU trade and trade with other industrialised countries dominates.
- On the import side Europe is more heavily dependent upon its trading partners, particularly the Russian Fderation for raw materials, and East Asia for manufactures.
- Imports of non-bulk commodities are expected to out-perform other sectors in terms of growth. Growth rates will be lower on average than during the last decade.
- As an export destination for other world regions, such as Latin America, the EU27 is becoming less important in volume (tonnage) terms, relative to other world regions such as East Asia.
- Thus the economic dominance of “North Atlantic” countries within world trade is diminishing, and the relative dynamism of the Pacific and Indian Ocean economies is causing the centre of gravity of European trade to move South and East.

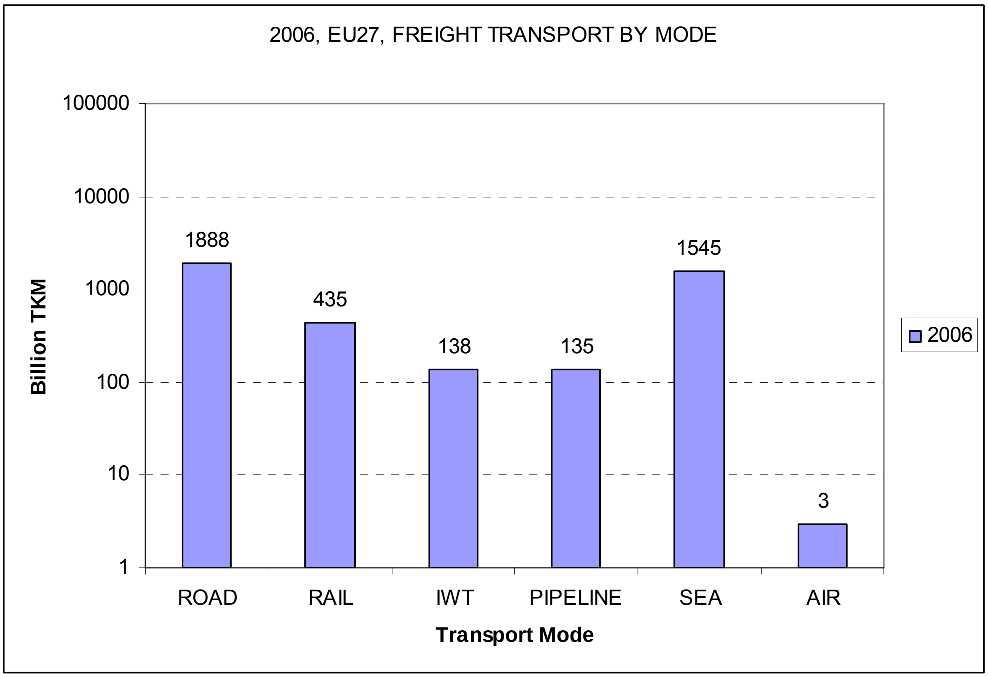
Using WORLDNET data, it is therefore possible to observe not just European trade has changed, but also how Europe’s share of world trade has been affected. Moreover, since the WORLDNET database tracks trade volumes, rather than just trade values, it is also possible to feed the results into transport analysis. These are exemplified in the following sections.

5.2 Motorways of the Sea

One of the important innovations within WORLDNET has been to extend the analysis of European freight flows beyond the conventional definitions used within freight market share analysis. One of the limitations within conventional approaches has been the exclusion of large volumes of sea freight. Typically, when European freight modes are compared, air and sea freight are limited to domestic services e.g. Greek ferries, and intra EU 27 services e.g. UK to France. With these assumptions, sea transport has a large market share, approximately 37% of the total, but while this is a good indicator for intra European volumes, it is also useful to be able to include the main inter-continental routes for sea and air modes.

The standard analysis of EU27 mode shares is as follows:

Figure 35: EU Pocketbook, Freight Market Shares



Source: EC Pocketbook, 2008. Note logarithmic scale.

By performing a traffic assignment, using the data in the WORLDNET OD matrix (v5), the following results are obtained:

Table 13 Summary of WORLDNET Traffic Assignment

Mode Split: WORLDNET, DataV6 According to Tonne Kilometres Estimated according to National Territory					
	Sum of Tonne KM, 2005 Annual Estimates, (Millions)				
	MODE				
Country	**RAIL**	**ROAD**	**SEA**	**WATER**	**TOTAL**
Albania	14	1,705		0	1,719
Armenia	338	340		0	678
Austria	15,781	32,333		185	48,299
Azerbaijan	0	2,579		0	2,579
Belarus	7,700	25,367		0	33,068
Belgium	7,287	48,862		12,491	68,641
Bosnia	46	2,789		0	2,835
Bulgaria	719	14,788		56	15,563
Croatia	451	3,843		0	4,294
Czech Republic	6,384	50,297		10	56,691
Denmark	4,499	6,867		0	11,366
Estonia	897	3,299		0	4,196
Finland	11,332	23,921		0	35,253
France	40,244	359,386		20,242	419,871
Germany	142,190	605,466		33,016	780,673
Greece	179	26,619		0	26,798
Hungary	7,190	30,918		51	38,158
Ireland	25	17,675		0	17,700
Italy	38,656	164,228		0	202,884
Latvia	6,152	9,363		0	15,515
Lithuania	2,414	9,818		4	12,236
Luxembourg	220	2,010		0	2,231
Macedonia	329	1,062		0	1,391
Montenegro	373	92		0	465
Netherlands	3,639	50,494		32,883	87,016
Norway	3,285	15,627		0	18,913
Poland	19,845	119,140		419	139,404
Portugal	40	20,509		0	20,550
Romania	5,677	47,854		75	53,606
Russia	18,144	941,669		0	959,813
Serbia	3,231	7,806		31	11,067
Slovak Republic	2,871	20,356		5	23,233
Slovenia	2,270	15,765		0	18,035
Spain	1,082	186,096		0	187,178
Sweden	11,493	24,923		0	36,416
Switzerland	36,761	8,489		3	45,253
Turkey	211	61,406		0	61,617
Ukraine	21,725	95,958		0	117,683
United Kingdom	19,859	158,253		211	178,323
Maritime Corridors			15,699,442		15,699,442
TOTAL	443,552	3,217,974	15,699,442	99,682	19,460,650
Shares	2.28%	16.54%	80.67%	0.51%	100%

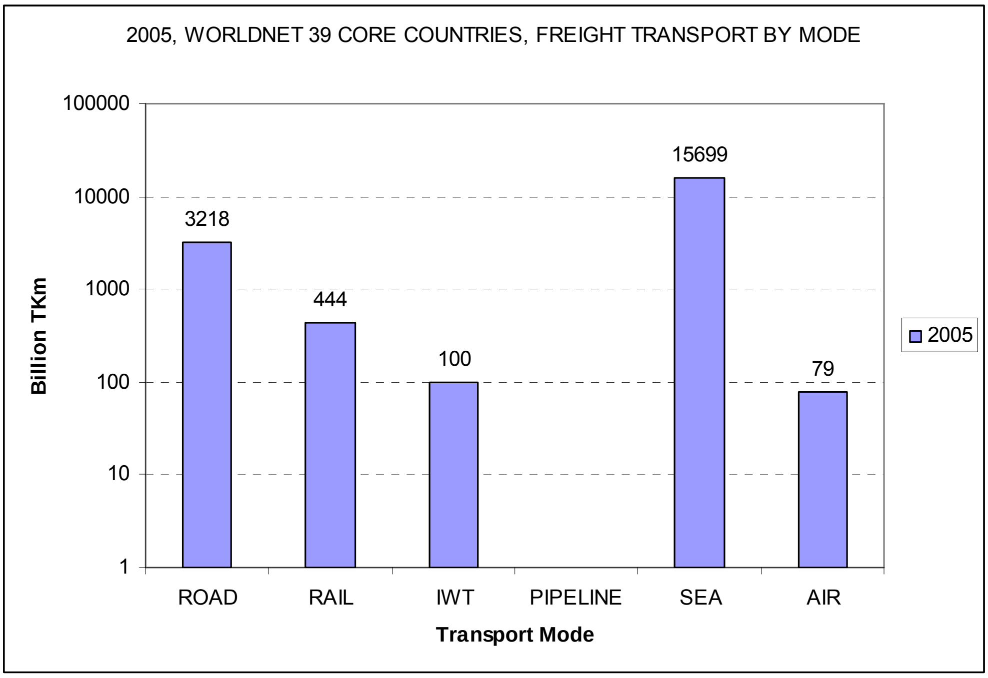
Mode Split: WORLDNET, DataV6 According to Tonne Kilometres Estimated according to National Territory					
	Sum of Tonne KM, 2005 Annual Estimates, (Millions)				
	MODE				
Country	**RAIL**	**ROAD**	**SEA**	**WATER**	**TOTAL**
EU 27	312,120	1,640,426	1,547,659	99,428	3,599,633
Shares	8.67%	45.57%	42.99%	2.76%	100%

Note: Sea Tonne Kms for EU27, includes only Intra-EU Flows.

The estimates for EU27 tonne kilometres agree reasonably well with the Pocketbook, but it is also possible to add in similar results for EU neighbouring countries, and to calculate the total share for maritime traffic.

The market share results for the whole set of 39 European countries can be summarised as follows. The air figures have also been calculated using the air cargo O/D matrix (also WORLDNET WP3).

Figure 36: WORLDNET Estimates of Freight Market Share for Extended Region



Source: WORLDNET, 2009. Note logarithmic scale.

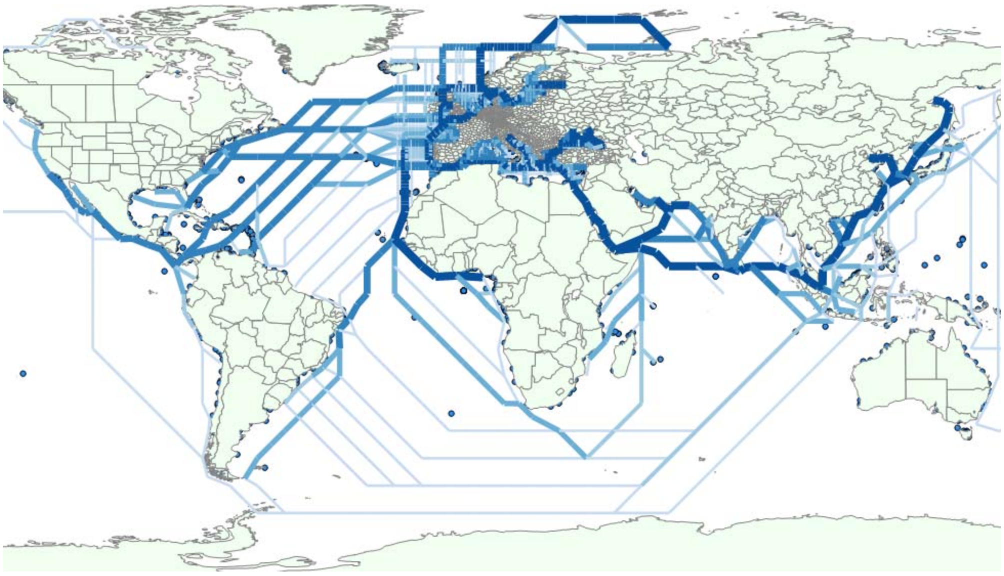
Pipeline: not estimated by WORLDNET.

The two obvious differences are the increased market shares for sea and air cargo. With these calculations, the sea share rises to approximately 80%, and the volume increases by a factor of ten from 1,545 bn TKm to 15,699 bn TKm. Air cargo rises from 3 bn TKm (intra EU and domestic) to 79 bn TKm (Europe-Worldwide).

From this basis, it is then possible to make similar traffic assignments, using the forecast traffic flows from the previous section.

In Figure 37 the sea freight flows related to European cargo are illustrated, with the line colours illustrating the expected changes in annual tonnages.

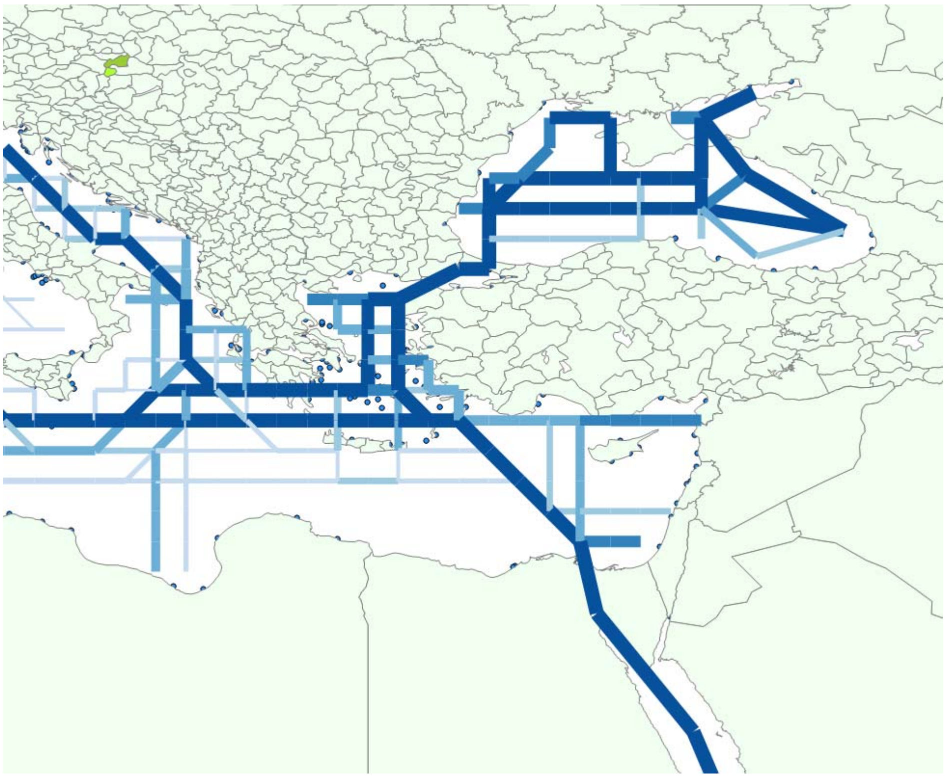
Figure 37: Forecast Changes in Sea Freight Corridors, 2025



Focusing upon the corridors in the East Mediterranean, the Turkish Straits and Suez routes can be identified.

The model assigns some 626 million tonnes per annum to the Suez and 353 million tonnes to the Turkish Straits.

Figure 38 : Forecast Changes in E. Med. Corridors, 2025



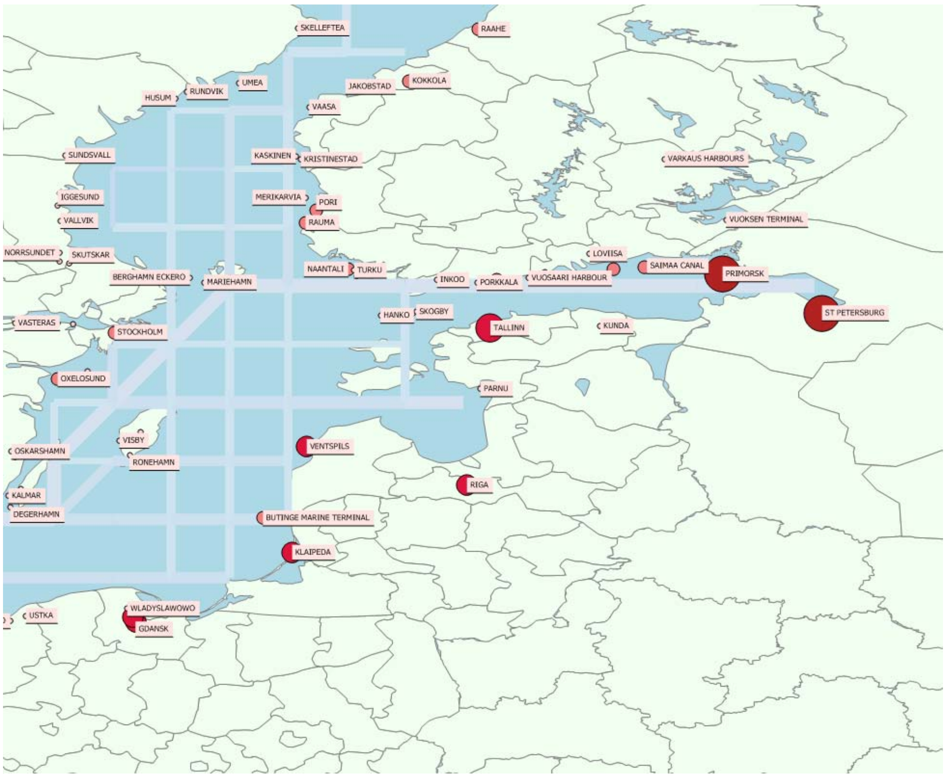
Data from the Egyptian Maritime Database (EMDB) indicates that total Suez traffic (from all origins and destinations) amounted to 20,384 ship passages and 844m net tonnage. Bearing in mind that the model is only assigning Europe-related traffic, and that all trips connecting the Mediterranean and the Indian Ocean will be assigned to this route, the comparison appears valid.

On the Turkish Straits, 54,794 ship passages were made in 2005. Bearing in mind that vessels using the Turkish Straits are typically smaller than those using Suez, the estimate seems reasonable.

Unconstrained, the trade forecast would imply that Suez traffic would rise to 1.4 billion tonnes per annum by 2025, and to 1.04 billion on the Turkish Straits.

From this point it is then possible to connect maritime flows to inland flows, and to derive a consistent and independent indication of port traffic growth, and therefore an indication of cargo handling requirements as well as hinterland connections. See Figure 39.

Figure 39: Estimated Port Traffic (2005 Tonnage)



Combining WORLDNET demand and supply data it is possible to convert expected tonnages into ship numbers classified by cargo type and ship size.

Figure 40: Analysis of Ship Sizes

COAL : Ship Sizes on Trades to Europe

2. COAL

	VESSEL SIZE ('000DWT)				TOTAL
	0-60	60-100	100-200	200+	
FROM :					
EUROPE	11	89	0	0	100
AFRICA	0	19	74	7	100
N AMERICA	6	69	23	2	100
C+S AMERICA	1	33	66	0	100
M.EAST	100	0	0	0	100
ASIA	8	74	18	0	100
AUSTRALIA	0	13	85	2	100
TOTAL	**4**	**45**	**48**	**3**	100

Source : OSC estimates

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Source: Ocean Shipping Consultants, January 2009

For example, coal cargo from Australia is more likely to be carried in ships exceeding 100,000 tonnes deadweight (DWT), than ships from North America.

Figure 41: Analysis of Port Facilities

Worldnet Port Details - Sample

REGION	COUNTRY	MAIN/SUB PORT M/S	PORT	SUB-PORT	ESCODE	LATITUDE [S= "-"]	LONGITUDE [W= "-"]	CONTAINER Y/N	DRY BULK Y/N	LIQ. BULK Y/N	RO-RO Y/N	MAX WATER DEPTH (metres)	MAX DRAUGHT (metres)
EU	LATVIA	M	LIEPAJA		LV00LVLPX	56.3	21. 0	N	Y	Y	Y	10.5	9.5
EU	LATVIA	M	RIGA		LV00LVRIX	56.58	24.06	Y	Y	Y	Y		12.2
EU	LATVIA	M	VENTSPILS		LV00LVVNT	57.24	21.32	Y	Y	Y	Y	16.6	15
EU	LITHUANIA	M	BUTINGE MARINE TERMINAL		LT00LTBOT	56.02	20.57	N	N	Y	N		16
EU	LITHUANIA	M	KLAIPEDA		LT00LTKLJ	55.43	21.07	Y	Y	Y	Y		12.5
EU	MALTA	M	MARSAXLOKK		MT00MTMAR	35.5	14.32	Y	N	Y	N		16
EU	MALTA	M	VALLETTA		MT00MTMLA	35.54	14.31	Y	Y	Y	Y		15.8
EU	NETHERLANDS	M	ALKMAAR			52.35	4.45	N	N	N	N		3.5
EU	NETHERLANDS	M	ALPHEN			52.08	4.36	Y	N	N	N		
EU	NETHERLANDS	M	AMSTERDAM		NL00NLAMS	52.23	4.53	Y	Y	Y	Y		16.4

11

Source: Ocean Shipping Consultants, January 2009

The WORLDNET port database allows ports to be classified according to the type of goods they can handle, and the water depth constraints (see Figure 41). In this way, expectations regarding traffic growth can be compared more accurately with supply side capacity, and traffic can be assigned to feasible paths containing maritime links.

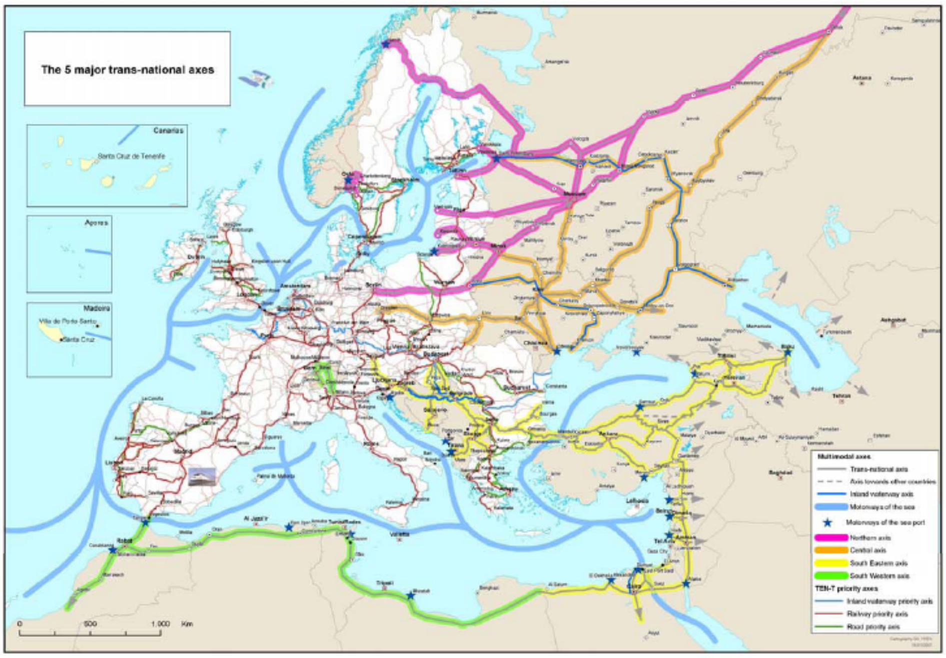
Implications for Policy Analysis:

- Motorways of the Sea remain at the heart of the Trans-European Networks, and has been demonstrated, account for the majority of European and Europe-related freight tonne kilometres, by a significant margin.
- Trade growth, even in a relatively pessimistic economic climate, with future growth rates projected to be half those of the last decade will bring about substantial increases in the demand for maritime services, as the European economy becomes more closely integrated with its neighbouring regions.
- WORLDNET links trade growth expectations to port traffic growth as well as growth of strategic maritime links e.g. Suez, Panama and the Turkish Straits.
- Policy to improve maritime connections, and thereby to promote modal shift towards the only "green" corridor with adequate capacity to absorb the expected growth, is constrained by the need to prevent a distortion of the market for maritime services.
- Thus, investments in ports and supporting infrastructure need to be justified according to need, and analysed in a strategic manner, taking into account the worldwide patterns of demand and supply.
- Combined, the supply and demand data collected for WORLDNET, provides a foundation for analysing motorways of the sea with a suitable geographical scope, European port demand, and hinterland requirements.

5.3 Trans European Networks and Transnational Corridors

While trade, maritime traffic and air cargo represent the main innovations of WORLDNET with respect to TRANSTOOLS, the extensions of WORLDNET into new member states, accession countries and European non-EU countries also enhance the possibilities for analysing inland cargo movements, along the Ten-T priority network and also with respect to the Transnational Axes.

Figure 42: The Five Major Transnational Axes



The need to monitor trade and traffic growth along the Transnational axes, and within the Accession regions of South East Europe has been a strong influence in the design of the WORLDNET database.

Figure 43: WORLDNET O/D Data in South East Axis

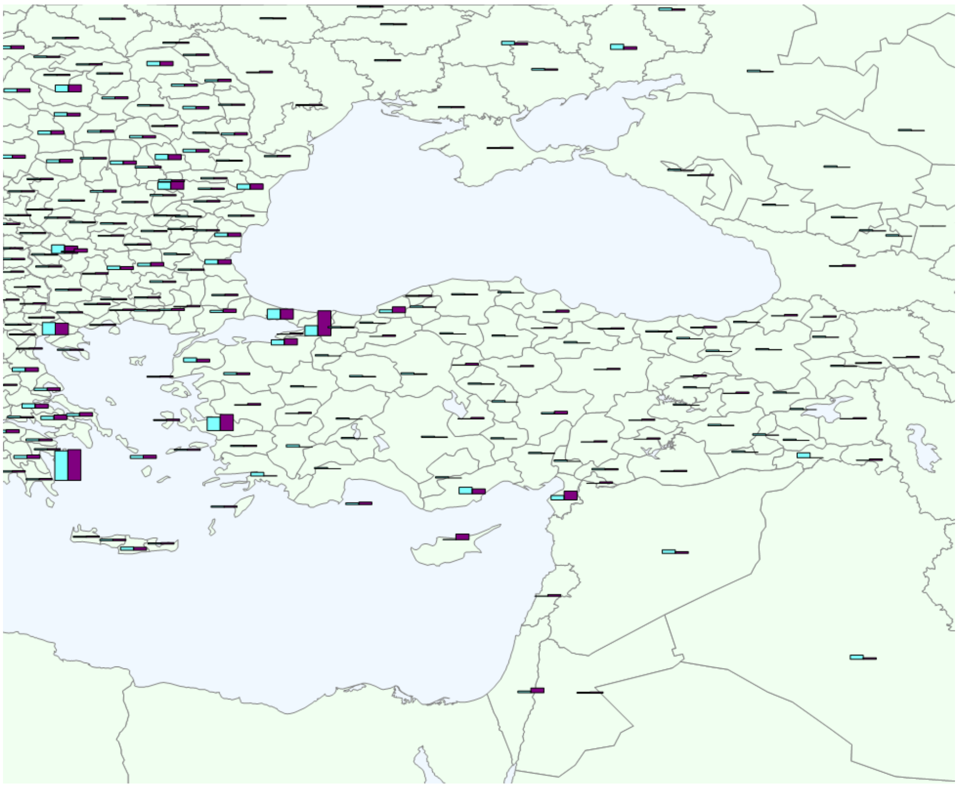
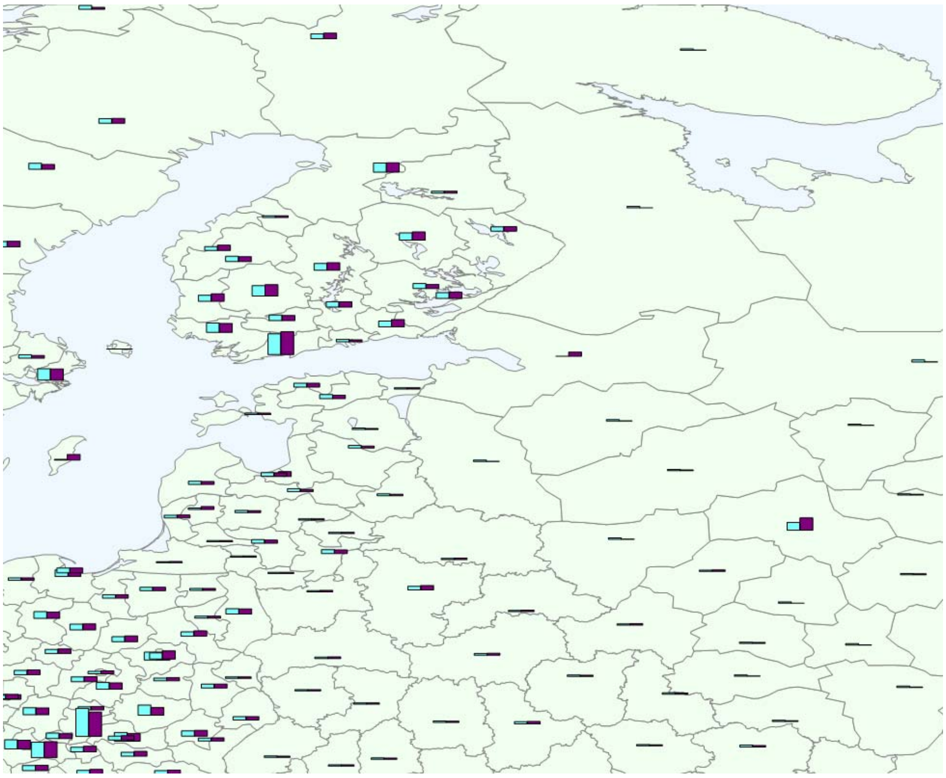


Figure 43 shows a summary of the freight tonnages estimated within the regions connected by the South-Eastern Axis.

The same is provided in Figure 44 for the Northern axis.

Figure 44: WORLDNET O/D Data for Northern Axis



The O/D flows at NUTS3 level, provides sufficient detail for analysing freight flows at the level of road and rail links. These flows can be directly assigned to the WORLDNET network (TRANSTOOLS v2, plus WORLDNET extensions).

With full integration into TRANSTOOLS it becomes possible to analyse cross-border freight flows in a more seamless fashion.

6 WORLDNET Multimodal Impedances

6.1 Surface Mode Impedances

WORLDNET has developed a set of impedance databases for the main surface modes:

- Road
- Rail
- Waterway
- Sea.

Within the road and rail categories, two variations have also been calculated.

For road:

- Impedances including ferry links
- Impedances excluding ferry links.

For rail:

- Impedances based on combined transport rail services (e.g. container trains)
- Impedances based upon wagon load services (e.g. conventional wagons).

The same databases have been used to compute efficient paths within the mode chain builder (WP3), and the same calculations are made for the test assignments. They are based upon the final WORLDNET networks, including all the TEN-CONNECT (TRANSTOOLS V2) updates, so there is a high degree of internal consistency.

Methodology for computing levels of service from within the networks is largely based upon the ETIS-Base methodology (based on market research by MDS-Transmodal, NEA, and AJI-Europe). Essentially, a set of basic costs are calculated for each country, to take account of different factors such as wage costs and fuel taxation. This information is combined with network information, e.g. road speeds and road tolls, and an estimate is made for a given O/D pair, based on an efficient route.

The cost model is provided as a WORLDNET deliverable:

Table 14 WORLDNET Freight Costs

Deliverable	*File Reference*
WORLDNET Cost Calculation	GCM-Costs-WNET-2009.xls

Source: MDST, NEA, AJI, (ETIS-Base)

6.1.1 Road – including ferries

Figure 45: Road Network (West)

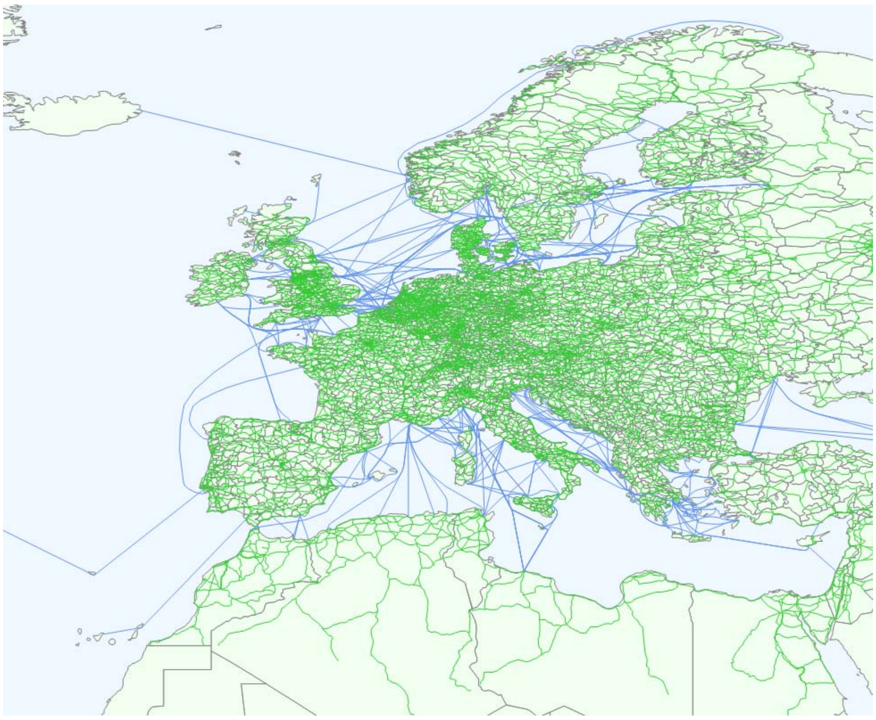
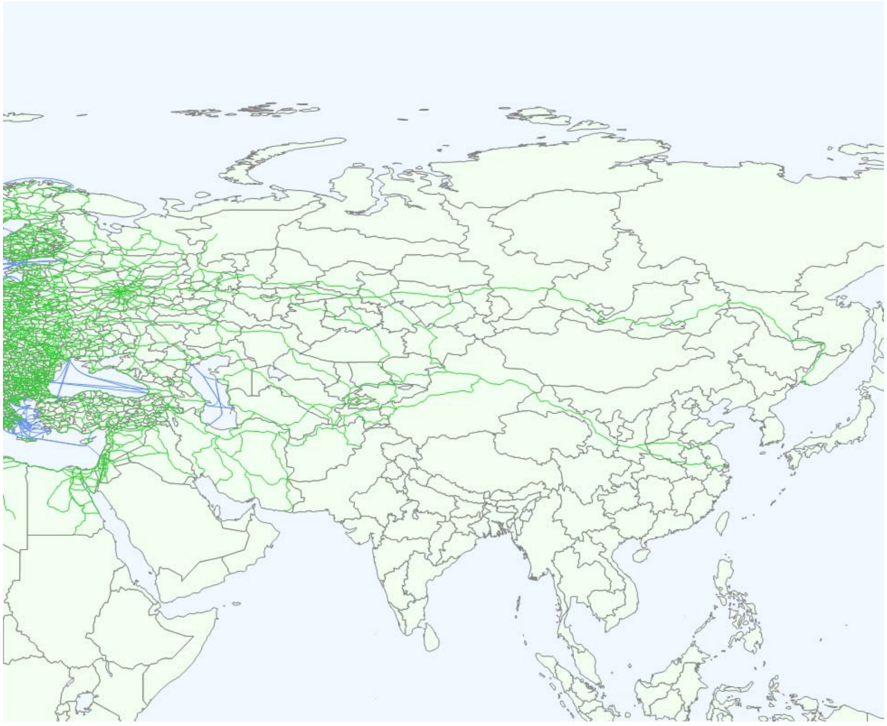


Figure 46: Road Network (East)



These networks produce the database:

Table 15 WORLDNET Road Impedances – With Ferries

Deliverable	*File Reference*
WORLDNET Road Impedances (with Ferries)	*wn_road_n3_dtc_with_ferries.csv*

Source: NEA

An extract is shown below.

Table 16 Road Impedances With Ferries

O_WNID	*O_Name*	*D_WNID*	*D_Name*	*Kms*	*Mins*	*Cost*
101010101	Mittelburgenland	101010101	Mittelburgenland	**24**	29	184
101010101	Mittelburgenland	101010102	Nordburgenland	61	37	257
101010101	Mittelburgenland	101010103	Sudburgenland	80	48	256
101010101	Mittelburgenland	101010201	Mostviertel Eisenwurzen	197	105	406
101010101	Mittelburgenland	133180101	**Inner London West**	1659	1753	2414
101010101	Mittelburgenland	348470000	**Moskva**	1990	2118	2368
101010102	Nordburgenland	101010102	Nordburgenland	**42**	50	184

Source: NEA

The data is stored as an ASCII, comma-separated-variable (csv) file. All WORLDNET region to region pairs are shown, provided that there are network links within the regions. Note that paths from the European continent to Britain are included as a result of the ferry network inclusion. Also, destinations towards the East, e.g. Russia, are included.

Table 17 Road Impedances, Meta Data

Field	*Type*	*Meaning*
O_WNID	Integer	Origin Code, WORLDNET NUTS3-Equivalent
O_Name	String	Origin Name
D_WNID	Integer	Destination Code, WORLDNET NUTS3-Equivalent
D_Name	String	Destination Name
Kms	Floating Point	Distance in Kilometres
Mins	Floating Point	Journey time in Minutes
Cost	Floating Point	Out of Pocket Cost in Euros (Per 12m Trailer)

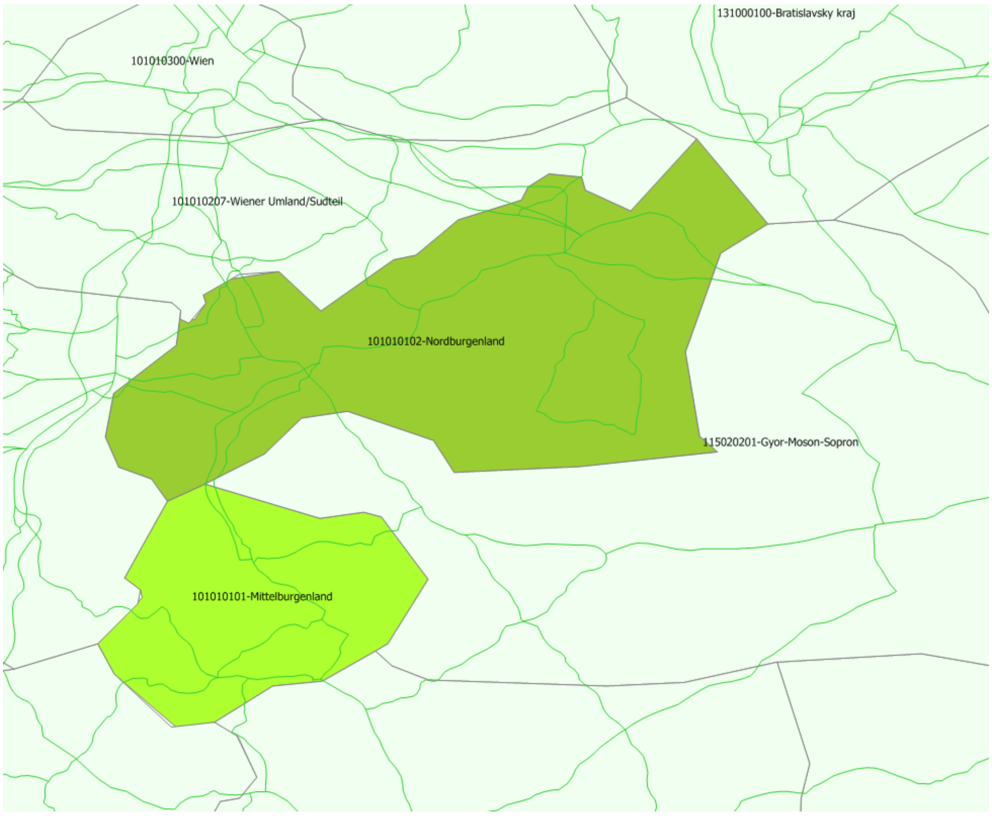
Source: NEA

See (D9, Annex A: Traffic zones used within WORLDNET) for a zoning reference.

Intra-zonal distances are estimated, based on the size of the zone. Note that, for example, intrazonal distances in Nordburgenland are bigger than in Mittelburgerland. (See example: Figure 47.) Doubling the size of the region approximately doubles the intrazonal length. Journey times are based on the speeds coded into the network (adjusted for freight maximum speeds), and costs are based on the ETIS-Base methodology. There is a fixed cost element as well as variable (time and distance based) elements.

By comparison, Google estimates a distance of 1,471 kms between Eastern Austria and London, and a journey time (based on car speeds and no stops) of 14 hours (approximately 105 kmph). The calculated impedances imply a journey time of 29 hours, and an average speed of 57 kmph. Over shorter distances the average speed rises because no drivers' breaks are added to the calculation. Ferry times are taken directly from the network, and no waiting for ferries is assumed.

Figure 47: Intrazonal Calculation (Austrian example)



6.1.2 Road – excluding ferries

An additional set of road impedances has been prepared omitting the ferry links. This is partly to correspond to the methodology established in ETIS-Base, and also to allow greater flexibility in the computation of mode chains.

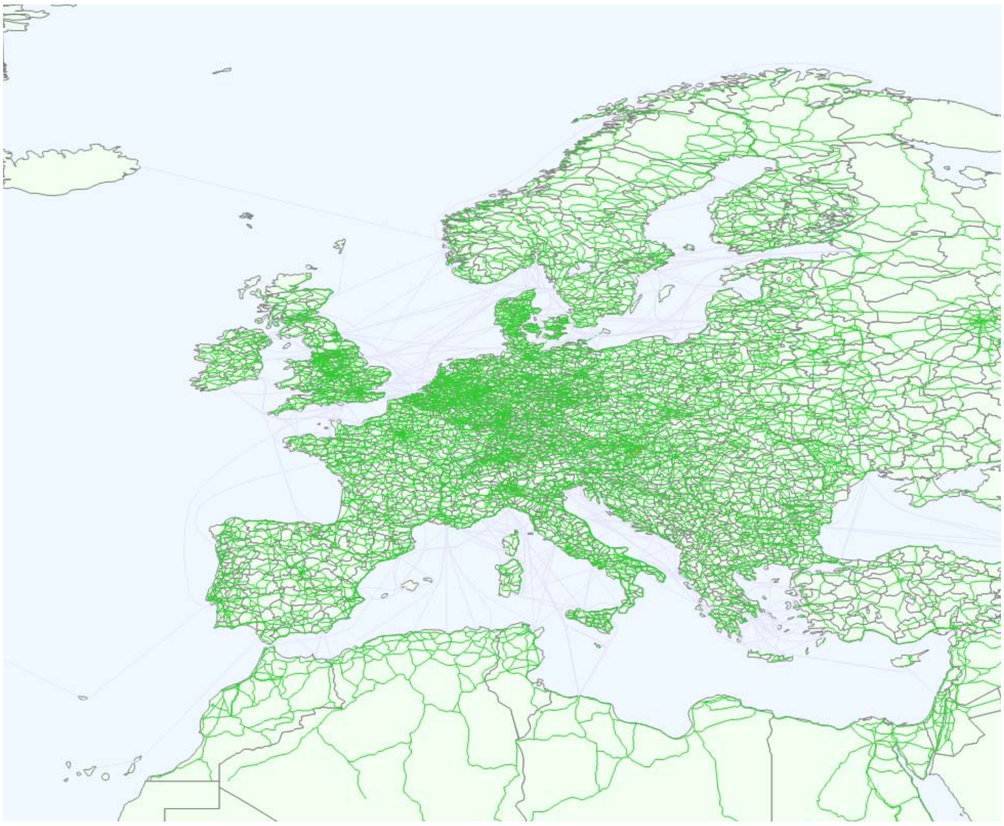
Table 18 WORLDNET Road Impedances – Excluding Ferries

Deliverable	*File Reference*
WORLDNET Road Impedances (no Ferries)	*wn_road_n3_dtc_no_ferries.csv*

Source: NEA

Apart from the removal of the ferry links, the network structure does not change. See below.

Figure 48: Road Network Excluding Ferries



The main advantage of using this network of disconnected "islands" is that the mode chain builder (WP3) can be used to search for multi-modal combinations, and the routing is not hard coded into the network. Thus a short path from Salzburg to London would be computed via the Dover Straits in the complete network, but the absence of a path between London and Salzburg in this database signifies that the client model needs to connect the British network to the Continental network with a maritime link, so this allows different route/mode choice heuristics to be explicitly modelled.

Table 19 Road Impedances Excluding Ferries

O_WNID	*O_Name*	*D_WNID*	*D_Name*	*Kms*	*Mins*	*Cost*
101010101	Mittelburgenland	101010101	Mittelburgenland	**24**	29	184
101010101	Mittelburgenland	101010102	Nordburgenland	61	37	257
101010101	Mittelburgenland	133180101	**Inner London West**	n/a	n/a	n/a

Source: NEA

Note that no record appears in the database for the Austria-UK pair. This is signified in the table by the “n/a” markers.

Meta data is the same as *Table 17 Road Impedances, Meta Data*.

6.1.3 Rail – combined transport

The default rail network has been set up to allow impedances for combined transport services to be calculated.

Results are stored in the D9 deliverables.

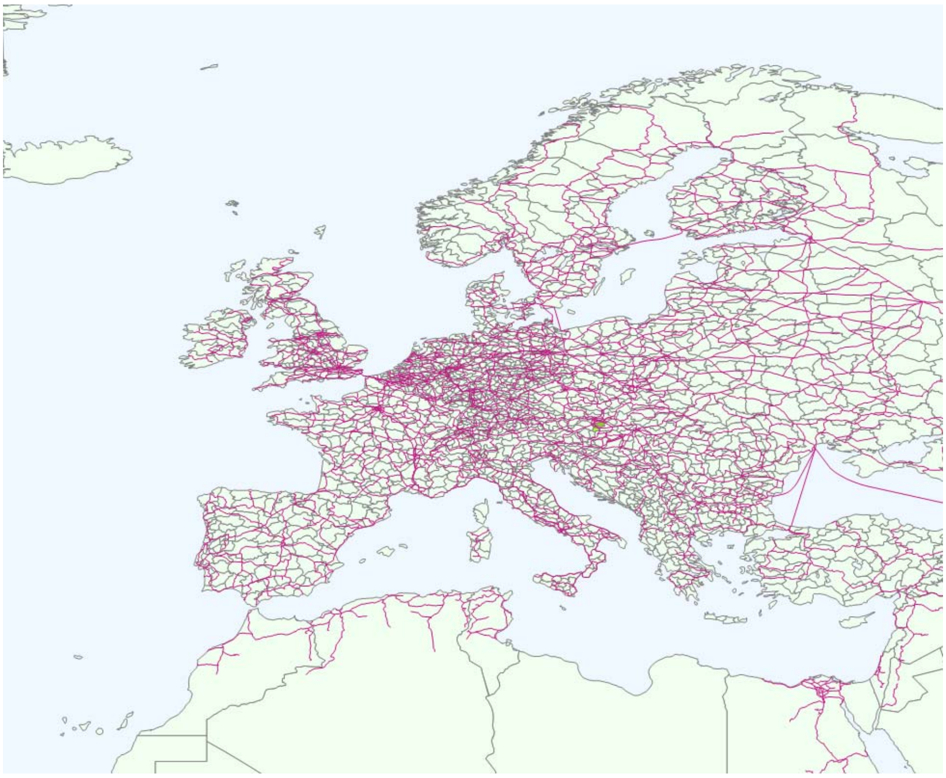
Table 20 WORLDNET Rail Impedances – Combined Transport

Deliverable	*File Reference*
WORLDNET Rail Impedances – Combined Transport	*wn_rail_n3_dtc.csv*

Source: NEA

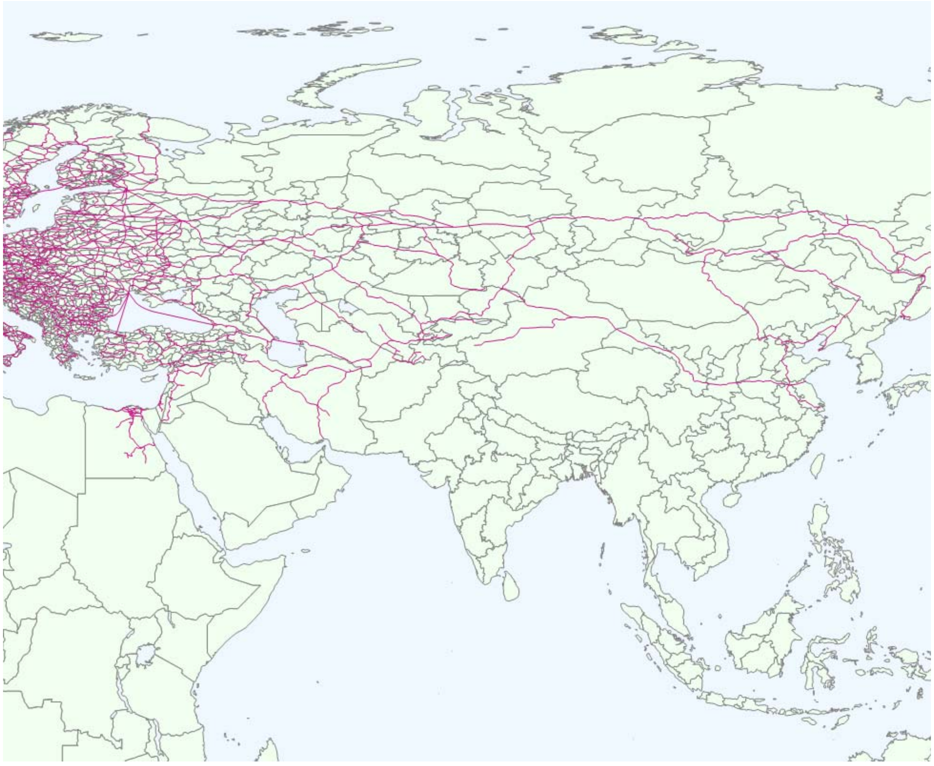
The network originates from TRANSTOOLS (the rail freight links), and contains the V2 updates, in addition to the WORLDNET extensions.

Figure 49: Rail Network (West)



Note that certain rail ferry links (e.g. connecting Ireland and Wales) have been removed (since there are no rail ferries there), but others remain, e.g. in the Black Sea, where they are important for connecting freight services. The Channel Tunnel also is included, so the British network is an integral part of the main Eurasian network. However, other “island” networks still exist for example in Ireland, Corsica, Sardinia and North Africa.

Figure 50: Rail Network (East)



On the Eastern side the main trans-continental Eurasian routes are included. Ferries are also included in the Caspian Sea.

Data structures follow exactly the road format.

Table 21 Combined Transport Rail Impedances

O_WNID	*O_Name*	*D_WNID*	*D_Name*	*Kms*	*Mins*	*Cost*
101010101	Mittelburgenland	101010102	Nordburgenland	76	282	234
101010101	Mittelburgenland	101010103	Sudburgenland	110	361	248
101010101	Mittelburgenland	101010201	Mostviertel Eisenwurzen	186	419	316
101010101	Mittelburgenland	133180101	Inner London West	1712	2447	2024

Source: NEA

Table 22 Combined Transport Rail Impedances, Meta Data

Field	*Type*	*Meaning*
O_WNID	Integer	Origin Code, WORLDNET NUTS3-Equivalent
O_Name	String	Origin Name
D_WNID	Integer	Destination Code, WORLDNET NUTS3-Equivalent
D_Name	String	Destination Name
Kms	Floating Point	Distance in Kilometres
Mins	Floating Point	Journey time in Minutes
Cost	Floating Point	Out of Pocket Cost in Euros (Per Forty Foot Unit)

Source: NEA

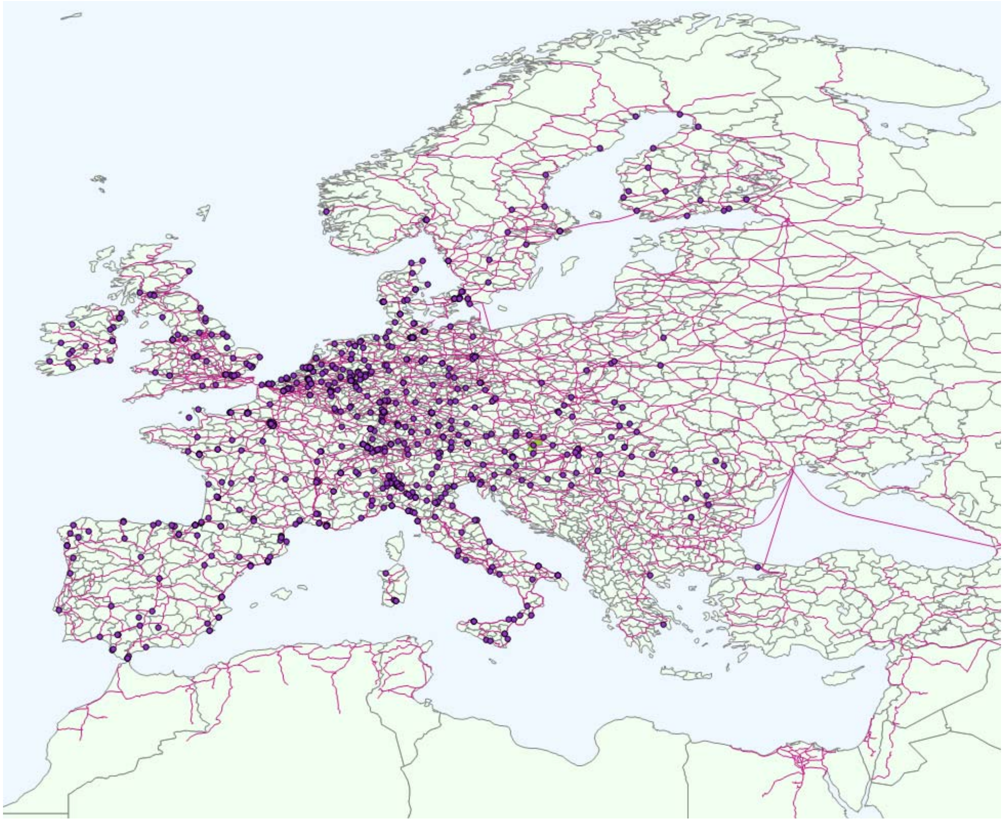
See (D9, Annex A: Traffic zones used within WORLDNET) for a zoning reference.

In general, road costs and combined transport costs can be compared directly because the units of measurement, Euros per forty foot unit, and Euros per 12m trailer are approximately the same.

Road freight tends to be faster, with lower fixed costs, but with higher variable costs. By providing separate figures for distance, time and cost it is possible for client applications, such as the TRANSTOOLS mode split model to calculate their own generalised costs, which can also be specialised by cargo type.

The network can also be combined with the database of inland terminals collected during ETIS-Base. See Figure 51. It is recommended that this database be updated and extended for the new network coverage, as it provided additional information about connectivity for rail freight. Without this data it is necessary to assume that cargo can access the rail network at a nearby network node. However, many regions do not have active rail heads.

Figure 51: Network of Rail Terminals



6.1.4 Rail – wagon load transport

An additional set of impedances are provided for wagon load rail services.

Results are stored in the D9 deliverables.

Table 23 WORLDNET Rail Impedances – Wagon Load Transport

Deliverable	*File Reference*
WORLDNET Rail Impedances – Wagon Load Transport	*wn_bkrail_n3_dtc.csv*

Source: NEA

The network is identical to that used for the combined transport computations, but the choice of network paths may differ due to the different cost structures.

Table 24 Wagon Load Transport Rail Impedances

O_WNID	*O_Name*	*D_WNID*	*D_Name*	*Kms*	*Mins*	*Cost*
101010101	Mittelburgenland	101010102	Nordburgenland	76	282	4.00
101010101	Mittelburgenland	101010103	Sudburgenland	110	361	5.00
101010101	Mittelburgenland	101010201	Mostviertel Eisenwurzen	186	419	5.00
101010101	Mittelburgenland	133180101	Inner London West	1705	2465	23.00
101010101	Mittelburgenland	348470000	Moskva	1992	3606	32.00

Source: NEA

Table 25 Wagon Load Rail Impedances, Meta Data

Field	*Type*	*Meaning*
O_WNID	Integer	Origin Code, WORLDNET NUTS3-Equivalent
O_Name	String	Origin Name
D_WNID	Integer	Destination Code, WORLDNET NUTS3-Equivalent
D_Name	String	Destination Name
Kms	Floating Point	Distance in Kilometres
Mins	Floating Point	Journey time in Minutes
Cost	Floating Point	Out of Pocket Cost in Euros **(Per Tonne)**

Source: NEA

See (D9, Annex A: Traffic zones used within WORLDNET) for a zoning reference.

Note that wagon-load (bulk) rail costs are expressed in Euros per tonne, and not Euros per forty foot unit. In general, the costs are considerably lower, but distances and times will be similar, since there is no differentiation between train speeds in the two categories.

6.1.5 Inland waterway transport

Impedances for inland waterways are provided in the following table, included in the D9 deliverable.

Table 26 WORLDNET Waterway Impedances

Deliverable	*File Reference*
WORLDNET Waterway Impedances	*wn_water_n3_dtc.csv*

Source: NEA

The network has been derived directly from TRANSTOOLS, without any extensions. (WP4 did not include inland waterway extensions). The network is relatively crude, but it contains the most active links for freight transport.

Figure 52: Network of Inland Waterways

The data structure follows the same pattern as road and rail.

Table 27 Inland Waterways Impedances

O_WNID	*O_Name*	*D_WNID*	*D_Name*	*Kms*	*Mins*	*Cost*
101010102	Nordburgenland	101010201	Mostviertel Eisenwurzen	201	12052	190
101010102	Nordburgenland	101010206	Wiener Umland Nordteil	55	3296	161
101010102	Nordburgenland	101010207	Wiener Umland Sudteil	55	3296	161
101010102	Nordburgenland	101010300	Wien	55	3296	161

Source: NEA

Cost measurement follows the same convention as road and combined transport, showing the cost per container unit rather than the cost per tonne.

Table 28 Inland Waterways Impedances, Meta Data

Field	*Type*	*Meaning*
O_WNID	Integer	Origin Code, WORLDNET NUTS3-Equivalent
O_Name	String	Origin Name
D_WNID	Integer	Destination Code, WORLDNET NUTS3-Equivalent
D_Name	String	Destination Name
Kms	Floating Point	Distance in Kilometres
Mins	Floating Point	Journey time in Minutes
Cost	Floating Point	Out of Pocket Cost in Euros (Per 40 Foot Unit)

Source: NEA

See (D9, Annex A: Traffic zones used within WORLDNET) for a zoning reference.

6.1.6 Sea transport

Maritime transport cannot be analysed in the same way as the other surface modes because there is no equivalent maritime network, only the services offered by shipping lines, which may or may not be running according to schedules. On-demand services effectively connect all ports to all other ports, and through feeder networks, connectivity within the container shipping networks is also very high.

Therefore, rather than attempting enumerate all the current port pairs served by sea freight services, we have connected all ports via a pseudo-network traced over the sea.

The deliverable is provided as part of D9.

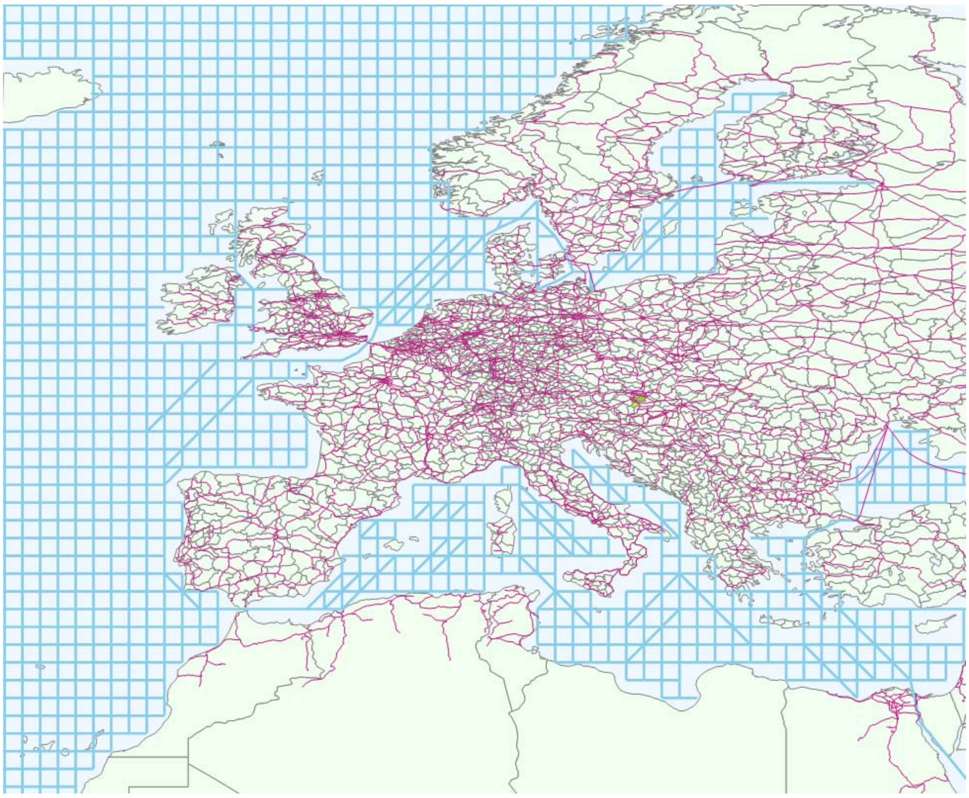
Table 29 WORLDNET Maritime Impedances

Deliverable	*File Reference*
WORLDNET Maritime Impedances	*wn_sea_n3_dtc.csv*

Source: NEA

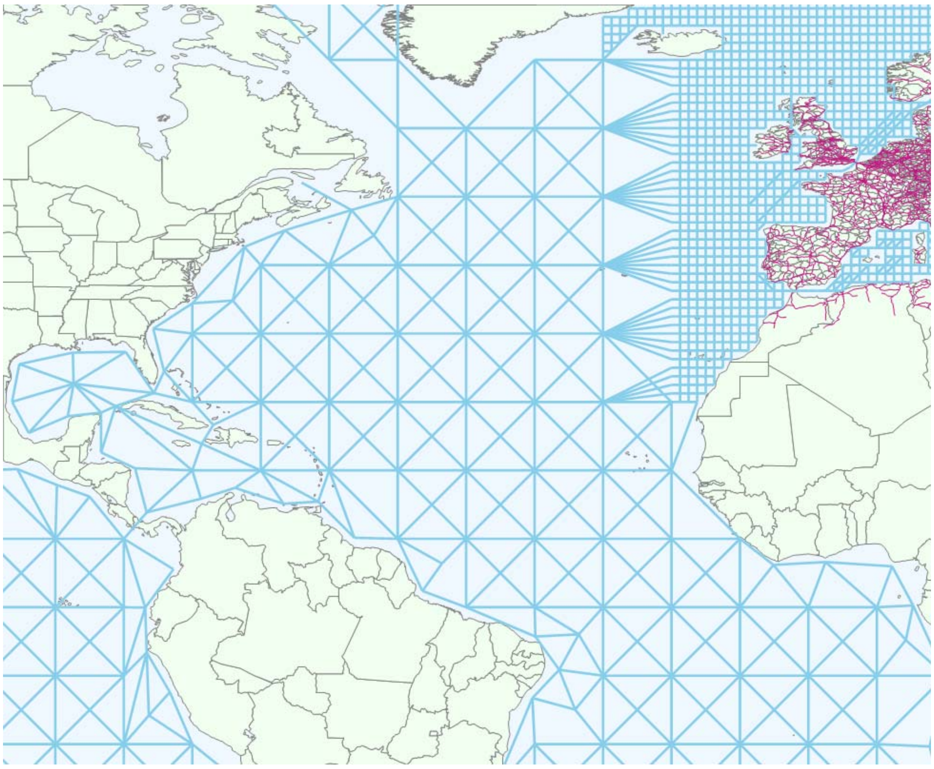
The network, derived from the network set up by ETIS-Base (MDS-Transmodal), is shown below:

Figure 53: Maritime Network (Europe)



The network extends worldwide, but with a higher density of links closer to Europe. Key maritime links such as the Panama Canal, the Suez and the Turkish Straits are all identifiable. With traffic assignment it is then possible to identify, and to forecast the flows adding cargo to these bottlenecks.

Figure 54: Maritime Network (Outside Europe)



Ports can also be added to the database, allowing connections to be made within the modelling tools between inland and maritime links. This allows regions containing ports to be identified, so that it is possible to calculate the access and egress from traffic zones (inland) to maritime routes.

See Figure 55.

By combining these port locations with the maritime data collected in WP4, it is also possible to match cargo flows of a particular mode of appearance to the ports which can handle these cargoes.

Figure 55: Network of Ports

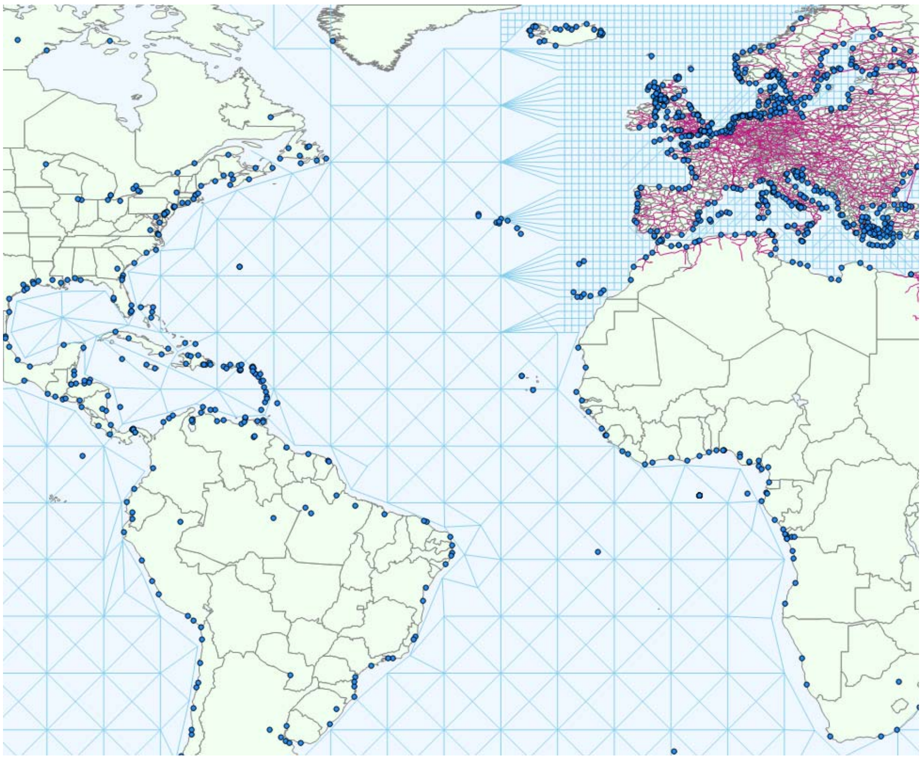


Table 30 Maritime Impedances

O_WNID	O_Name	D_WNID	D_Name	Access Kms	Egress Kms	Kms	Mins	Cost
102020101	Arr Antwerpen	102020501	Arr Brugge	83	87	75	111	163
102020101	Arr Antwerpen	103030301	Varna	83	41	6381	10922	1424
102020101	Arr Antwerpen	103030401	Burgas	83	79	6381	10922	1424
102020101	Arr Antwerpen	105000000	Kypros Kibris	83	96	6064	10379	1361

Source: NEA

Cost measurement follows the same convention as road and combined transport, showing the cost per container unit rather than the cost per tonne.

Table 31 Maritime Impedances, Meta Data

Field	*Type*	*Meaning*
O_WNID	Integer	Origin Code, WORLDNET NUTS3-Equivalent
O_Name	String	Origin Name
D_WNID	Integer	Destination Code, WORLDNET NUTS3-Equivalent
D_Name	String	Destination Name
Access Kms	Floating Point	Distance from Origin Zone centroid to Nearest Port
Egress Kms	Floating Point	Distance from Destination Zone centroid to Nearest Port
Kms	Floating Point	Distance in Kilometres between Ports
Mins	Floating Point	Journey time in Minutes between Ports
Cost	Floating Point	Out of Pocket Cost in Euros **(Per 40 Foot Unit)**

Source: NEA

See (D9, Annex A: Traffic zones used within WORLDNET) for a zoning reference.

The new inputs from WORLDNET WP4 would allow these calculations to be elaborated, so that costs could be recalculated (based on the distance alone) for different cargo, and therefore different ship types and sizes. The link and node network is nevertheless useful in allowing maritime distances and approximate routes to be calculated in a similar way as the other networks. It allows WORLDNET to be further extended in future.

6.2 Air Cargo Impedances

Air cargo impedances describe the attributes applying for a freight transport between a region of origin and a region of destination, when using air transport as a main mode. The impedances also include information about the feeder transport between a region and an airport where the freight is transhipped to an aircraft and as well between the airport where the freight is unloaded from an aircraft and transhipped to a truck to carry it to the final region of destination. So the air cargo impedances delivered in this project cover the full intermodal transport chain.

6.2.1 Methodology

The air cargo impedances delivered are calculated on base of the air cargo network as described in the D8 report. To recapitulate in brief this network consists of information about:

- transport times and distances between regions and airports in their vicinity
- the minimum times necessary for transhipment at airports (or between airports of an airport system) between truck and aircraft as well as between aircrafts

- information about flight times and the frequency of flights between airports on base of real flight schedules; for non-stop flights as well as for multi-airport-legs with up to two intermediate airports
- information about the flight distances.

In an intermediate step all flight options between a pair of airports during a typical week of the underlying flight schedule have been calculated and aggregated to flight paths, resulting in an artificial network of aggregated connections between airports. Combining this aggregated network with feeder links between regions and airports gives a network model for air cargo which can be used for model purposes.

Applying a shortest path algorithm on this aggregated network allows to calculate impedances for each pair of regions. In most cases (ca. 99,7%) such a shortest path consists of a feeder link between a region of origin and one airport in its vicinity, a flight path with up to two intermediate transhipment airports from this airport of origin and an airport of destination and finally a feeder link connecting the airport of destination with the region of destination. Usually two intermediate airports are sufficient, as air cargo shipping even on the longest distances works with the following scheme: Trucking to the next adequate secondary airport, tranship to a flight connecting to an intercontinental hub in the same continent, tranship there for flight to an intercontinental hub in another continent and from there a last connection flight to a secondary airport in this hemisphere followed by trucking to the destination region.

This does not apply for impedances between two quite remote areas, where it is not possible connecting them with three flights as mentioned above.

An example for such a situation is the impedance which applies for air cargo between the region of Tirana, Albania (Region Code 145110000) and Nauru, Oceania (Region Code 410000000). In this case air cargo is shipped along the shortest as follows:

1. Trucked to Tirana, the national airport of Albania
2. Flown from Tirana to Athens, Greece
3. Transhipped and flown from Athens to Singapore
4. Transhipped and flown from Singapore to Brisbane, Australia
5. Transhipped and flown to the airport of Nauru and
6. Trucked “the last mile” to the destination.

Another situation where it is not possible to derive the shortest path directly from the network is in case of remote areas with a very limited supply of air connections. For example this applies to the island of St. Helena which is served only by weekly flights connecting its airport, Georgetown, with the airport Brize Norton, United Kingdom (a military base). As this military base is not served by any other flights available for civil purposes, air cargo not originating in the United Kingdom has to be flown to another airport in the United Kingdom first and trucked from there to Brize Norton.

As it is possible that there could exist a pair of regions where both examples of several transhipment could apply, we had to foresee up to 6 intermediate airports which in principal can occur on a shortest path connecting two regions.

Although origin-destination pairs with more than two intermediate airports are quite rare (0.3% of all pairs of the impedance matrix) they have to be incorporated as well when an impedance matrix covering all regions considered is needed, irrespective if there are any relevant air cargo flows to or from such remote areas or not.

So applying a shortest-path algorithm to all pairs of regions of which at least one is situated within Continental Europe leads to the impedance matrix which is described in the following section.

6.2.2 The resulting impedance matrix: format and definition

The air cargo impedances are delivered in one ASCII file (WORLDNET_imp_221208.csv). The code plan of the file is in the first line. The values for the distinct fields are separated by a semicolon (";"). The impedance matrix covers all OD-pairs where at least one of the regions is situated in Europe, i.e. impedances between regions outside Europe are not covered.

The values for each pair of origin and destination region covered describe the complete path for this pair of regions including the feeder to the airport of origin and destination, all transhipment times at the airports of origin, destination and on intermediate airports and the flight time on the flight segment(s). The impedances apply to the shortest path between two regions. In cases where there is more than one path with this shortest time for one pair of regions, all those paths with identical total time are included in the file.

The impedances consist of the addition of the values out of the files - air_cargo_connector.csv (feeder links), - air_cargo_flight_paths.csv (links between airports) and - transhipment times at the airport of origin and destination of each 90 minutes between road feeder and a domestic flight, respectively 120 minutes between road feeder and an international flight along a shortest path between two regions. These files built the air cargo network as already described in the D8 report.

The air cargo impedances consist of the following information for each pair of regions covered:

- Origin [WORLDNET code for the region]
- Destination [WORLDNET code for the region]
- Total transport time [minutes]
- Distance from region of origin to airport of origin [km]
- Distance from airport of destination to region of destination [km]
- Total distance [km]
- number of transfer airports
- frequency [flights per week]
- intermediate airport 1 [Three Letter Code (TLC)]
- intermediate airport 2 [TLC]
- intermediate airport 3 [TLC]
- intermediate airport 4 [TLC]
- intermediate airport 5 [TLC]
- intermediate airport 6 [TLC].

As – different to the transport time – the distances for the trucked feeders are outlined separately, one can apply a distance based cost function which differentiates between surface and air transport on these impedances, if required for model purposes concerning generation, distribution or modal split.

6.2.3 Limitations

As the impedances base on the air cargo network prepared for this project, in principle all limitations already mentioned for the air cargo network in the D8 report more or less apply for the air cargo impedances.

While some of them, namely,
- Strictly time shortest paths
- up-to-date flight information
- completeness of the network
- changes of air cargo alliances
- incorporation of rail feeders
- airport specific transhipment times

do not play such a dominating role for impedances, there is one field, where an improvement in modelling air cargo is needed: transport costs.

For the time being, air cargo is about ten times as expensive as sea shipping, so that only very specific groups of goods qualify for air cargo due to their value. As the latest trend in worldwide transport is to split up the transportation of a specific good to both, sea transport and air cargo, to bring a (small) part of goods as soon as possible to the markets for marketing purposes, the biggest part of a delivery will be done by sea transport. So introducing air cargo into a modal split model for distinct commodity groups is a future field in modelling freight transport. The challenge one faces here is the huge price variation for air cargo transport depending on:

- the relation specific available cargo capacity and demand (e. g. Asia -> Europe vs. Europe –> Asia), as an empty aircraft is quite expensive;
- seasonal change of demand;
- specific commodity groups of carried cargo (perishables different to spare parts), i.e. to consider air cargo as an own commodity group is not feasible any more when introducing prices in modelling air cargo and
- different routings in intercontinental air cargo implies to implement a route choice model which includes prices reflecting different air paths and mode combinations.

The impedances covered in the matrix are all based on the intermodal scheme truck -> aeroplane -> [aeroplane -> ... -> aeroplane ->] truck, meaning air is the main mode and surface transport is only considered as a feeder to and from airports.

A second type of intermodality has not been considered within this project now: the combination of the modes sea and air for cargo. This kind of co-operation applies for some air links where the flow pattern of air cargo are very asymmetric (e.g. Europe – Asia), so that cargo aircrafts have to be flown (nearly) empty in one direction. The idea of this intermodality is to close the performance gap between sea and air (air five times faster, but ten times more expensive than sea), to fill unused air cargo capacities. As stated in a presentation at the WORLDNET meeting in Beijing, this kind of intermodal transport sums up to 400,000 tonnes worldwide in 2006, which is quite a small amount of all air cargo.

Nevertheless this form of intermodality could be considered in a future update of WORLDNET, in case commodity group specific price information will be incorporated into the air cargo impedances in future. Under such circumstances a third alternative for intercontinental transport combining sea and air transport in competition to full surface transport and air transport with minimal surface feeder services could be included in modelling modal split for freight transport. Actually this transport chain combination of road – sea - air – road modes is quite rare and just applicable where air cargo flows are very asymetric, sufficient infrastructure capacities and air as well as sea services are anyhow available along the nearly direct transport path. In the case outlined above this is the matter due to the new facilities of infrastructure and the strong presence of the air and sea transport industry at Dubai.

6.2.4 An example for using impedances (Air Cargo Accessibility)

Finally we want to show an example for the application of air cargo impedances. The example deals with an indicator we call air cargo accessibility which expresses the quality of air cargo transport available in a region. As an indicator therefore the average transport time for air cargo from a distinct region to any other region in the world, weighted by the GDP of the destination region was chosen.

This indicator is calculated as follows:

Figure 56: Calculation formula of the air cargo accesibility

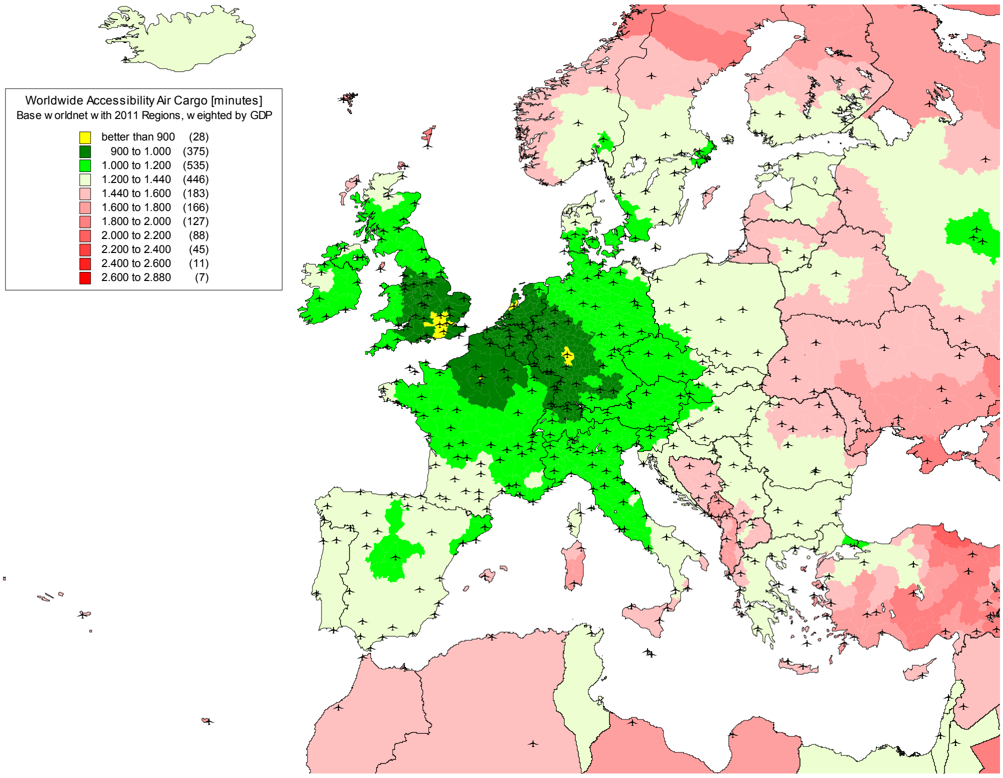
$$\forall i \in WN-\mathrm{Re}\,gions:$$

$$avg_{time_{fastest},GDP}(i) := \frac{\sum\limits_{\forall j \in WN-\mathrm{Re}\,gions;\, j \neq i} time_{fastest}(i,j) * GDP(j)}{\sum\limits_{\forall k \in WN-\mathrm{Re}\,gions} GDP(k)} [\min]$$

Calculating this indicator for all regions used in WORDLNET (WN-Regions) leads to values between 874 minutes (Surrey, United Kingdom, the region where the airport London Heathrow is situated) and 2778 minutes (Cook Islands, Oceania, situated more than 3000 kilometres East of Australia).

In other words: world wide air cargo to Surrey, England in average needs less than 15 hours to reach this destination while air cargo destinated to the Cook islands in average will need two days to reach this area.

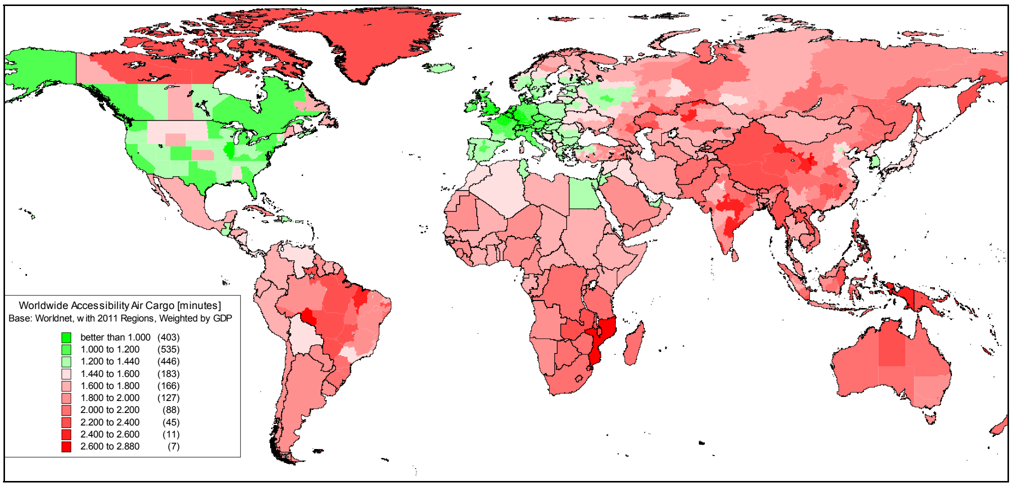
Figure 57: Usage of air cargo impedances to illustrate regional accessibility (Europe)



The figure above shows a map of Europe, coloured by the values for the air cargo accessibility which apply to the distinct regions. For large parts of Europe the average transport time for air cargo is below 24h (1440 min) or better. These parts are coloured in green, while the regions with top accessibility values (better than 900 minutes) are marked in yellow. The latter are situated around the airports of London, Frankfurt, Amsterdam and Paris.

So within Europe only in Northern Scandinavia, the Ukraine, Moldavia, Bosnia, Montenegro and Albania, as well as parts of the Baltic States, Belarus, Russia, Romania, Serbia, Macedonia and Turkey together with some islands belonging to other European countries accessibility values exceeding 24 hours apply.

Figure 58: Usage of air cargo impedances to illustrate regional accessibility (World)



In the worldwide focus the situation differs significantly: An excellent air cargo accessibility can be stated only for the United States of America, Canada, Guatemala and some countries in the Caribbean like the Bahamas or Puerto Rico etc., Tunisia, Egypt, Israel, Lebanon, Jordania, the United Arab Emirates, Korea and parts of India (Delhi) and China (Bejing), where the accessibility is on a level similar to most parts of Europe.

6.3 Network-Based Impedances to Airports

For regions where comprehensive road network data are available, the region-to-airport impedances were computed via the road network. This is the case for the whole of Europe, North Africa, the Middle East and several other Asian countries. The network data are based on the WORLDNET network which is an extension of the TEN-CONNECT network. In the following, the most important network data with regards to the calculation of network impedances between regions and airports are summarised and described.

6.3.1 Link type

The network links are differentiated by five link types being listed in the table below. Each type has been assigned to a speed class. For a selection of countries the corresponding speed figures are listed in Table 33.

Table 32 Network-Links differentiated by type

Link_Tpe_ID	***Road_Type***	***Applied Speed Class***
1	Motorway	M
5	Rural road with separate directions	D
6	Rural two-lane road	O
9	Urban road	B
90	Ferry	F

6.3.2 Speed

Information on speed stems from the database of the International Road Transport Union (IRU) and are classified by the speed categories listed in Table 32. The following table shows these data for a selection of European, African and Asian countries. Although the data are differentiated by type of road, the speed figures represent computed average values, since most countries distinguishe further between the weighting categories of the different transport vehicles in determining the speed limit.

Table 33 Speed limits (in km/h) in a selection of countries

Country	Country_Code	B	O	D	M
Arab Republic of Egypt	EG	50	80	80	90
Austria	AT	50	70	70	80
Azerbaijani Republic	AZ	60	70	70	90
Belgium	BE	50	75	90	90
Bosnia and Herzegovina	BA	50	100	100	100
Bulgaria	BG	50	80	80	100
Croatia	HR	50	75	75	75
Cyprus	CY	50	90	100	100
Czech Republic	CZ	50	80	80	90
Democratic and Popular Republic of Algeria	DZ	50	80	80	90
Denmark	DK	50	70	70	80
Estonia	EE	50	90	100	100
Finland	FI	50	80	80	80
France	FR	50	80	85	90
Georgia	GE	60	70	90	100
Germany	DE	50	70	70	80
Greece	GR	50	70	80	90
Hashemite Kingdom of Jordan	JO	40	70	100	100
Hungary	HU	50	70	70	80
Ireland	IE	50	80	85	90
Italy	IT	50	75	75	80
Kingdom of Morocco	MA	50	80	80	90
Latvia	LV	50	85	85	85
Lithuania	LT	50	80	85	90
Luxembourg	LU	50	75	75	90
Moldova	MD	60	80	90	90
Netherlands	NL	50	80	85	85
Poland	PL	50	80	90	95
Portugal	PT	50	80	85	95
Republic of Albania	AL	40	90	90	90
Republic of Armenia	AM	60	90	90	90
Republic of Belarus	BY	60	80	90	100
Republic of Iraq	IQ	50	80	80	90
Republic of Kazakhstan	KZ	60	90	90	90
Republic of Tunisia	TN	40	80	80	90
Romania	RO	50	80	90	100
Russian Federation	RU	60	70	70	90
Serbia	RS	60	75	75	75
Serbia and Montenegro	ME	50	75	75	75
Slovakia	SK	60	80	80	80
Slovenia	SI	50	75	75	75
Socialist People's Libyan Arab Jamahiriya	LY	50	80	80	90
Spain	ES	50	70	80	90
State of Israel	IL	50	80	80	80
Sweden	SE	50	70	80	90
Switzerland	CH	50	80	80	80
Syrian Arab Republic	SY	40	60	80	80
The Former Yugoslav Republic of Macedonia	MK	50	75	75	75
Turkey	TR	50	50	80	90
Ukraine	UA	60	70	90	100
United Kingdom	UK	48	70	90	100

Source: based on data from IRU

The ferry type is not explicitly listed in the table above. The speed value was set to 30 km/h uniformly.

6.3.3 Nodes

In order to compute the impedances from a region to an airport, it is required to assign both the region and the airport to network nodes. This allocation has been performed as follows:

Airport nodes
The nearest network node in terms of minimum air-line distance was chosen to represent the access point from the airport to the road network.

Region nodes
The computation of the population centre of gravity that is not the geographical centre of gravity, but a centre taking into account all cities and their belonging population yielded to a point representing the region. The bigger the city is in terms of number of inhabitants, the higher the gravity. The resulting population centre of gravity was then assigned to the nearest network node (in terms of air-line distance).

Based on these data and assumptions, the shortest paths[1] - which represent those paths with the minimum travel time between the assigned region nodes and airports nodes – were computed. Adding the air-line distance and air-line travel time (computed by using an air-line travel speed of 50 km/h) from the airport node to the airport itself, resulted in the impedances between the regions and the airports. Since the catchment area of an airport is limited to a certain number of regions depending on the travel time to the airport, the impedances between regions and airports were only determined on relations with a travel time of less than ten hours.

It is important to mention, that the resulting impedances (in terms of travel time and distance) are theoretical and potential values respectively, since speed limits (i.e. upper limits) were used for their computation. In other words, the calculated travel times are in most cases significantly lower than the actual travel times.

6.4 Generic Impedances to Airports

In order to compute impedances for regions without network data, such as for regions in North/ South America or Australia, a generic approach had to be developed.

Each WORLDNET region has been assigned to at least one major airport. The determination of average access and egress impedance values to/from the airports without using a road network explicitly can be summarized with the following points:

- Determination of the average air distance
- Determination of an average detour factor
- Computation of the average travel time.

[1] For the identification of these shortest paths the Dijkstra-Algorithmus has been applied.

6.4.1 Average air distance

In order to obtain the average distance to the airport, cities (belonging to the region the airport was assigned to) with a population above 50,000 people were identified in a first step[1]. In a second step, the spherical air-line distances from each city i in region r to the airport k have been computed. Weighting these city-to-airport distances $dist_{ik}^{air}$ with the belonging population pop_i resulted in the average air-line distance to the regional airport ($avg\_dist_{rk}^{air}$). This was done by assuming that economic activities/markets generating air cargo flows are bundled/located especially in major agglomerations, even besides the fact that such flows are eventually collected in distribution centres outside these agglomerations. The determination of the average air distance can be exemplified as follows:

$$avg\_dist_{rk}^{air} = \frac{\sum_i pop_i * dist_{ik}^{air}}{\sum_i pop_i}$$

r	WORLDNET region
i	city in region r (population > 50.000)
k	airport assigned to region r
pop_i	population of city i
$dist_{ik}^{air}$	air-line distance from city i to airport k
$avg\_dist_{rk}^{air}$	average air-line distance to the airport k in region r

6.4.2 Average detour factor

However, the average air-line distance is only the lower bound of the actual average distance via the road-network. In order to get a more realistic distance measure an average detour factor was determined. This detour factor can be interpreted as average distortion which is caused by travelling via the road-network rather than travelling as-the-crow-flies and can be determined as follows:

$$d\_factor_r = \frac{\sum_i dist_{ik}^{network} * pop_i}{\sum_i dist_{ik}^{air} * pop_i}$$

pop_i	population of city i
$dist_{ik}^{air}$	air-line distance from city i to airport k
$dist_{ik}^{network}$	air-line distance from city i to airport k
d_factor_r	average detour factor in region r

[1] In those regions without any cities above 50,000 inhabitants either all cities were taken into account, or the geographical centre of gravity was determined.

For setting up the detour factor, a sample of city-to-airport relations was drawn up[1]. For example, in the US, the sample size amounted to 250 relations all across the country. The comparison between the real distances out of the sample and the air line distances finally yielded to an average detour factor of 1.23. In countries where no real data were collected, an average detour factor of 1.35 (which is approximately the mean of all sample relations) is considered to be appropriate.

However, it is important to note that the average detour factor differentiated by countries is strongly influenced not only by the network density, but also by the geographical factors.

6.4.3 Average travel time

With these detour factors on hand and an average free flow speed limit for each country, straightforward computations (as can be seen in the following formula) resulted in the region-specific average travel time and distance to the airport.

$$avg\_tt_{rk} = \frac{avg\_dist_{rk}^{air} * d\_factor_r}{speed_r}$$

$avg\_dist_{rk}^{air}$	average air-line distance to the airport k in region r
d_factor_r	average detour factor in region r
$speed_r$	average free flow speed limit in region r
avg_tt_{rk}	average travel time to the airport in region r.

[1] Data sources: Google Maps, Microsoft Live Search.

7 WORLDNET - Freight Flows

Work package 3, **Freight Flows**, had three original objectives:

- To update the ETIS freight transport matrix to the year 2005
- To refine the ETIS freight transport matrix to the country level in non-EU countries
- To refine the ETIS freight transport matrix for aviation data.

The main deliverable for WP3 is a freight flow database.

This section summarises the technical methodology, outcome and conclusions of the work involved in producing the updated database, and will serve as a user guide for the published data.

7.1 Database Specification

One of the basic tasks of WORLDNET concerns the update and refinement of the freight flows data that is employed in the TRANSTOOLS model. As stated before, the TRANSTOOLS model uses, as its main freight input, the ETIS database which has been developed to serve as a reference dataset for DGTREN.

ETIS Freight Flow Database Design

The most recent year available in ETIS/TRANSTOOLS is 2000, which is in line with the collection year of the UN/ECE road traffic count data – one of the major primary data sources. A general recommendation was to update the ETIS data sets every five years, in order to remain synchronised with the relevant UN/ECE/EUROSTAT data collection initiatives. 2005 was therefore chosen as the year to update.

Specifically, WORLDNET has focused on updating the freight flows matrix produced by the ETIS-BASE project. For the construction of the relevant data sets for 2005 it employed the definitions, concepts, structures, classifications and dimensions that are in line with or easily translatable into the ones used in ETIS and TRANSTOOLS.

However there are differences between WORLDNET and ETIS. The core area of countries has been expanded, in order to reflect the new EU borders due to recent EU expansion. The external areas have been given a more detailed approach than the one applied in ETIS and TRANSTOOLS. The air transport mode has been considered with equal attention to road, rail, inland waterways and sea.

ETIS freight flows matrix 2000 was constructed on a region to region basis that included transport chain information.

The chain structure included two transhipment locations between the origin and the destination of goods and respectively the transport mode for each route leg. The goods were specified per commodity chapter (NST/R).

The freight flows transport chain matrix both in ETIS and in TRANSTOOLS contains the following structure:

- Origin zone
- First transhipment zone
- Second transhipment zone
- Destination zone
- Mode at origin
- Mode between transhipments
- Mode at destination
- Commodity
- Weight of the commodity.

The dimensions of the variables considered in the ETIS freight OD transport chain matrix are as follows:

Table 34 Dimensions of the ETIS freight OD transport chain matrix

Core countries	*EU-25, Norway, Switzerland*
Regional detail*	NUTS 2 or similar regional detail where no NUTS classification is valid.
Country and country group detail	All European countries separate with exception of the smallest (like Andorra, Vatican, etc), MEDA countries separate, USA, Rest North America, Middle and South America, Japan, Rest Asia, Rest Africa, Australia and New Zealand, Rest world
Transhipment location*	Selection of ports. Selection of inland terminals (excluded for the ETIS pilot)
Modes*	Road, Rail, Inland navigation, Sea, Rest
Commodities	NSTR 2 digits as much as possible and aggregation to NSTR 1 digit when modelling becomes necessary
Cargo types*	liquid bulk, dry bulk, other general cargo
Cargo characteristics*	Hazardous, temperature controlled, other
Containerized*	Yes/No
Other Typologies*	Vehicle/vessel types (definition depending on data availability)
Measuring units	Values Tonnes Ton-km *Number of vehicles/vessels *Vehicle-km/vessel-km *TEU *TEU-km
Base year	2000

**Can only be obtained by estimation and/or modelling*

Similar structures, however containing more refined dimensions, have been used in the WORLDNET freight flows matrix.

WORLDNET O/D data specification

Within WORLDNET, data is being produced according to the published TRANSTOOLS (v1) specification, and a flexible approach has been adopted so that alternative specifications could be supported in future.

Table 35 TRANSTOOLS/WORLDNET O/D Specification

Field	***Type***	***Description***
DestinationZoneID	Long Integer	NUTS2 Region in Europe, Country elsewhere
OriginZoneID	Long Integer	NUTS2 Region in Europe, Country elsewhere
Transhipment1ZoneID	Long Integer	NUTS2 Region in Europe, Country elsewhere
Transhipment2ZoneID	Long Integer	NUTS2 Region in Europe, Country elsewhere
Stage1ModeID	Integer	Transport Mode at Origin
Stage2ModeID	Integer	Transport Mode between Transhipments
Stage3ModeID	Integer	Transport Mode at Destination
CommodityGroupID	Integer	NST Product Sector
Tonnes	Double	Traffic Volume in Tonnes
Base Year = 2005		

The matrix is a combination of recorded data and estimated (synthetic) data. The estimation procedures are applied consistently throughout the database, and for both EU and non-EU countries.

Table 36 WORLDNET O/D data Usage

Field	***Description***
DestinationZoneID	Recorded Data at National level. Estimated at Regional Level.
OriginZoneID	Recorded Data at National level. Estimated at Regional Level.
Transhipment1ZoneID	Estimated
Transhipment2ZoneID	Estimated
Stage1ModeID	Estimated
Stage2ModeID	Estimated
Stage3ModeID	Estimated
CommodityGroupID	Recorded

Each O/D revision is published with a set of release notes providing additional information related to the accuracy and completeness of the estimations.

Following TRANSTOOLS, the data is published in the Access format.

7.2 Methodology – Surface Mode Database

Transport models typically address patterns of vehicle movements within limited geographical territories in order to quantify the interactions between traffic patterns and a realistic representation of the transport infrastructure. In practice this generally results in local, urban, regional, and at the upper extreme, national models. Consequently, if these models address goods movements at all, they are limited to covering trips that take place entirely within their study areas and cannot accurately model realistic origin-to-destination trips for long distance transport.

Local and regional models, while suitable for many passenger transport analyses, as well as detailed studies of vehicle interactions, lack the ability to model goods distribution because their geographic scope does not permit them to trace the supply chain for more than one or maybe two stages, e.g. distribution centre to city centre. If a typical car journey is 25 km, a typical HGV journey might be 100km, but the cargo inside the HGV may have travelled much further through a multi stage journey.

From the point of view of the policy analyst, it is the structure of these multi-stage journeys, the location of production, consumption and distribution, the mode sequences, and the location of transhipment points, and their associated costs that matter. Otherwise it is only likely that amelioration measures might be considered, such as cleaner lorries and peak to off-peak diversions and so on, and not the issues that affect total cargo kilometres and co-modality.

Freight policy cannot be limited simply to managing the “last 100km” of a given set of deliveries. There is a need to consider the impacts of externalities outside the national territory. Reducing freight activity within an economy by relocating production to more distant economies masks a shift in the distribution of externalities that a national model typically will not capture.

In this way, systems for analysing goods movement, such as WORLDNET, are developing more extensive geographical scopes, whereas passenger models and highways models are moving towards greater precision at the agent level.

Perhaps the most important consideration is the apparent mismatch between the view that policy makers within Europe frequently have concerning the freight transport industry, and the view that the industry has of itself. While public transport policy is dominated by local and national concerns such as the problems arising from HGV traffic on roads, deliveries in cities, congestion and so on, the industry takes a broader view of the global supply chain, the development of mega-ports and the role of air cargo hubs for example. Adopting this perspective of a world without borders, the economy as a single entity, rather than the traditional territorial approach can potentially be advantageous.

WORLDNET sets out the objective of developing a long distance, multimodal origin-destination matrix, combined with a network model (WP4) that will cover Europe, its neighbours, as well as intercontinental routes e.g. maritime and air cargo.

These outputs will be developed for DG-TREN's IPR-free TRANSTOOLS model, allowing greater scope for analysing the impacts of globalisation on transport networks. This is a potentially useful IPR-free resource for modellers wishing to capture long distance freight flows within their own national models.

This section will focus on the methodology for estimating the long-distance origin-destination matrix. Previous exercises of this nature e.g. ETIS-BASE and NEAC have tended to use methods focusing upon data combination to estimate transport chains. However, as the geographical areas being considered have grown, along with the resulting data sourcing and harmonisation requirements, and as wide area representations of the transport supply side have improved, it has become more feasible to use a simplified "four step" model as a matrix generator.

A world trade model is used to estimate traffic generation at national level; a regional (NUTS3) distribution model is applied to subdivide the trade flows; a multi-modal assignment procedure is then used to assign to transport chains.

7.2.1 Methodology review

WORLDNET is a direct successor to previous DG-TREN research projects, ETIS-BASE (NEA, 2005) and TRANSTOOLS (TNO, 2008), and therefore inherits many of the same design goals, although specialised for the fields of long distance freight flows and freight networks.

Compared to previous work, the main innovation is the extension of the system geographically. However, between 2000 (the ETIS/TRANSTOOLS base year) and today, many structural changes have taken place in Europe, including the accession of ten new EU members, and the level of data quality and availability is also different. So whereas ETIS aimed to develop a repeatable methodology for producing a multi-purpose transport policy database, WORLDNET aims to develop a more flexible methodology for generating inputs for a specific application, namely TRANSTOOLS.

Designing and developing databases, either demand or supply oriented, for transport models is closely related to the design of the model applications themselves. On one hand, the data structures need to be constructed with the practical requirements of the models in mind, and on the other, several transport modelling techniques may be used to complete the databases where there are errors or gaps in the original inputs.

To a large extent transport modelling has developed in the field of local transport analysis, and in particular, for estimating or simulating vehicle movements in highly detailed network representations, typically road networks. These local models may involve a high degree of sophistication in capturing precise vehicle movements by time of day and driver behaviour. WORLDNET starts out from a different perspective.

In general, there are two important categories of models that might be employed:

- Dynamic/simulation models, in which the system captures the behaviour of individual agents such as drivers and passengers, and how they interact with each other.

- Rational pipe, or four-stage models, i.e. generation, distribution, mode split and assignment, in which 'blocs' of demand are estimated and then shared out, first between zones, then by transport mode, and then to links within given modal networks.

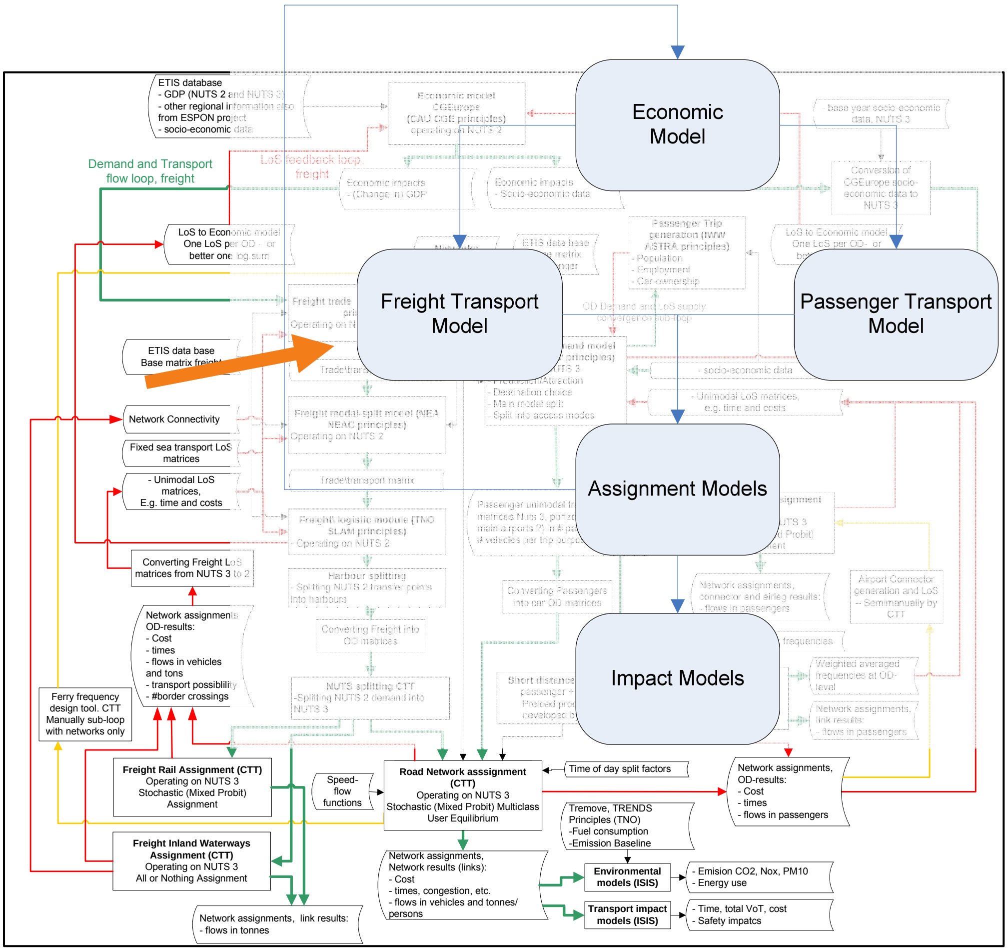
Four stage models have been popular, often because they can be developed with commonly available data and software tools, and also because they are scale-able to conurbation or national level. Zones and networks can be scaled up by simplification, but agents have to be recognisable entities. However, as in many areas of economics, agent based models are becoming increasingly popular in transport applications because they can emulate more complex dynamic interactions in a more natural way, making them particularly valid for traffic simulation.

Models from both categories have been influential upon WORLDNET, within the design of the matrix estimation system.

TRANSTOOLS

The development of a Europe-wide multi-modal four-stage model has been a key influence upon the methodology of WORLDNET. It has established a precedent for a wide area model, and also set out a data specification, including a detailed format for the origin-destination matrix.

Figure 59: Modular Structure of Transtools (v1)

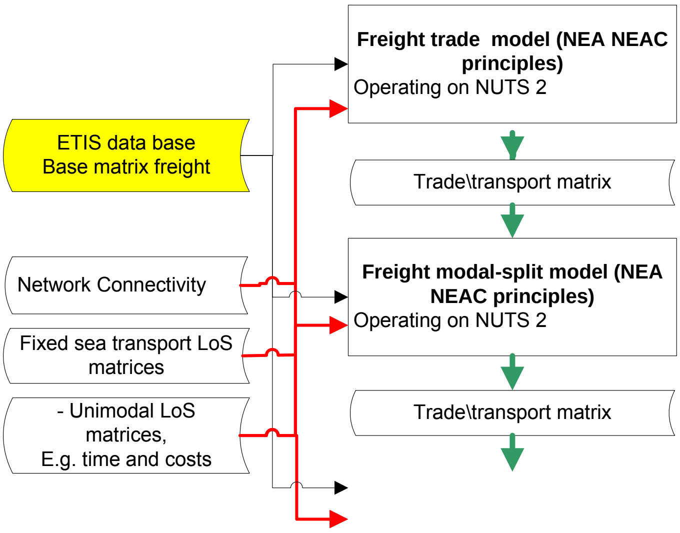


Within the *freight modules* of TRANSTOOLS:

- ETIS-BASE Freight flow origin/destination (O/D) data for the base year (2000) is fed into the freight module. This is segmented by NUTS2 region and NSTR1 product sector, and represented in the form of a transport chain, with transhipment points and mode sequences.
- If a scenario for a present or future year is being modelled, the TRANSTOOLS Trade Model uses information from the economic model (aggregate income) to expand the base year flows.
- Then, the Modal Split Model uses level of service (LOS) matrices derived from the networks in the assignment model to estimate the share of traffic by mode, relative to the base year. Thus, a reduction in cost of a given mode should, ceteris paribus, increase its market share.
- The Logistics Module is then used to model the effects on traffic distribution, taking into account the number and location of warehouses. It extends the

transport chain structure inherited from ETIS by adding European and National distribution centres.

Figure 60: Structure of Transtools Freight Model (v1)



The additional harbour splitting and NUTS splitting modules add greater spatial detail by identifying ports (inside NUTS2 regions) and sub-dividing the NUTS2 regions into NUTS3 regions.

These freight outputs are then handed over to the assignment and impact models.

Consequently, the key characteristic of this system is that the main volumes and shares are derived from the ETIS base year matrix, i.e. regional structure, product segmentation, mode split, and traffic volume, and the subsequent stages can only modify what is already present. Furthermore, the mode split parameters in TRANSTOOLS are also estimated from the mode split already calculated within ETIS. However, the TRANSTOOLS modules cannot build the O/D matrix directly.

Therefore, the main limitations in terms of:

- geographical scope
- regional detail
- product segmentation
- use of recent input data
- definition of modes, and
- allowable combination of modes,

all come from the ETIS system.

Provided that the TRANSTOOLS modules are internally well designed to handle foreseeable future requirements, the system can most easily be expanded by updating the ETIS inputs to give greater scope, timeliness, greater accuracy and greater detail, and only making minor modifications to the TRANSTOOLS system itself. For this, it is necessary to look at models that do estimate O/D matrices and mode chains.

STEMM / GBFM

TRANSTOOLS, ETIS-BASE, and NEAC are characterised by their use of national demand data to derive transport chains in the base year. They are enhanced transport demand databases constructed from simpler demand databases. Marginal (elasticity) models are then added to estimate variations in response to given policy inputs. There are distinct processes for the base year and forecast year estimations.

STEMM (Strategic European Multimodal Modelling) was a Fourth Framework research project (see MDS-Transmodal, 1998). STEMM set out to develop a methodology for modelling multi-modal chains for passenger and freight transport.

Rather than deriving transport chains from statistical sources, the STEMM project focused specifically on estimating them within a model structure, using multi-modal transport networks and transport costs. In this way, the required demand databases were constructed with reference to a fixed representation of the supply side of the market, and then calibrated using network link counts, where they are known.

The STEMM freight model, developed by MDS-Transmodal, ITS-Leeds, and IWW, could therefore be used to estimate existing transport chains. An important goal in STEMM was to understand the circumstances in which different transport modes were complements (choose x AND y) or substitutes (choose x OR y).

Since STEMM, the multi-modal freight model concept was developed further by MDST in a UK context, as GBFM, part of the national model (see MDST, 2004).

GBFM is essentially a network model, which can construct synthetic O/D matrices and assign flows to multimodal transport chains, fitting the results to known flows. International flows are assigned to sequences of transhipment points and modes in a flexible manner, making it possible to include impacts such as port competition, and the relationships between different modal networks. The model parameters are either literature sourced and invariant or calibrated by calculating shadow prices on network links, until estimated flows match observed flows at those points where a comparison can be made e.g. seaports. Thus the model is calibrated to transport data, rather than derived directly from it.

The main advantage of multi-modal network based models like GBFM is their ability to work around substantial data gaps, to unify the processes of mode split and assignment, and to make the estimation of the base year essentially the same process as the estimation of a forecast or scenario.

Their relative simplicity and transparency makes it easier for the user to trace the relationships between the inputs and the outputs.

The idea of trying to reduce the system to a smaller number of more general and more transparent stages (following Wigan and Southworth, 2006, "What's wrong with freight models, and what should we do about it?"), has been an essential design guideline.

For WORLDNET, the experience is relevant because in the absence of pan-European mode chain data, systems of this nature provide a means for calculating transport chains with available inputs. With the parallel development of supply-side freight networks and cost databases (STEMM, TEN STAC, ETIS and TRANSTOOLS) this is now feasible at a European level.

Container World

Container World (Imperial College London, 2004) takes the dynamic aspects of freight modelling and the concept of reduction one stage further by using agent based techniques to model global container flows. Whereas models like GBFM make the demand side of the freight market fluid, Container World also modelled the supply side, and like an urban traffic simulation, it allows individual agents (shipping lines, ports, forwarders) to interact. The ambition was not to construct demand forecasts in the conventional sense, but to discover patterns of emergent behaviour, i.e. successful strategies that could be adopted by real world agents.

From the perspective of WORLDNET, Container World was interesting first, because of the global geographical scope, and second because of the focus on the container sector. A global network was constructed using the actual ship deployment and strings (port rotations) used by shipping lines at the time of the study (sourced from the MDS-Transmodal Containership Databank). It showed that in order to understand why a 8,000 TEU ship arrives in Rotterdam it was necessary to consider the economics of global shipping operations, the dynamics of the market, and the use of ship rotation-based costs (following MDS-Transmodal, Lincost Model).

Container World succeeded in addressing a policy area which could not be encapsulated in a national model, which is also the goal of WORLDNET.

MDST Global Demand and Supply

The most recent advance in terms of developing a worldwide freight database was by MDS-Transmodal in 2007 (see Garratt M., 2007, and MDS-Transmodal 2007). Like Container World it focused upon the container trades, and had a global scope, and it further developed the methodologies for using trade data to estimate container flows, linked to known port volumes. Linking expected traffic flows to port statistics, and supply side data (MDS-Transmodal Containership Databank) allowed the system to be validated.

7.2.2 WORLDNET O/D estimation methodology

Combining aspects of these various methodologies, WORLDNET has set out to construct a transport-chain database, using global trade data and European transport data by means of a calibrated four step model. Like many of the recent approaches it is top down, and like STEMM and GBFM (unlike NEAC and ETIS-BASE) it uses multimodal assignment to estimate mode chains synthetically.

As far as possible, an attempt has been made to keep a straightforward and transparent structure.

The following sections describe the data requirements, and the processes of trip generation, distribution, mode split/assignment. It should be emphasized that although this is a conventional transport model structure like GBFM, the purpose has been to construct software to produce base-year input data for an existing model, i.e. TRANSTOOLS. For this reason, the system cannot be used to generate forecasts or scenarios.

Most of the new work has focused upon the conversion of origin-destination data into synthetic transport chains, so this area will be highlighted.

Scope, Format and Definitions

Previous O/D estimations have produced data for EU member states, their domestic traffic, their intra-EU trade and their extra EU trade. For the extra-EU set, partner countries have often been aggregated, so that flows to smaller countries or more distant countries are grouped. With EU enlargement this approach is no longer appropriate, because in many applications it is desirable to treat accession and neighbouring countries as part of the core set. Furthermore, with the development of trade links across the world it is also informative to preserve the details of trade partner countries as far as possible.

The *geographical* scope of WORLDNET requires a pan-European core area, including Russia, Turkey, Georgia and Ukraine for example, but the data systems and coding have been set up so that other countries can be easily added, for example to cover North Africa and Central Asia. There are no strict limits.

Outside the core area, all countries are included as partner regions, so their trade with the core area is included, but their national and bilateral flows are excluded.

Again, following ETIS and NEAC the matrices are subdivided by region. Previous freight matrices have used NUTS2 definitions for the EU members. WORLDNET is based upon NUTS3 definitions, with equivalents for non-EU countries. The additional detail is particularly useful when modes have to be assigned to the transport chains, and for the calibration of volumes at transhipment points. However, since TRANSTOOLS expects a NUTS2 equivalent, the final matrix is currently aggregated.

In addition, several large non-EU countries including Russia, USA, Canada, Brazil, India, China and Australia have also been subdivided into standard political subdivisions. Like this it will be possible to make a more realistic assignment of maritime flows. For Eastern Europe and Central Asia it is particularly important that China and Russia are subdivided. See below.

Figure 61: Scope and Zoning in WORLDNET

Source: IWW, Worldnet Beijing Seminar, 2008

Commodity and mode definitions follow the TRANSTOOLS convention, with NST-1 digit product categories and main modes, i.e. road, rail, sea, and inland waterway. Additional product detail is feasible for international cargo flows but generally non feasible for national traffic. Hence the lowest common denominator is used.

Further attributes e.g. containerisation, and subdivision by unitised and non-unitised modes of appearance, dry bulk, liquid bulk also follow naturally, although they are not required in TRANSTOOLS.

Volumes are measured in tonnes, and again, translation to vehicle numbers is delegated to TRANSTOOLS. No estimation of empty trips or empty container loads is currently made.

Data Inputs

As far as possible the system has been set up to work with data that is regularly published e.g. by EUROSTAT, and which is likely to be available in coming years. Furthermore, harmonised multi-country sources have been used in preference to national sources.

Since the methodology needs to assign modes and transhipment points to the transport chains, there is a need for both demand and supply side data.

On the demand side the main inputs are:

- EUROSTAT COMEXT Trade data
- UN COMTRADE Trade data
- EUROSTAT Transport data – primarily road freight data

- EUROSTAT Port data.

International flows are derived directly from the main trade data sources. The inland transport data sources are used for the generation of national trips, and for regionalisation of international trips, and the port data is used for calibration.

On the supply side road, rail, waterway and sea networks are used to permit the calculation of impedances within the respective modal networks. These are combined with ETIS-BASE transport cost models. These networks are integrated into a geographical information system (GIS) so that linkages can be made between model regions and network access points.

Some additional inputs have also been sought for non European countries such as the USA and China to allow regionalisation in those areas. Where no data is available, simple socio economic indicators such as population, and GDP have been obtained.

Trip Generation

Underlying transport volumes are, as far as possible, observed in WORLDNET, not modelled, so the process of calculating the freight volumes is still done by combining databases. International flows are collected from the trade databases, and national flows either from the EUROSTAT transport data or in the case of non-EU countries from the national statistical offices.

Trip Distribution

Trip distribution follows the methodologies established in ETIS-BASE. International flows are only known at the whole-country level, and need to be subdivided into regions. This process follows the structure established in ETIS-BASE.

National flows are generally known at a regional level, but EUROSTAT reports flows by origin and flows by destination separately, so these need to be combined. A simple gravity model is used to generate O/D combinations.

Mode Split / Assignment

Following the trip generation and distribution stages a single O/D matrix is created containing:

- Cargo Origin – NUTS3
- Cargo Destination – NUTS3
- Commodity
- Tonnage.

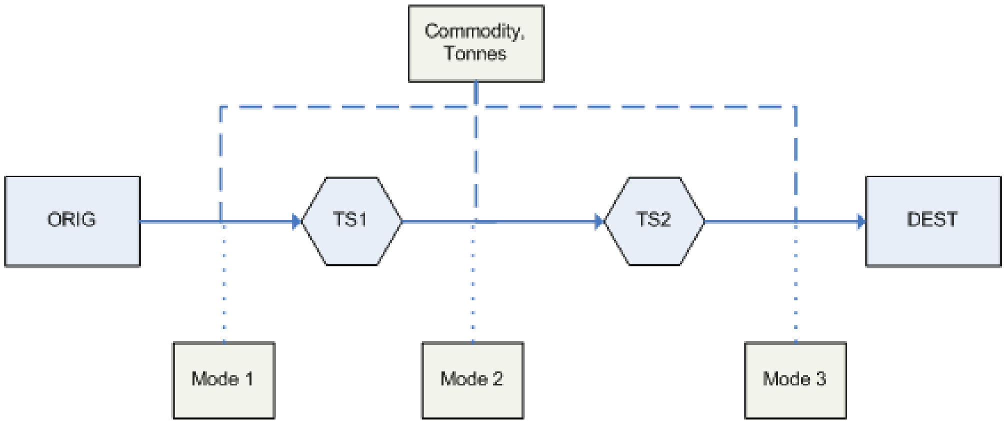
The mode split/assignment stage transforms this into the ETIS-BASE transport chain, with the emphasised attributes included:

- Cargo Origin – NUTS3
- Cargo Destination – NUTS3

- *Transhipment Point 1*
- *Transhipment Point 2*
- *Mode at origin*
- *Mode between transhipments*
- *Mode at destination*
- Commodity
- Tonnage.

This transport chain structure can be visualised as shown below:

Figure 62: Transport Chain Structure



As a data structure this is simply a stack of link objects, and could be calculated as such with flexible dimensions. However, the principal applications for the data expect a stack size of either one, two or three, so this limit is also required for the estimation.

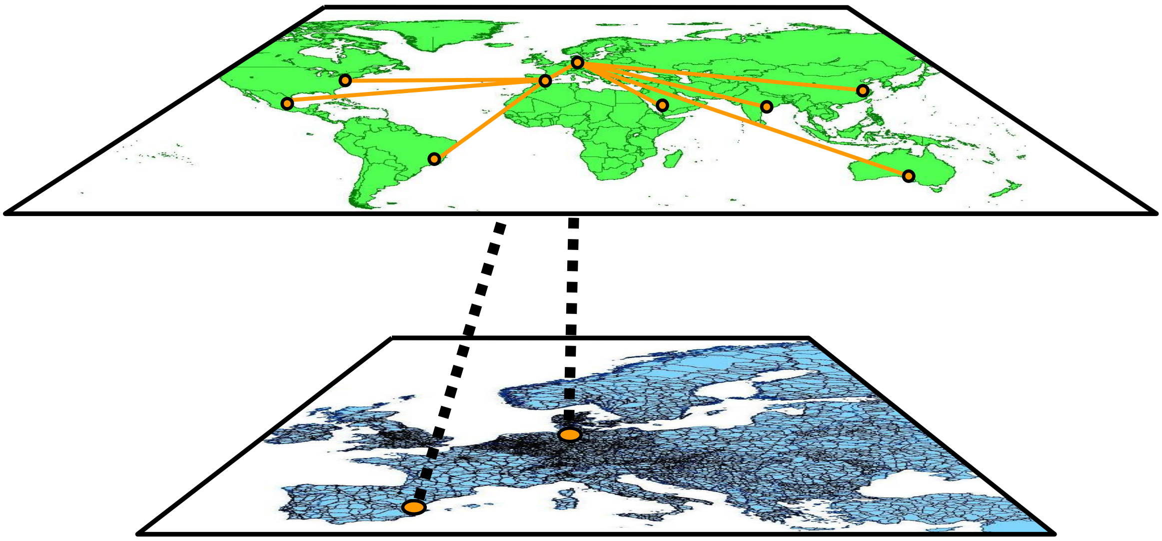
In principle the link objects in this stack could be simple infrastructure connectors (e.g. roads) with head and tail nodes and a simple impedance (e.g. metres) or an abstracted object, itself consisting of a set of infrastructure connectors, and a combination of fixed and variable impedances. This could be an entire road haulage trip expressed as a door to door cost.

Abstraction within a given mode to create these hyperlinks can be advantageous when the primary need is to generate sets of multi-modal combinations aggregated into a fixed three-link transport chains.

Within highly detailed infrastructure networks, for example as used within TRANSTOOLS, an exhaustive method for enumerating paths, even within a single mode would generate a vast choice set. In a combined multimodal network it would be even worse. Given that the path enumeration process needs to be repeated for each consignment in a matrix with over twenty million entries, reducing search space and complexity at this stage is imperative.

Therefore a two stage process has been developed.

Figure 63: Connecting terminals and networks – multimodal approach

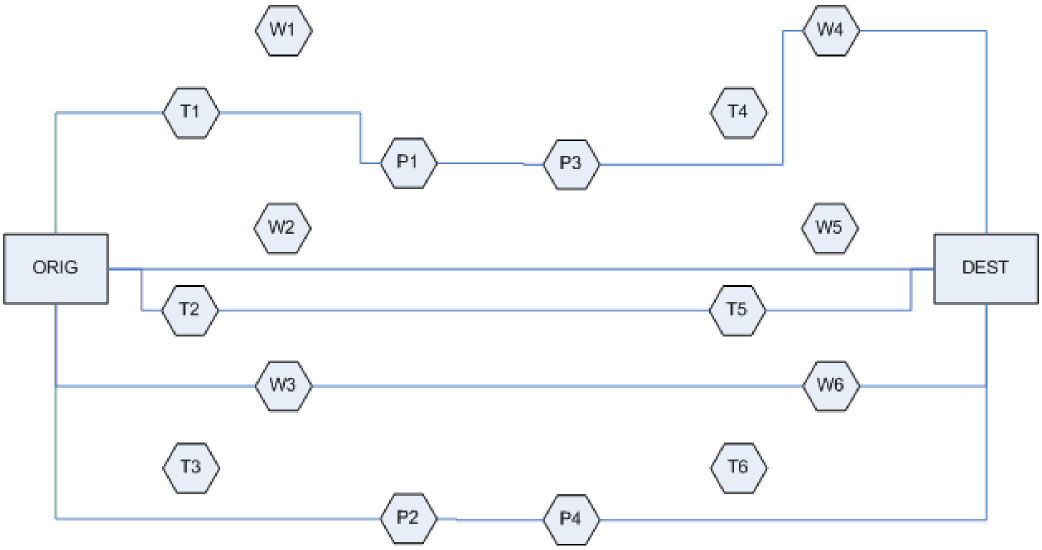


Source: IWW, Worldnet Beijing Seminar, 2008

First, a set of short path impedances are calculated for each of the single mode networks. Then a high-level multimodal graph is constructed using the single mode data as inputs. In the diagram it shows how a worldwide transport chain might be constructed containing a single hyperlink connecting Spain to Denmark. That hyperlink itself would represent an entire journey by road. Its impedance could respond to the characteristics of a much more detailed underlying road network, and traffic across this hyperlink could also be assigned from the high level transport chain to the lower level road network.

The design of the high-level multimodal graph, and the degree of abstraction is therefore crucial to the resulting characteristics of the system. A schematic is shown below.

Figure 64: Proposed Multimodal Graph Design



ORIG, and DEST are specific origin and destination regions connected by a freight flow. The nodes P1-P4 are ports (seaports), T1-T6 are rail terminals, W1-W6 are inland ports. Some paths have been added to the graph with directional links. There is a simple road path connecting the origin and destination directly, an intermodal rail path via T2 and T5, an intermodal waterway path via W3 and W6, a road-sea-road path via P2 and P4, and a road-rail-sea-waterway-road path via T1, P1, P3 and W4.

To arrive at this construction, the system needs to generate sets of interchange nodes and then try to connect them.

The origin and destination are given, fixed points. The single-mode networks can be used to find a sensible short list of accessible inland rail, waterway terminals and seaports for the origin and destination respectively. In the diagram, only a few nodes are shown, but a practical application could have several hundred without a serious time penalty. Node selection can also be linked to the commodity type to refine the choice process.

Mathematically, all nodes could be connected to all other nodes by all possible modes, but in practice this is not necessary. Origins and destinations connect to anything by road, (except in the special case where the origin and transfer node coincide). Origin rail terminals connect to destination rail terminals by rail. Origin rail terminals also connect to seaports by rail. Origin ports connect to destination ports by sea, and so on.

In this way it is possible to elaborate the graph structure in a realistic, hierarchical way, and then with reference to the underlying networks, the system can test whether a given link exists, and what its impedance is.

In this way, impossible connections are eliminated (e.g. Cyprus to Malta by road). Improbable, but possible connections are allowed, but they will be discarded later if their impedance is too high (e.g. Austria to Germany via Genoa and Antwerp by sea) relative to other options.

The main value of this approach is that a simplified graph of hyperlinks prevents the feasible path set from expanding beyond a predictable level, and that simplification allows the model to enumerate all the paths, not just the shortest one. The model can then assign to the best 'k' paths, which is far more realistic.

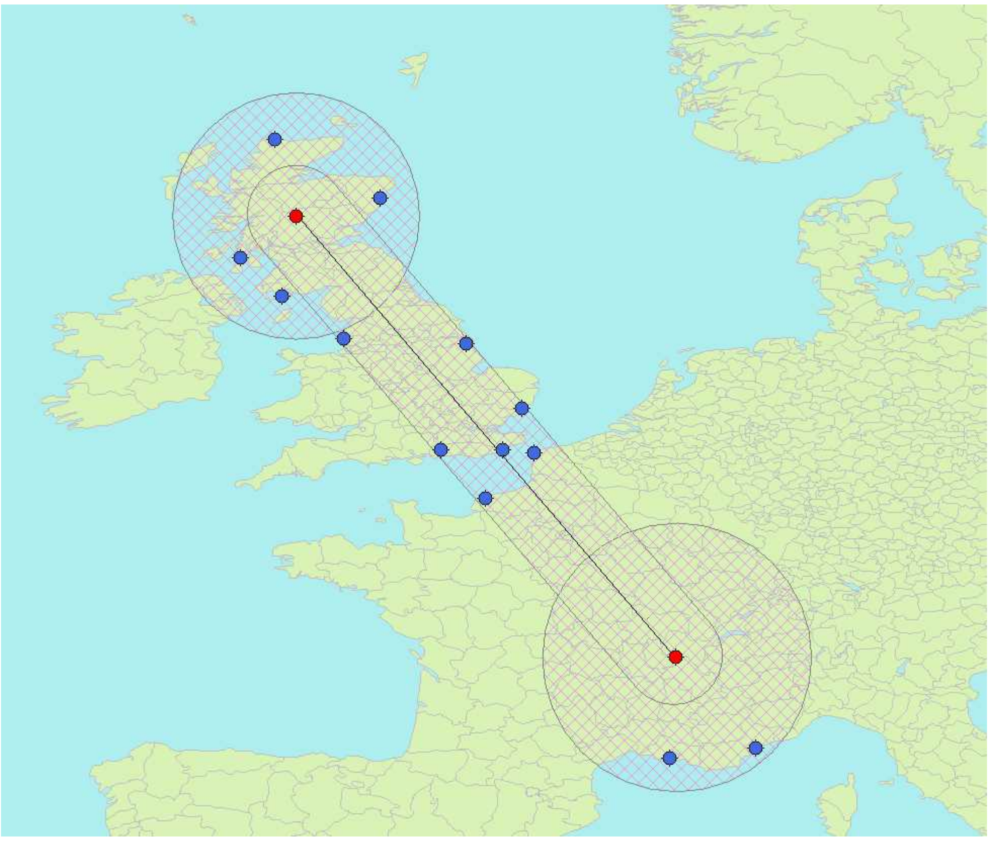
A related benefit is that the system cannot produce paths with more than five links (four transhipment points), aiding the process of harmonisation with TRANSTOOLS. Additionally, one of the main problems with multimodal assignment can be avoided. An unconstrained multimodal assignment process can produce unrealistic chains with too many links.

The key challenges have been limiting the size of the graph within the full-scale application and developing a one-size-fits-all structure that is equally applicable for intra and inter island and continental journeys. In practice there is a limitation imposed by the need to build a transport chain with only two transhipment points, when four might be a more realistic option for inter-continental transport, but the approach has been to include the sea leg and the main inland link at each end if more links are found.

A particular problem has been the selection of sea ports. While transfers to rail and inland waterway are likely to occur close to the origin or destination, different heuristics need to be developed in order to create a realistic choice set for sea ports. The system now selects the nearest 'n' ports to the origin, the nearest 'm' ports to the destination, and the 'p' ports that deviate least from a straight line between origin and destination.

See example below:

Figure 65: Bounding Box for Port Selection



By controlling 'm', 'n' and 'p' it is possible to set absolute limits on the number of ports entered as transhipment points in the network, and at the same time ensure that different types of paths are entered.

Considering a traffic flow from Central Scotland to Central France, the system would enter the nearest Scottish ports, the English South Coast ports directly en-route to France, the French Channel ports, and the Mediterranean ports closest to the destination. Thus, the path enumerator would then be able to compare the costs of a trip with a high proportion of overland transport e.g. Glasgow-Portsmouth-Le Havre-Lyon with a trip with a high proportion of sea transport e.g. Glasgow – Clydeport – Marseilles – Lyon.

Since the attractiveness is only known after all the paths are enumerated the key concern is to create enough diversity in the port choice mechanism to ensure that structurally different routes can be compared. The system can be improved by filtering the port choice to match the cargo's mode of appearance to the facilities at the ports. Thus crude oil would not be diverted via a ferry port.

Having generated the best 'k' paths, the system allocates traffic to them using a multinomial logit function. The size of the bounding box and the value of 'k' are set to permit feasible calculation times.

Calibration

As might be expected, calibration of the WORLDNET system is another problematic area. Key issues are:

- Matrix size, and the resulting processing time required for each iteration.
- Lack of multi-modal data against which the results could be corroborated.
- Local exceptions – it is unknown in advance if different choice function parameters are required to take account of specific local preferences.

Matrix size limits the number of model iterations which it is feasible to perform. Lack of data, or unreliability thereof, makes it difficult to compare modelled results with reality. Localisation is a potential hazard if calibration is limited to certain parts of the territory where good data can be found, e.g. France or Spain.

A related problem is that in order to compare the mode share results with national statistics, the transport chains have to be assigned to the detailed single-mode networks.

As a result, the high level mode chains are then broken out into their constituent hyperlinks, and each modal segment is assigned back to the underlying modal networks, in which the links are small enough to be attributed unambiguously to national territories. In this way national mode split estimates expressed as tonne kilometres can be compared against national surveys where they exist. A hyperlink between Spain and Denmark, for example, would be related back to the transit volumes of France and Germany.

Ports also provide a calibration point. Multimodal chains identify modal interchange points (at least they identify the NUTS3 regions containing the interchange points). If port volumes within these regions are also known, the estimates can be compared with the actual tonnages. Some simplification is also required because within EUROSTAT, port volumes are typically aggregated by mode of appearance (e.g. RORO, LOLO, liquid bulk).

Once the need for calibration arises, so does the need for repetition i.e. running the system iteratively to improve the estimation with shadow prices attached to the calibration points. In practice this has been attempted by sampling from the O/D matrix, and gradually increasing the sampling rate as the estimates improve.

7.2.3 Software implementation

WORLDNET's O/D methodology has been designed so that it can be regularly and easily updated. It is based only upon data which is in the public domain, and which is backed by EUROSTAT statistical directives.

The seminar programme has underlined the need for current data to support policy analysis, and in fact WORLDNET has limited value added unless it is at least as good as the underlying EUROSTAT and UN trade and transport data.

In view of recent experience with TRANSTOOLS and the initiatives taken by the Commission to encourage the development of IPR-free databases and methodologies, the decision has been made to base the data production system for WORLDNET upon non-proprietary (free and open source) software platforms. The use of multi-platform tools such as Java and MySQL means that the system is not tied to a given operating system, operating system version, or hardware platform, and no commercial licences are needed to run, apply, modify or extend the system. By selecting scaleable technologies, i.e. those which do not have arbitrary limits on the amount of data which can be stored or processed, it would be possible in future to extend the system, for example to increase the degree of regionalisation or the number of countries being processed.

With this latter point in mind, the main data estimation has been carried out using regions based upon NUTS3 definitions for Europe, and with three digit commodity codes. Currently TRANSTOOLS does not support this level of detail for freight modelling, but in future, given that passenger modelling and traffic assignment in TRANSTOOLS are NUTS3, this might change. Therefore a final aggregation step has been included to provide an interface to the existing TRANSTOOLS model.

The software implementation (see schematic below) consists of three main processes, indicated by the darker colour boxes:

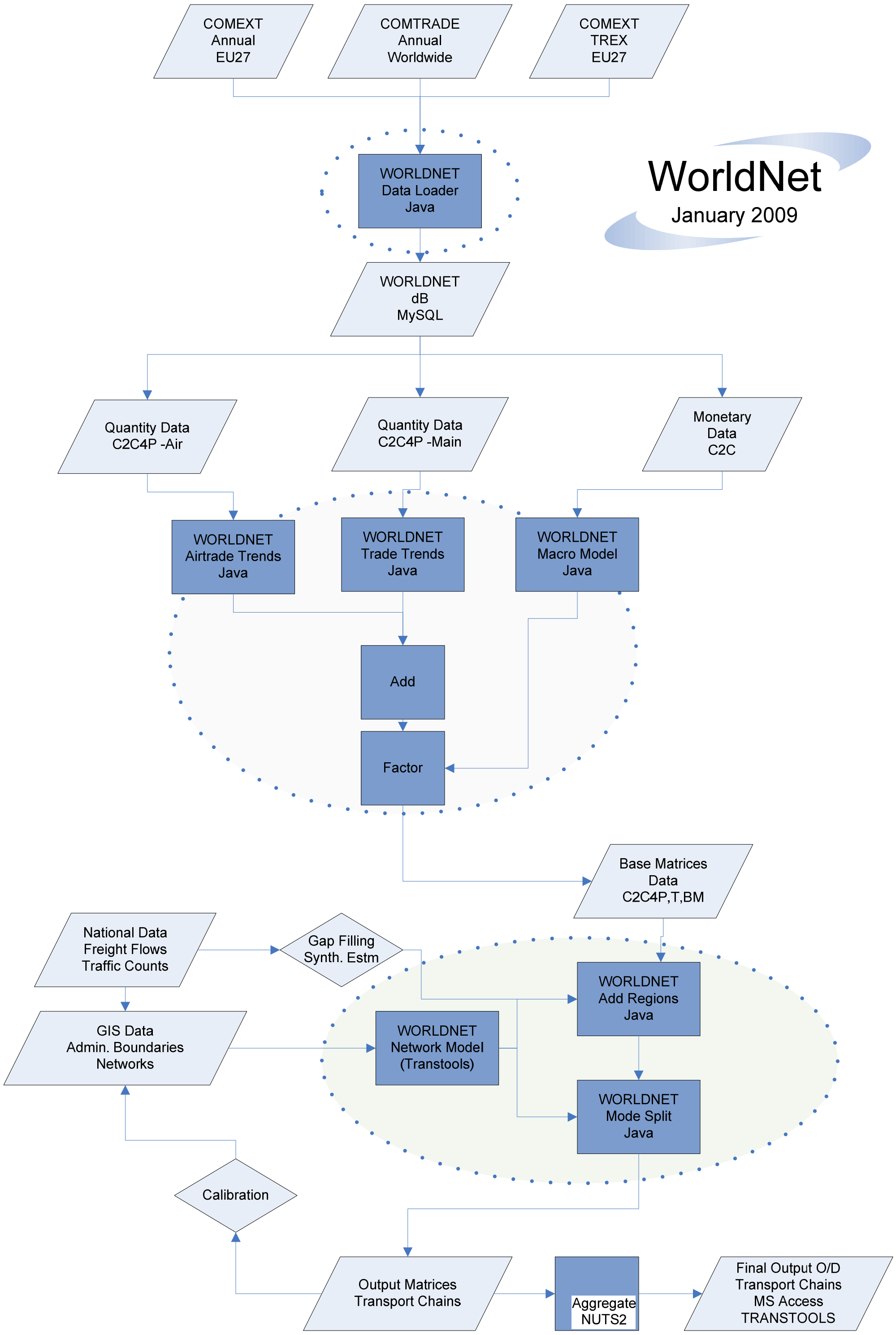
They are:

1. A data loader to convert raw inputs into harmonised MySQL tables.
2. A set of processes to read the basic input data and to construct a single country-country (C2C) O/D matrix. Here there is also a link to the forecasting models designed for the ITREN project.
3. A set of processes to convert the intermediate O/D data into a calibrated transport chain database, with a final step to make the interface to TRANSTOOLS.

The details are shown overleaf (See Figure 66).

Note that the estimation of multimodal paths is itself based upon the TRANSTOOLS network model, now extended by WORLDNET, WP4.

Figure 66: WORLDNET Software implementation

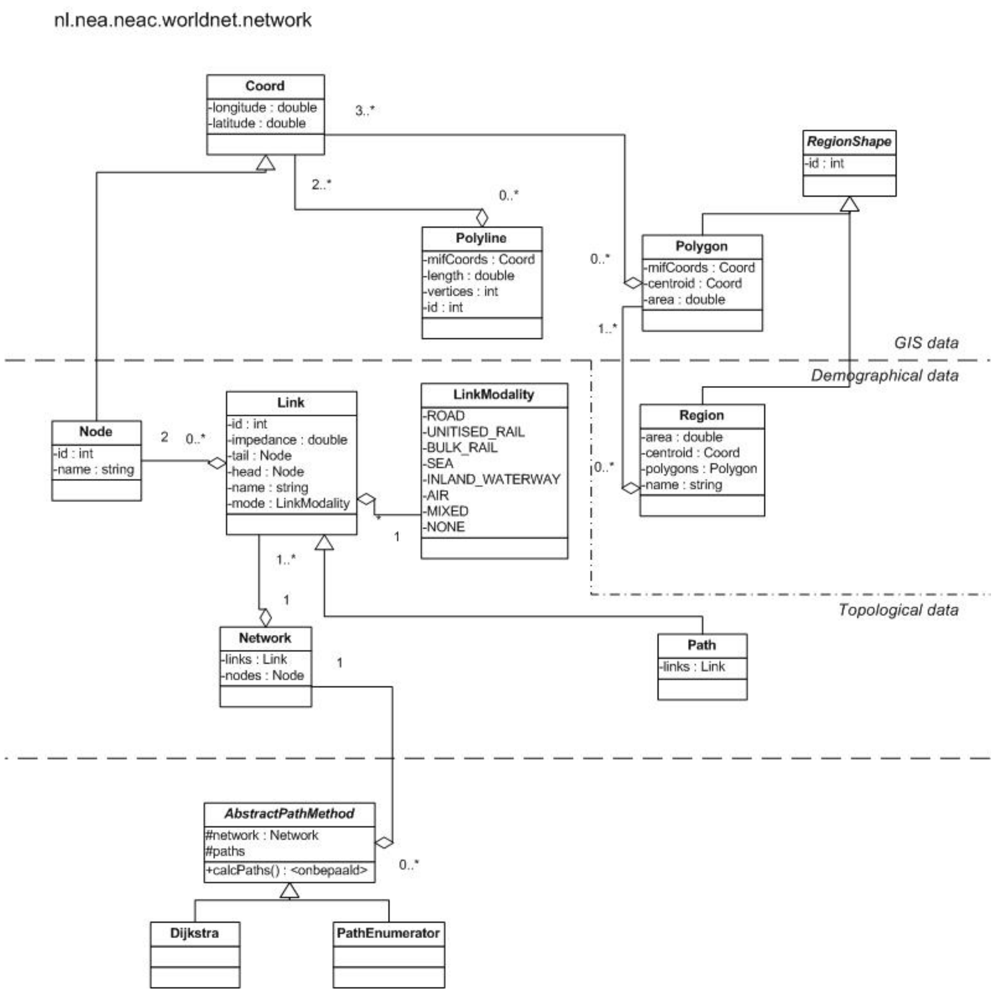


The main innovation, compared to the ETIS methodology has been the estimation, rather than reliance upon observation of the mode chains. This process has required a linkage to be made with the spatial data representing the supply side (the transport network).

In fact, the need to handle spatial data (region boundaries, and transport links) is fundamental for much of the processing system. Therefore a generic Java class library has been set up so that all the processing modules can perform basic spatial queries, using the raw GIS databases. As a result it is possible to modify the networks and the administrative regions using GIS software (e.g. the DEMIS web-based Internetter tool, or Mapper), and to update all the O/D processing with these changes.

A hierarchical Java class library has been constructed (See Figure 67) containing primitive shapes as base classes, from which higher level classes are derived such as nodes, links, regions, networks and paths. A set of graph algorithms has then been constructed to provide basic functionality such as the enumeration of network paths, and the calculation of shortest paths. Modal networks (road, rail etc) can be combined into multi-modal networks from which mode chains can be extracted.

Figure 67: WORLDNET O/D Network Class Library



In future it could be an option to redevelop freight components for TRANSTOOLS based on these libraries, in order to provide more consistency between model stages and the data construction.

The mode chains are synthesized from the high-level network by enumerating the paths connecting origin and destination through the high-level network. In the ideal situation this enumeration would contain *all* possible paths. In reality this would take too much space and time to be computable, in addition many paths would not be allocated any traffic due to their unlikelihood.

Figure 68: Finding paths within a multi-modal network

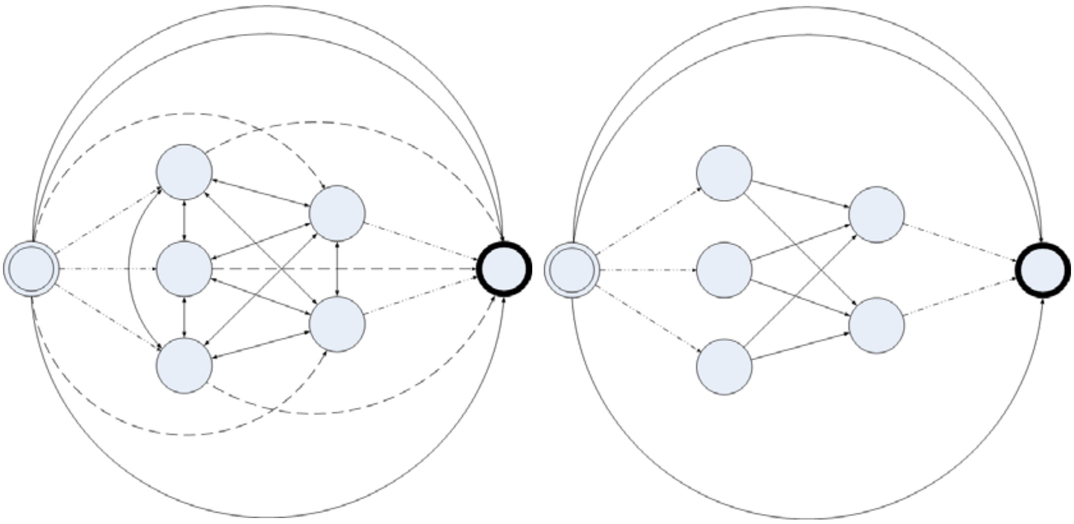


Figure 68 displays a network connecting an origin (leftmost node) and a destination (rightmost node). These network contain five sea ports (centre nodes). The dashed links represent (at most) the three modalities that can be used to connect origin and destination to the ports.
The figure on the left displays an "ideal" network where origin and destination are connected to all ports, and the ports are fully connected to each other.

The figure on the right displays a network as output by our heuristic approach. Here the ports are divided into two sets, one for the origin and one for the destination. A single port may appear in one or both sets.

Due to the method used to select ports the sets of ports will not intersect too much, reducing the potential number of paths.

Table 37 Number of paths arising from different network sizes

Ports	*"Ideal"*	*Heuristic*
1	12	12
2	39	12
3	138	21
4	539	39

The table displays the amount of possible paths in networks for a given origin and destination. The figures given for the heuristic approach are for the scenario where the sets of ports are distinct and of equal size.

Beyond four ports, the calculation time expands at a factorial rate using the exhaustive search. The heuristic method however allows a set of paths to be found which is on the one hand large enough to be representative of the main (and likely) route options, and on the other, not so large as to require unreasonable calculation time. Finding this balance has been an important element in being able to carry out a detailed network search for a very large set of traffic flows.

7.2.4 The resulting matrix

The estimated mode shares are summarised below. Note that these results are calculated according to the national territories, and not according to the national fleets, as frequently used.

The most striking result is the assignment of 80.67% of total European transport to the sea mode. This figure includes all trade flows between 42 European countries worldwide.

Table 38 Summary of Resulting Matrix

Mode Split: WORLDNET, DataV6 According to Tonne Kilometres Estimated according to National Territory					
	Sum of Tonne KM, 2005 Annual Estimates, (Millions)				
	MODE				
Country	**RAIL**	**ROAD**	**SEA**	**WATER**	**TOTAL**
Albania	14	1,705		0	1,719
Armenia	338	340		0	678
Austria	15,781	32,333		185	48,299
Azerbaijan	0	2,579		0	2,579
Belarus	7,700	25,367		0	33,068
Belgium	7,287	48,862		12,491	68,641
Bosnia	46	2,789		0	2,835
Bulgaria	719	14,788		56	15,563
Croatia	451	3,843		0	4,294
Czech Republic	6,384	50,297		10	56,691
Denmark	4,499	6,867		0	11,366
Estonia	897	3,299		0	4,196
Finland	11,332	23,921		0	35,253
France	40,244	359,386		20,242	419,871
Germany	142,190	605,466		33,016	780,673
Greece	179	26,619		0	26,798
Hungary	7,190	30,918		51	38,158
Ireland	25	17,675		0	17,700
Italy	38,656	164,228		0	202,884
Latvia	6,152	9,363		0	15,515
Lithuania	2,414	9,818		4	12,236
Luxembourg	220	2,010		0	2,231
Macedonia	329	1,062		0	1,391
Montenegro	373	92		0	465
Netherlands	3,639	50,494		32,883	87,016
Norway	3,285	15,627		0	18,913
Poland	19,845	119,140		419	139,404
Portugal	40	20,509		0	20,550
Romania	5,677	47,854		75	53,606
Russia	18,144	941,669		0	959,813
Serbia	3,231	7,806		31	11,067
Slovak Republic	2,871	20,356		5	23,233
Slovenia	2,270	15,765		0	18,035
Spain	1,082	186,096		0	187,178
Sweden	11,493	24,923		0	36,416
Switzerland	36,761	8,489		3	45,253
Turkey	211	61,406		0	61,617
Ukraine	21,725	95,958		0	117,683
United Kingdom	19,859	158,253		211	178,323
Maritime Corridors			15,699,442		15,699,442
TOTAL	443,552	3,217,974	15,699,442	99,682	19,460,650

Mode Split: WORLDNET, DataV6 According to Tonne Kilometres Estimated according to National Territory					
	Sum of Tonne KM, 2005 Annual Estimates, (Millions)				
	MODE				
Country	**RAIL**	**ROAD**	**SEA**	**WATER**	**TOTAL**
Shares	2.28%	16.54%	80.67%	0.51%	100%
EU 27	312,120	1,640,426	1,547,659	99,428	3,599,633
Shares	8.67%	45.57%	42.99%	2.76%	100%

Note: Sea Tonne Kms for EU27, includes only Intra-EU Flows.

It has also been possible to estimate the difference between intra-EU sea transport and Europe-worldwide sea transport. It is apparent that the intra-EU figure is in line with standard EUROSTAT estimates, but also that this only represents around 10% of the total performance that could be attributed to the sea mode. Taking the broader definition creates a different perception of the importance of the maritime freight industry, and of the balance of long and short distance freight flows.

7.2.5 O/D matrix summary

WORLDNET starts from the objective of constructing a base year O/D matrix for TRANSTOOLS, future-proofing it by increasing the geographical scope and detail, and designing a repeatable methodology. These pressures, combined with recent trends in terms of transport data reporting and harmonisation are leading away from direct data-oriented approaches towards hybrid data-based/modelled approaches.

Wide area policy models of goods transport such as TRANSTOOLS, although internally complex as software systems, are limited by their scale in terms of the modelling complexity they can adopt. As a consequence they depend upon the availability of data inputs that go well beyond the sophistication of currently available statistical publications, and this creates a major barrier to the use and updating of the system.

An additional level of modelling is required in order to reduce the gap between the data layers and the applications, and this is somewhat independent from the application methodologies adopted.

WORLDNET has built and implemented a simplified four-step methodology for this matrix estimation which follows a conventional design pattern but which is simplified to allow direct data feeds where possible and to maintain feasible calculation speeds. The process is only required to “forecast the present” in a one-off base year matrix, so much of the complexity of a full transport model can be eliminated in favour of more general-purpose, familiar and transparent processing steps. In turn this simplification permits the use of very large datasets.

Unlike the ETIS-BASE approach for freight demand estimation, the WORLDNET methodology is uniform across EU countries because it only uses harmonised multi-country inputs, and because it fills the same data gaps in every country using the same method. While this may be a step backward compared to ETIS-BASE for the accuracy of the results in those member states still producing detailed transport statistics, it improves transparency. The assignment of a flow to a particular configuration of mode chain can only arise from a single calculation step in WORLDNET, and there is no difference between one country pair and another. It also improves completeness, eliminating the occurrences of links marked with unknown attributes.

The need for wide area (multi-country) freight transport models is clear but the satisfactory implementation thereof remains an ambition, with divergent and competing methodologies and much still to be proven. However, the development of wide area transport databases and forecasting systems is well established and now progressing, aided by the increased acceptance of standards for data description and interchange.

The contributions of WORLDNET follow these standards and like predecessors are made available IPR-Free, with the agreement of the European Commission, via the REORIENT knowledge base platform (RKB). It is hoped that the system will be updated, tested, and applied beyond the current scope of the research project.

7.3 Methodology – Aviation Database

Air cargo, when measured in tonnes, only forms a very minor part of all freight traffic (a thousandth part in total and about 2% of the freight transported globally). Nevertheless it has increased by a third within the last ten years although domestic and intra-European was declining, so that the growth of this transport sector solely comes from intercontinental transport. For this reason air cargo should not stay disregarded any longer within multimodal transport models dealing with freight and WORLDNET tries to include this mode into an European transport network model. For air cargo such a model must cope with the mentioned dominance of intercontinental flow patterns – the underlying regionalisation of WORLDNET, with about 500 traffic zones representing the world outside Europe and more than 1500 for Europe (NUTS3-level) forms the base for an adequate detail. For details concerning the regionalisation we refer to section Annex A of the Worldnet D7 report.

So the objective of this part of WP3 is to set up a flow matrix on the given regional level for the year 2005 covering air cargo within Europe and as well between Europe and the world.

7.3.1 Methodology

As air cargo is just a small part of all air cargo an approach for modelling the flow patterns just from trade statistics, focusing on distinct commodity groups which qualify due to their value or specific characteristics (e.g. perishables) to be transported by air which is about ten times as expensive than surface transport has been considered as inadequate.

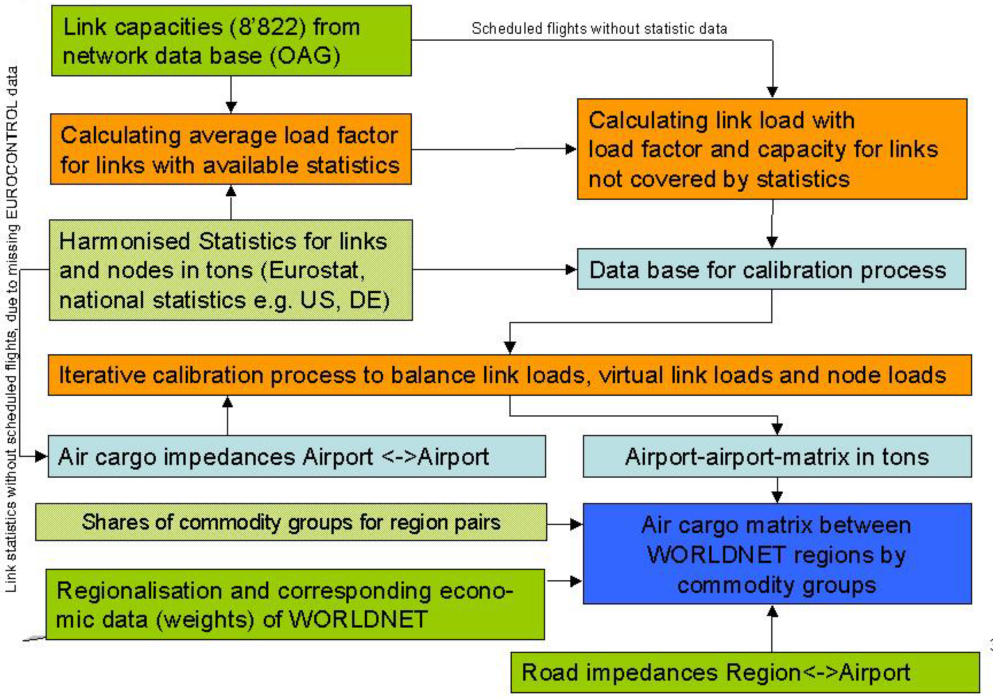
For this reason, actual transport statistics on the air cargo volume transported on specific airport pairs and additional similar information had to be included in the process of modelling air cargo flows on the given level of detailness, taking a “raw” matrix of air cargo flows derived from trade statistics only as a starting point to produce a final matrix.

In brief the original plan to model the air cargo flow was to

- build up an air cargo network between airports,
- enrich the air links and the air nodes (airports) of the network with measured or estimated cargo volumes,
- calculate impedances airport - airport
- run an iterative calibration process to balance link loads, virtual link loads and node loads resulting in an airport-airport air cargo matrix
- enlarge this network by adding road feeder links connecting the WORLDNET traffic zones with these airports
- distribute the air cargo flows from airports among the traffic zones connected to them by using regional economic data
- split up these air cargo flows by OD-specific shares of commodity groups

The following figure illustrates the planned approach of matrix construction.

Figure 69: Scheme of planned approach for constructing the air cargo matrix



External input is coloured in green, resp. in light green when adapted.

Calculation procedures are coloured in orange.

Results are coloured in blue, resp. light blue when only intermediate results.

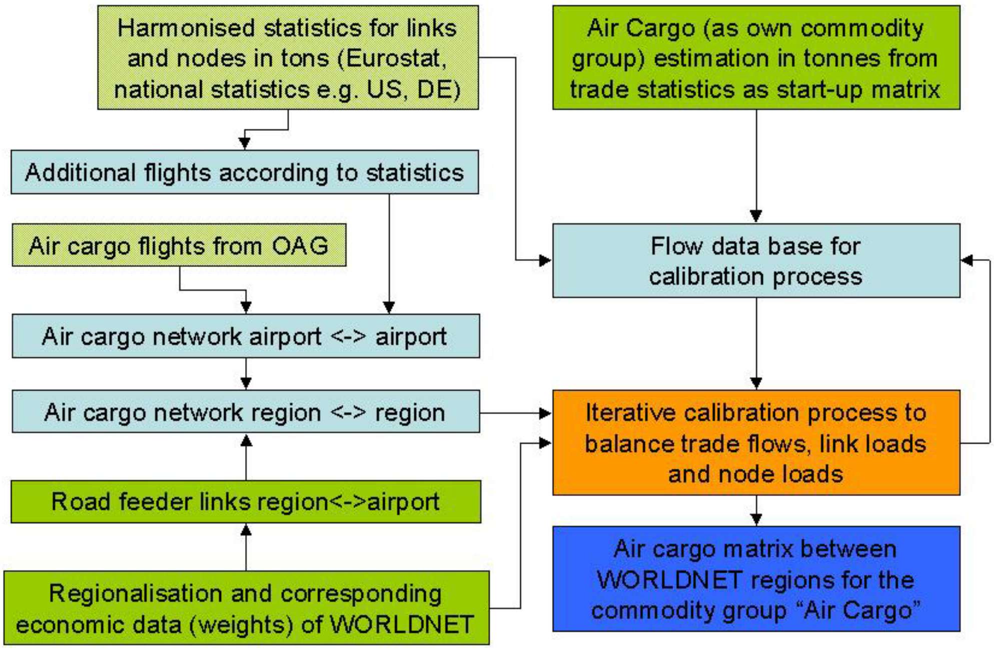
This approach had to be revised, as it turned out that calculating the load factors for links resulted in a value range between 1% on some scheduled passenger flights which are available to carry some additional cargo and more than 100% which is physically not possible. This especially holds when an air link is (exclusively) served by pure cargo flights. Obviously numerous passenger flights in fact have not been used for air cargo although it would have been technical possible, while on other routes, the cargo capacity offered by regular flights was enlarged by additional (charter) flights according to temporary peaks of demand.

Example: The route between the airports of Milan Malpensa (MXP) and Düsseldorf (DUS) has been served up to five times daily with small jet aircraft, each flight offering a cargo capacity of 0,7 tons. This sums up to a total annual capacity of about 1.100 tonnes. In fact when following Eurostat statistics the carried air cargo between MXP and DUS was only at 7 tonnes. On the other hand the capacity of the flights published in the OAG between Milan Orio al Serio / Bergamo (BGY) and Cologne (CGN) sums up to 5.700 tonnes, as these flights were not supposed to be run all year round according to the OAG. The cargo volume reported by Eurostat for this air link was at 17.500 tonnes, what is about three times as high as the capacity in respect of the air schedule.

For this reason the approach for air cargo was modified to the following sequence:

- Build up an air cargo network, combining air links between airports and feeder links between regions and airports (see D8 report)
- Enrich those air links and air nodes (airports) of the network with actually measured cargo volumes from statistics
- Create a start-up freight matrix for air cargo, which is considered as an own commodity group of all freight
- Run an iterative calibration process to minimise the total sum of deviations between assigned and measured link loads as well as between start-up cargo flows and flows adjusted according to the link statistics on country-level.

Figure 70: Scheme of revised approach for constructing the air cargo matrix



External input is coloured in green, resp. in light green when adapted.

Calculation procedures are coloured in orange.

Results are coloured in blue, resp. light blue when only intermediate results.

7.3.2 Data sources and procedures

The data sources and procedures used for the preparation of the air cargo matrix are

- a start-up matrix of air cargo flows derived from trade statistics (see section 7.3.3
- an air cargo network (see D8 report)
- intermodal impedances from region to region including information about the path (see D9 report)
- air link and airport statistics
- socio-economic data for the underlying traffic zones
-
- assignment procedures (in house development)
- calibration procedures (in house development).

Unless otherwise noted these sources are described in the following subsections.

7.3.3 Estimation of air cargo related trade flows

An initial step for the estimation of air cargo flows has been to identify in precise detail the trade flows that are likely to generate traffic for the air sector.

This section provides a short description of working method for the estimation of the air cargo share of trade data in WORLDNET. The estimation of the probabilities for air cargo has been carried out using the regression method in SPSS.

EU Trade Transport data (COMEXT) was used for calibration. Currently, EUROSTAT publishes a Transport Supplement within COMEXT, in which it is possible to identify the air mode for extra-EU trade flows. The objective has been to use this information to calculate a model which can be applied to any trade data, including intra-EU and non-EU flows.

The air cargo flows were first selected from this transport data and a smoothing algorithm was applied to fix the major errors. Errors arise when trade flows are miscoded in relation to the cargo weights. This is particularly important for air cargo, where in general the consignment weights are low, and the value to weight ratios are relatively high. A single miscoded air cargo flow could bias the estimation procedure.

The smoothing procedure has been developed based on the time-series analysis conducted by NEA. By tracking the air cargo flows over a period of ten years it is possible to identify normal ranges for trade flows per commodity and by country pair. These estimates can be applied to tonnages and to value densities. Value densities (ratios of value to weight) are useful because trade flows are regularly corrected with respect to value, and air cargo values are generally high. Over time it can be expected that value density for a given air-trade flow would be relatively constant over time.

The smoothed data was entered into the estimation procedure.

The regression coefficients were determined separately for each commodity group (NUTS0: 0-9). Value per kg (US$/kg) and transport distance were chosen as explanatory variables. During the first calculation runs each value per kg was included. The results were not significant or had wrong signs.

After some testing the following segmentation was chosen:

Table 39 Variable vrange (value range)

Category for value per kg	*Value vrange*	*Number of cases*
[0, 10]	0	237128
[10, 16]	1	15142
[16, -]	2	28439

Three categories for value density were chosen (see above). In addition, eight distance bands were chosen.

Table 40 Variable kmrange (distance range)

Category for distance (km)	value	number of cases
[0, 1000]	1	23100
[1000, 1800]	2	27624
[1800, 3000]	3	29157
[3000, 4000]	4	23378
[4000, 6000]	5	47885
[6000, 8000]	6	42151
[8000, 9500]	7	40531
[9500, -]	8	46883

The dependent variable was calculated as logarithm of air tonnage percentage:

$$LN\_p\_air = \ln\left(\frac{p\_air_{ton}}{1 - p\_air_{ton}}\right)$$

with

$$p\_air_{ton} = \frac{air\_tonnes}{total\_tonnes}$$

In table 3 the results are presented. The estimation of air percentages are calculated as follows:

E_percentage = exp(e_value)/(1+exp(e_value))
e_value = constant + coeff1*kmrange+ coeff2*(vrange)

Table 41 List of coefficients

NST0	*variable*	*coefficient*	*t-value*	*sig.*
0	Constant	-14.60	-144.60	0.00
	kmrange	0.70	37.49	0.00
	vrange	6.88	84.19	0.00
1	Constant	-13.75	-210.51	0.00
	kmrange	0.49	41.13	0.00
	vrange	4.40	66.60	0.00
2	Constant	-16.03	-78.83	0.00
	kmrange	0.26	6.45	0.00
	vrange	3.11	5.02	0.00
3	Constant	-14.38	-82.43	0.00
	kmrange	0.46	13.83	0.00
	vrange	4.65	17.81	0.00
4	Constant	-16.14	-84.17	0.00
	kmrange	0.43	11.97	0.00
	vrange	5.59	30.34	0.00
5	Constant	-14.88	-148.55	0.00
	kmrange	0.68	36.22	0.00
	vrange	4.59	54.59	0.00
6	Constant	-15.41	-133.41	0.00
	kmrange	0.64	29.38	0.00
	vrange	5.58	32.35	0.00
7	Constant	-16.49	-86.32	0.00
	kmrange	0.53	14.64	0.00
	vrange	5.25	18.19	0.00
8	Constant	-12.42	-114.11	0.00
	kmrange	0.48	24.29	0.00
	vrange	4.36	69.98	0.00
9	Constant	-9.85	-132.88	0.00
	kmrange	0.37	28.42	0.00
	vrange	3.00	93.09	0.00

The column of zeroes on the right hand side indicates that the variables are each significant at the 99% level for each commodity segment.

7.3.4 Regionalisation of air cargo

The conversion of air cargo trade data from a country to country (C2C) level of detail to region to region (R2R) was carried out using an identical process as the surface modes.

7.3.5 Air link and airport statistics

Air link and airport specific information about cargo volumes were taken from Eurostat as the most important source. This source in principal should offer data about each air link to or from any airport in Europe, according to EU-regulations. As these regulation implies multiple time limits for compulsory reporting of data by the member states depending on the amount of cargo or passenger volumes for distinct airports, there were a lot of links for which no data has been available for 2005. In some cases where member states reported information, it was not published by Eurostat, as the volumes were below the limit for compulsory reporting.

We compared the data availability for 2005 with 2006 data and found that the number of routes for which data were available significantly raised within this period of just one year. For this reason we decided to use 2006 data for routes already existing in 2005 where no data have been reported for that year.

In some cases we had to modify the information from Eurostat. This applied for air links where one of the airports is part of a multi-airport-system under a common city code, like Paris Charles de Gaulle (airport code CDG) and Paris Orly airport (airport code ORY) which both belong to the airport system of Paris, France (city code PAR). For some airports there were cargo flows reported to a destination which actually had no flights form the reporting airport but to a destination which is within the same airport system of the outlined destination. This mismatch of airport designators probably already existed in the data reported from a member state to Eurostat, so in such cases we adjusted the information to an airport pair which actually has been connected with direct flights.

To fill at least partly the gaps in data available from Eurostat we enriched this information by data from several national statistics. Just to name to them Germany and USA (for air links to/from Europe) statistics, which are available online at www.destatis.de and www.transtats.bts.gov . This helped not only for air links where no data were available from Eurostat in line with the regulations or reporting but also for some routes where data should have been available from Eurostat, e. g. like Frankfurt, Germany – Buenos Aires, Argentina.

Finally out of all statistics (about 5,000) which could be acquired there remained 3.500 data sets for links of airport pairs actually connected with nonstop flights. As there are 6,900 links to or from airports situated within continental Europe, of which not all are situated in the European Union, this means a quite good coverage (>50%) of them by transport statistics for air cargo.

7.3.6 Socio-economic data

For the process of matrix calibration one needs to have a kind of "weight" for a traffic zone representing its relevance as an origin or destination for a cargo flow. Our experience in developing procedures for matrix generation in air passenger transport showed that without such a component, algorithms to adjust matrices to measured links loads tend to leave numerous gaps in a matrix, when just focusing on link loads and impedances (transport time etc.).

For this reason socio-economic data for all of the traffic zones of the underlying WORLDNET regionalisation were needed.

Concerning the European Union and some EFTA countries figures for population, gross domestic product (GDp) and employment were available from Eurostat on the NUTS3-level.

For countries outside the EU which consist of more than one traffic zones this data have been prepared by NEA.

For the remaining countries outside Europe which form a single traffic zone data for population and GDP were derived from the CIA World Factbook (www.cia.gov/library/publications/the-world-factbook). In cases where available data were not for the reference year of the matrix to build (2005), data were taken for the available year closest to 2005 and extrapolated for 2005 by using the annual growth rates for population or GDP stated in this source. GDP values outlined in US$ were transferred to Euro by exchange rate of June 2005.

First tests with the calibration algorithms used which were adapted from an exiting in-house model for generating passenger flows showed that pure overall GDP values turned out to give best results – prior to any combination of GDP, segment specific GDP, population or employment figures when used as a region specific "weight".

For this reason we opted for the use of GDP as the only region specific "weight" to be used in the calibration routine described in the following section.

7.3.7 Assignment and calibration routines

First tests in assigning the flows of the start-up matrix to the network just using shortest path algorithms showed results which made obvious the necessity to be improved. For this reason we implemented a route choice procedure, which splits up a cargo flow between a region of origin and a region of destination to in maximum 16 different routings. These routings may not differ only between different starting or ending airports of a routing, but also if and which intermediate airports may occur. The table below gives an example of 16 different routings between two traffic zones used within WORLDNET. "Karlsruhe, Stadt, DE122" and "Japan". The routings differ not only by total traffic time, but also in feeder distance and flight distances, which may represent a kind of cost using a distinct routing and further more in the number of transhipments required, or the number of services offered per week to mention just a few of variables to be considered.

Table 42 Example for Route Choice in Air Cargo Karlsruhe – Japan

Starting Airport	*Transfer Airport*	*Destination Airport*	*Total Time [minutes]*	*Connections / week*	*No. of airside Transhipments*	*Estimated probability*
FRA	---	NRT	1379	22	0	72,4%
ZRH	---	NRT	1518	9	0	14,2%
CDG	---	NRT	1672	25	0	5,0%
MUC	---	NRT	1538	6	0	4,3%
AMS	---	NRT	1693	15	0	2,2%
FRA	PEK	NRT	1759	18	1	0,7%
FRA	PVG	NRT	1838	19	1	0,4%
FRA	LHR	NRT	1851	34	1	0,4%
MUC	PEK	NRT	1838	7	1	0,1%
MLH	ZRH	NRT	1926	7	1	0,1%
FRA	ICN	NRT	1890	24	1	0,1%
MLH	LHR	NRT	1901	7	1	0,1%
ZRH	ICN	NRT	1861	3	1	0,0%
MLH	MUC	NRT	1968	6	1	0,0%
MLH	ICN	NRT	1913	3	1	0,0%
FKB	MUC	NRT	1909	1	1	0,0%

For airport codes see network report D8

Adapting an existing in-house model for route choice the probability function for air cargo showed reasonable results in assigning the start-up matrix to the network meeting the link loads available from air cargo statistics. In an iterative process the route choice model has been applied and the flows of the start-up matrix have been assigned to minimise the residuum of a linear system of equations.

This linear system of equations consists of one line per air link statistic (see section 'Air link and airport statistics') and one column per origin-destination pair, i. e. its size is about 4000 lines x 16.000.000 columns. The linkage between the lines consists of the up to 16 route alternatives, the flows of the start-up matrix and the 'weights' i. e. the GDP values for each pair of regions.

The iterative process terminated when the deviation between statistics and links loads as well as between start-up-matrix and adapted matrix have come to a minimum. The result, the air cargo matrix, is described in the next section.

7.3.8 The resulting air cargo matrix

The air cargo matrix shows the cargo flows in tonnes for each pair of regions covered within WORLDNET. At least one of these regions has to be situated in Europe, i. e. the matrix covers all cargo flows to, from or within Europe. Cargo flows between two regions outside Europe are not covered, irrespective the routing this cargo is carried touches Europe or not.

The flows are shown in tonnes for the year 2005. There is no further distinction of these flows in specific commodity groups, as air cargo is considered to be a commodity group of its own.

The total flow of air cargo to/from and within Europe including also domestic flows sums up to 11,25 mill. tonnes for the year 2005. Three fourth of this volume has been carried on intercontinental relations, while 20% were international, intra-European transport and less than 5% were of domestic nature. Flows within or between countries situated in other continents than Europe are not part of the matrix delivered.

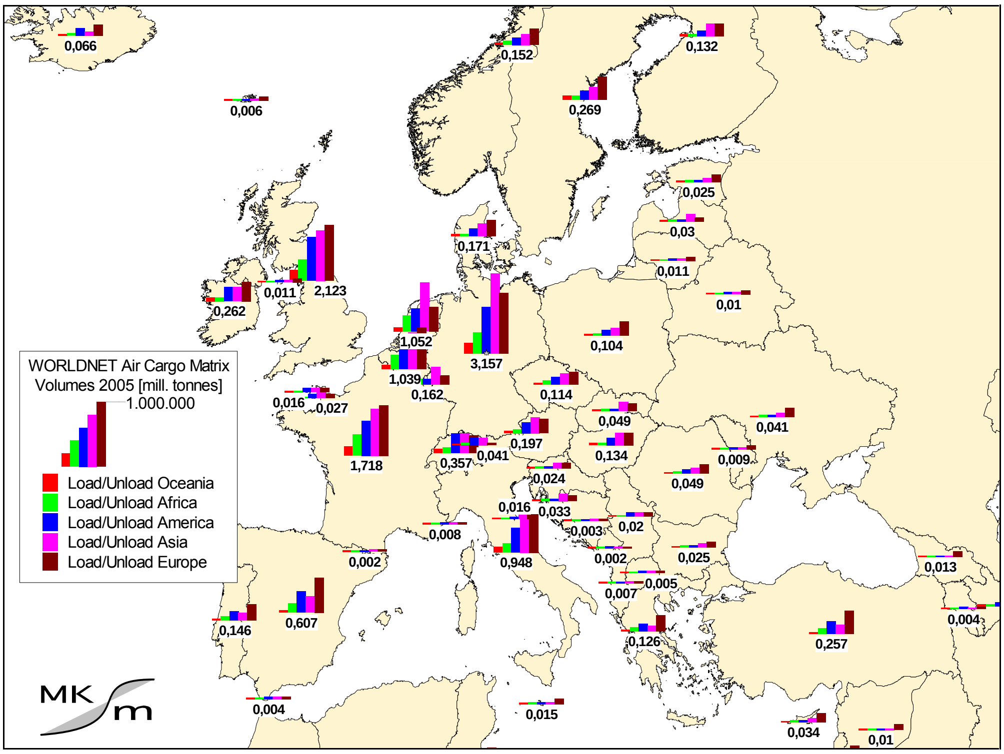
Air cargo to or from Asia forms about 40% of all freight flows of this mode, while cargo to or from America makes about 25% of the total amount. Cargo to or from Africa brings another 7% of the cargo volume, while the flows concerning Australia/ Oceania are minor building a share of just 3% of all air cargo flows. The remaining quarter is the intra-European air cargo demand already mentioned. The following table summarises this overall cargo volumes.

Table 43 Air cargo volumes - Overview

WORLDNET Air Cargo matrix Overview	***Cargo volume [mill. tonnes]***
Within Europe	2,75
Europe to / from Asia	5,0
Europe to / from America	2,6
Europe to / from Africa	0,7
Europe to / from Oceania	0,2
Total Cargo volume	**11,25**

An overview about the country specific air cargo volumes in Europe is shown on the following map. Please keep in mind that these volumes represent the sum of cargo volume of the region and therefore not necessarily match the cargo volumes loaded and unloaded at the airports of a country. E.g. for Luxembourg the total air cargo volume outlined is at 162.000 tonnes, while the air cargo at Luxembourg's airport Findel is about four times as high.

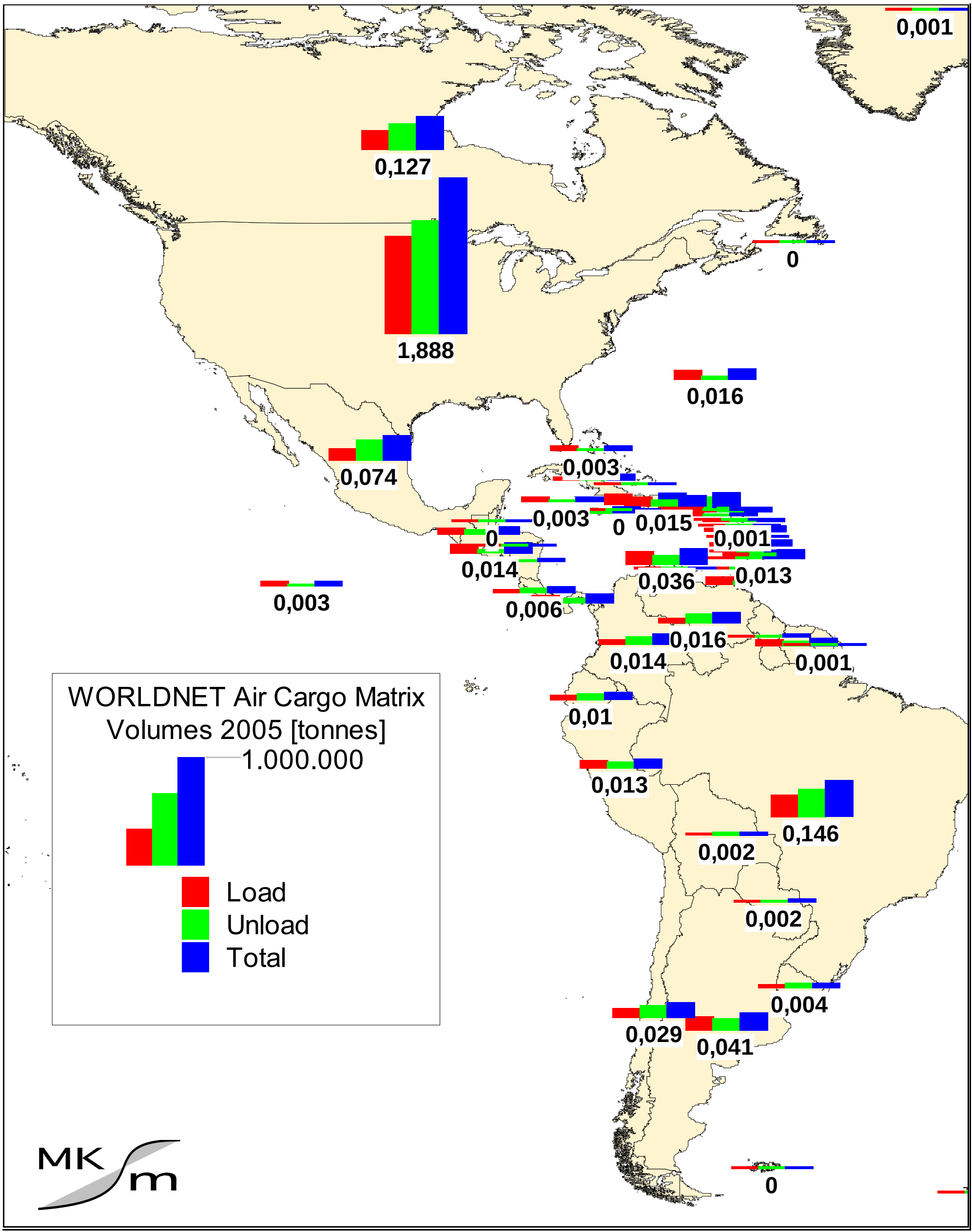
Figure 71: Cargo Volumes by European country



A lot of air cargo is carried from the distinct regions in Europe to the big cargo hubs by surface transport instead of using feeder flights, in many cases this trucking crosses national borders. Another reason for differences in the cargo numbers between a country and its airports lies in the transhipment of cargo between two aircrafts at an airport. Such cargo is counted twice at an airport, similar to passenger figures, where transfer passengers also are counted twice – a first time as an arriving passenger and a second time as a departing passenger.

Considering the country specific volumes, the top five countries in Europe are Germany (3,2 mill. tonnes), United Kingdom (2,1 mill. tonnes), France (1,7 mill. tonnes), The Netherlands (1,1 mill. tonnes) and Belgium (1.0 mill. tonnes), which makes about 80% of all air cargo carried to, from or within Europe. Other important countries for air cargo are Italy, Spain and Russia (only flows to Europe covered).

Figure 72: Cargo Volumes to and from America

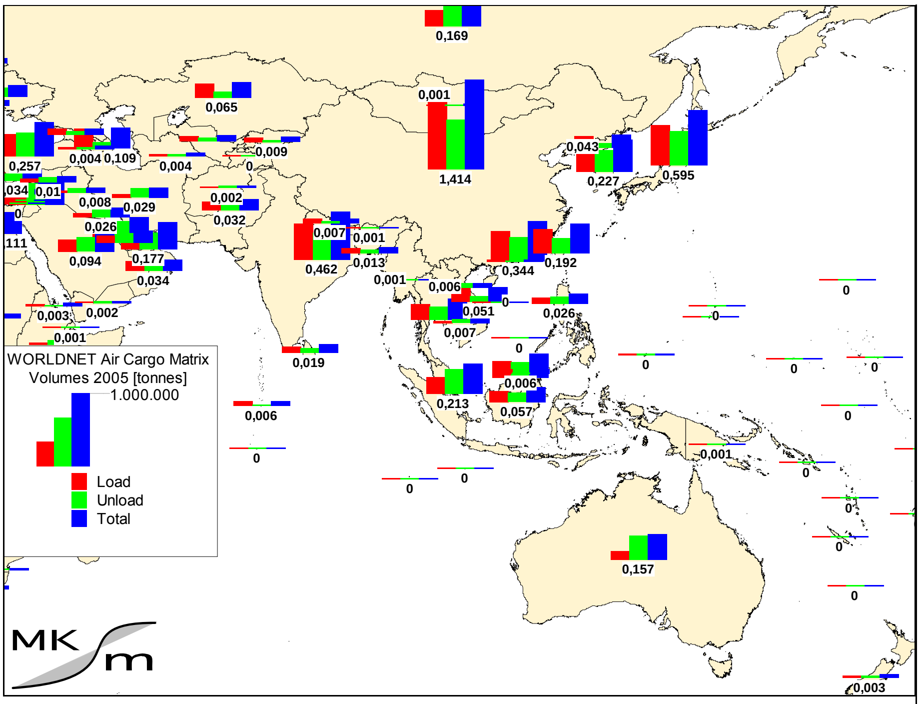


When looking to the American continent, it is obvious that this market is clearly dominated by the United States, which are the origin or destination of more than 70% (1,9 mill. tonnes) of all air cargo carried to or from Europe (total amount 2,6 mill. tonnes). The only two other countries with a noteworthy cargo volume with Europe are Brazil and Canada, each exceeding 0.1 mill. tonnes. Concerning the direction of carriage it has to be stated that air cargo from Europe to America is 0.3 mill. tonnes higher than in the opposite direction.

Different to America the air cargo relations with Asia (total amount 5,1 mill. tonnes) have a significant dominance of goods carried to Europe (+0.8 mill. tonnes) than to Asia.

The most important countries in Asia for air cargo are P.R. of China (1,4 mill. tonnes), Japan (0,6 mill. tonnes), India (0,5 mill. tonnes), Hong Kong (0,3 mill. tonnes), Korea, Singapore and Taiwan (0,2 mill. tonnes each). Other important countries für air cargo to or from Europe are United Arab Emirates, Israel, Jordan, Malaysia, Thailand, and Bahrain where more than 100 tsd. tonnes were carried to or from Europe per each of those countries in 2005. Similar as already stated for Luxembourg, for some countries, the cargo volume from air link statistics to Europe is significantly higher than the cargo volume originating or destinating in the country. E. g. for the United Arab Emirates the cargo volume reported for air links is seven times higher than the cargo to or from this country, as most of the cargo carried on these flights is transhipped to corresponding flights at the airports of Dubai or Abu Dhabi to or from other airports in Asia. See also section 1.4 for these specific cargo flows.

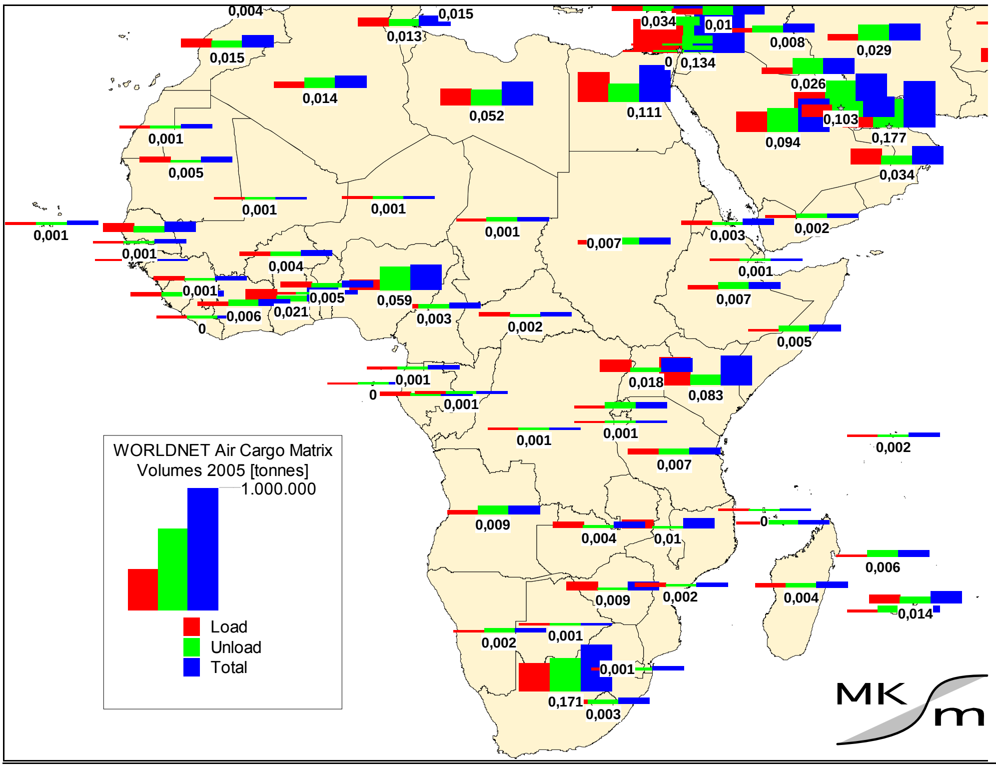
Figure 73: Cargo Volumes to and from Asia and Australia / Oceania



The air cargo volume between Europe and Australia/Oceania is totally different to the one for Asia: First it is just a small amount (less than 0,2 mill tonnes) and as a second point much more cargo is carried from Europe to this continent (140 tsd. tonnes than the other way round 25 tsd. tonnes).

The cargo volume to and from Africa is at 0,7 mill tonnes, of which a majority is carried to Europa (0,4 mill. tonnes), while cargo to Africa has an amount of 0,3 mill. tonnes. The most important countries are South Africa and Egypt, where the air cargo volume exceeds 100 tsd. tonnes. Other important countries are Kenya, Nigeria and Libya with an annual amount of air cargo between 50 tsd. and 100 tsd. tonnes.

Figure 74: Cargo Volumes to and from Africa



Different to all other continents, where air cargo has a dominating direction (Asia to Europe, Europe to America, Europe to Australia/Oceania) which usually applies for all countries of a continent, this is not valid for Africa. While cargo flows from Europe to South Africa and Nigeria are higher than in the opposite direction, the amount of cargo carried from Egypt, Kenya and Libya to Europe is higher than the one from Europe to these countries.

7.3.9 Limitations / lessons learned / possible steps in future

Due to the limited available information on the demand and supply side of air cargo the available air cargo matrix is a result of a combined approach of trade statistics with measured link loads gained from statistics. In consequence the resulting flows have been checked and adjusted to represent the actual air cargo flows of 2005 much better than it would have been possible just using one of the two components trade statistics and link loads separately.

The quality of this approach improves even more, when the number of available link statistics will rise in future. Analysing Eurostat data shows, that the number of available statistics in 2006 is significantly higher than for 2005 and for 2007 there will be even more numbers available. The more the member states of the EU meet the guidelines to report cargo statistics and the more Eurostat increases the number of published link loads, the better the data base becomes for the approach used in this project.

A further progress could be made in splitting up air cargo into different commodity groups.

To achieve this, it would be necessary to survey air cargo statistics not only by tonnes, but also by the kind of goods carried. When the air cargo reporting within the EU will be well established for all membership countries concerning tonnes, this would be next logical step to improve the statistics.

The flows covered in the matrix are all of intermodal kind truck -> aeroplane -> [aeroplane ->] truck. Rail feeder to airports do not play any relevant role for multimodal transport chains where air transport is involved for the time being. This might change in future (a first pilot for this has been inaugurated this year at the airport of Frankfurt, Germany). For this reason the approach chosen should incorporate rail feeders in case of a future matrix-update.

A second type of intermodality has not been considered within this project now: the combination of the modes sea and air for cargo. This kind of co-operation applies for some air links where the flow patterns of air cargo are very asymmetric, so that cargo aircrafts have to be flown (nearly) empty in one direction. The idea of this intermodality is to close the performance gap between sea and air (air five times faster, but ten times more expensive than sea), to fill unused air cargo capacities. As stated in a presentation at the WORLDNET meeting in Beijing, this kind of intermodal transport sums up to 400.000 tonnes worldwide in 2006, which is quite a small amount of all air cargo. Nevertheless it can play a significant role for specific air links (e. g. between airports in the Gulf Area and Europe) so it should be incorporated into the air cargo matrix, by its actual origins and destinations. For the time being this kind of cargo flows are represented in the available matrix only for the air link and the final road based feeder. E. g. some cargo flows from Far East (China et al) going to ports in the United Arab Emirates and are transhipped there to the airports of Dubai, Abu Dhabi or Sharjah to be flown to their European destinations from there, have their origin in the matrix in the United Arab Emirates and not in China et al.

The last field where an improvement concerning the modelling of air cargo should be taken into account, is the introduction of costs for air cargo. For the time being, air cargo is as about ten times as expensive as sea shipping, so that only very specific groups of goods qualify for air cargo due to their value. As the latest trend in worldwide transport is to split up the transportation of a specific good to both, sea transport and air cargo, to bring a (small) part of goods as soon as possible to the markets for marketing purposes, the biggest part of a delivery will be done by sea transport. So introducing air cargo into a modal split model for distinct commodity groups is a future filed in modelling freight transport. The challenge one faces here is the huge price variation for air cargo transport depending on

- the relation specific available cargo capacity and demand (e. g. Asia -> Europe vs. Europe –> Asia), as carrying even empty aircraft is quite expensive
- seasonal change of demand
- specific commodity groups of carried cargo (perishables different to spare parts), i.e. to consider air cargo as an own commodity group is not feasible any more when introducing prices in modelling air cargo
- different routings in intercontinental air cargo implies to implement a route choice model which includes prices.

Finally it has to be stated that not all air cargo flights are reported in the published commercial schedules, e.g. cargo charter, so that such supply information gaps are a significant burden for the modelling and validation process. To overcome this unpleasant situation one should quote upon the memorandum concerning cooperation between the European Commission and Eurocontrol to e.g. exchange technical information and data which can be used here for such purposes like the matrix generation. Due to air navigation purposes any flight is monitored at Eurocontrol and are at hand already so that the information (e.g. origin-destination airport, aircraft type, airline, departure time and day, type of flight) could be extracted easily without any major effort whereby the exact flight routings need not to be deployed.

7.4 Methodology – Maritime Database

An update of the freight matrix of ETIS BASE, incorporating ports outside the EC and an examination of flows to/from EC member countries from/to non-EC States.

The main aim of the overall deliverable is to update and refine the freight flow data that is used in TRANSTOOLS. This includes extending the coverage to include non-EC member States, principally other European countries and non-European Mediterranean States.

7.4.1 Methodology

Trade data on a national/pan-national basis is invariably unavailable in terms of specifying the quantity/pattern of movements by sea. The extensive number of trade routes and associated shipping/transport patterns for exports from any single country effectively precludes the availability of such information – with the actual detail of shipping patterns and transport modes often subject to short-term market factors (e.g. changes in relative transport costs, port congestion).

At the same time, analysis of actual vessel deployment on routes to/from EC member countries – and therefore of likely cargo volumes carried – also does not provide accurate portrayal of cargo moved on any one route, due to the multi-port calling patterns of many vessels (most especially containerships), the role of transshipment ports (mainly containers within the EC), the use of multi-transport modes on specific routes (e.g. via sea/rail/road), the part-laden deployment of ships, and the lack of sufficient detail on vessels' cargo on individual sailings.

The most reliable method to derive a usable and credible database for maritime freight flow is to analyse actual port volumes for all countries under study. In this case this involves analysis of EC member countries' ports, as well as those of neighbouring countries (i.e. other Europe and the Mediterranean region).

Whilst available port data does not include analysis of import/export movements by cargo volume, ship type and origin/destination, the provision of reliable information on actual volumes of cargo handled (by shipment type where available) provides a sound basis on which Customs data can be super-imposed to establish a detailed indicative profile of maritime trade movements to/from EC member States.

Through subsequent analysis of vessel type/size profiles on major routes, the database forms the critical basis for providing an insight into actual shipping patterns (volumes, routes, ship sizes), representing an invaluable tool for use in forward modelling and forecasting projects.

7.4.2 Outputs

Within the port database, and for each port, the most recent volumes of cargo throughput by type (container, dry bulk, liquid bulk, ro-ro, general cargo) is analysed.

For example, an extract from the database for some of the ports of Germany:

Table 44 Extract from Port Traffic Database

COUNTRY	*PORT*	*CARGO VOLUMES (in million metric tons) 2007 (if not, latest available)*					
		General	*Dry Bulk*	*Liquid Bulk*	*Container*	*Ro-Ro*	*Total Annual Handling*
GERMANY	BRAKE	2.492	2.461	2.668	0.029	0.063	7.713
GERMANY	BREMEN	4.851	8.381	1.870	0.148	0.030	15.280
GERMANY	BREMERHAVEN	1.233	0.087	0.484	35.699	2.734	40.237
GERMANY	BRUNSBUTTEL	0.027	1.631	4.578	0.000	0.000	6.236
GERMANY	BUSUM	0.000	0.111	0.000	0.000	0.000	0.111
GERMANY	BUTZFLETH	0.023	2.564	2.236	0.000	0.000	4.823

This enables instant information to be derived from the database on the volume of a particular type of cargo handled at a specific port.

Attention in the preparation of the Report has been centred on non-EC ports, as information on EC ports can be easily updated at a later stage (most especially using the ESCODE database field). The volume information is presented in terms of million tonnes.

It should be noted that not all ports provide such detailed throughput information, and many ports also do not differentiate clearly between the different shipping modes, and often cargo is categorised by commodity sector rather than shipment mode (e.g. data is presented for agricultural products, which can include both dry bulk and general cargo shipment modes).

The cargo throughput information, where included, is 2007 data where available, or the most recent year possible (typically 2006).

7.4.3 Main issues

There are several issues of key significance in the collection and interpretation of the data :

1. Data Availability
2. Data Compatibility
3. Classification of Shipping Modes
4. Definition of Ports
5. Ownership/Operation of Ports.

These are briefly discussed hereunder :

i. **Data Availability**

The extent of reliable data for port throughput volumes is extremely variable between individual ports. Where possible, official individual port authority statistics are used, subject to compatibility with any terminal- or quay-specific data supplied independently. Latest available data has been used in all instances – this generally encompasses 2006-07 data; where such data is unavailable, previous years' data is used as a starting basis for 2006 or 2007 volume estimates, where sufficient information exists to enable reasonable estimates to be formulated.

For the collation of port data, all public sources of information (printed and online published data) has been utilised, supplemented with information supplied and ratified by OSC's reliable industry contacts within relevant ports/companies/government departments.

ii. **Data Compatibility**

There exist several areas of potential non-compatibility of data, principally:

- Definition of shipment modes
- Level of data capture
- Limited release of information to be published.

Of these, the level of data capture and limited information publication are highly port-specific, and might refer to the overall port traffic or discrete parts thereof (e.g. individual terminals).

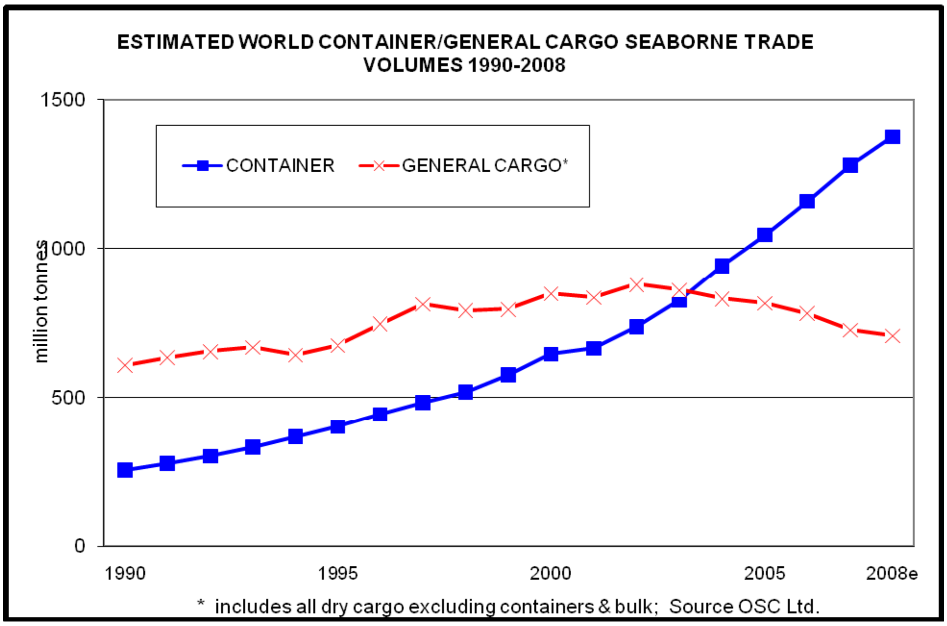
The definition of shipping modes is an area of increasing importance against a background of increasingly specialist shipping type utilisation and very different growth trends for individual shipping types. As an example, cargo shipped as dry bulk can be classified as dry bulk, general cargo, dry cargo, break-bulk – at least partly due to the fact that dry bulk commodities are frequently transported in each of these shipping modes. Cement is often transported as a dry bulk commodity, as well as in bagged form on general cargo vessels and containerships – the port classification of cement cargoes can thus often be incorrectly classified in terms of shipment type.

iii. Classification of Shipping Modes

As intimated above, there are often few definitive distinctions applicable to individual products/cargoes to enable certainty of shipment type – the recent dramatic surge in dry bulk shipping costs has seen many traditional bulk commodities (e.g. grain) transported in containers, and such shipment mode shifts are always liable to occur, depending on movements in relative shipping costs.

One of the most significant and continuing changes in shipment types is the transference of general cargo to containerised cargo. Whilst container penetration of the general cargo trades has reached relative maturity in many North European markets, less developed port markets continue to witness significant change in the mode profile. As indicated in Figure 75, the growth rates recorded by world container trade in the past 20 years are in marked contrast to the minimal growth and recent decline of general cargo trades - with this due mainly to the transfer between shipping modes rather than differences in products shipped.

Figure 75: Relationship between Container and General Cargo Trades



The blurring of distinctions between different products or product groups and their likely shipment modes is an important factor in any modelling of sea movements and database integrity. The critical factor determining mode selection at any one time for any product will continue to be the associated economics – i.e. which mode offers the preferred solution in terms of cost, time etc. With the underlying cost profiles, and the relation between different shipping modes, continuing to represent key variables, the shipment modes of specific commodities/cargoes can change within a relatively short period of time, dependent on the availability of adequate handling facilities (at sea and onshore).

For example, after the massive rise in dry bulk shipping costs in recent years, the shipment of large volumes of grain exports from Australia and the USA was transferred from bulk to container – effectively taking advantage of the large volumes of empty containers available in those countries, looking for return transport to Asia. The more recent collapse in dry bulk freight rates (see Deliverable 8 Report) is likely to see a reversal of this trend.

iv. Definition of Ports

It is important to note the existence of separate quays within a port – such a situation can often lead to double-counting in terms of throughput volumes as well as separate listing for the port as a whole and for individual quays within the port. The optimum procedure to adopt to avoid such data distortion is the presentation of data for ports only, rather than for separate quays located within a port. This necessarily translates to less total detail than presenting information for each individual quay, but ensures a higher level of data integrity. Furthermore, given the scale of the model and the volume of traffic flows included, quay-specific data is not necessary.

This factor is often most significant in the case of multi-purpose ports within which specialist cargo handling operations are located at individual quays. In these situations there is the danger of including both the overall port and the specialist terminal (e.g. container terminal) as separate listings. It is important to note that in many cases, specialist handling operations within a port are liable to change over time (e.g. as leases expire, market conditions change) and are therefore far more variable over time than overall port operations - again supporting the inclusion of information for the overall port rather than for specific quay operations.

Careful consideration has also been taken of the multiple names assigned to the same port – typically the name of the port in the native language and the English language version. The inclusion of the location specifics (latitude/longitude) and mapping capability within the model is critical in this regard.

v. Ownership/Operation of Ports

Allied to the preceding issue of the definition of individual ports, the varying stage and scale of private port operations witnessed within the EC and beyond translates to a complex and dynamic profile of port ownership and operation. This, in itself, has direct important implications for some of the preceding issues, and also highlights the potential variability of port operations, especially in some of the less developed port markets under consideration.

Whilst such developments have led to cargo exclusivity at specific quays within ports, the variability/potential impermanence of such operations dictates that for optimal use within the Worldnet model it is important to focus on overall port throughput and facility availability, rather than attempt to identify any potential restrictions to cargo handling at specific ports through port ownership/operational profile.

7.4.4 Data sources

The data has been compiled using a number of sources, cross-referenced where possible. These include :

Port facilities :
- Port Authorities (websites, publications, direct contacts)
- Eurostat database
- OSC database
- Industry contacts.

Port volumes :
- Port Authorities (websites, publications, direct contacts)
- Eurostat database
- OSC database
- Industry contacts.

7.4.5 Potential applications/limitations

There are several key areas of potential application, including:

- To examine the prospects for future trade flows via European ports
- To examine the potential impact of shipping modal shifts for specific commodities and/or trades
- To be combined with information on ship sizes (trade deployment and individual port restrictions) to provide a model for estimating future shipping patterns and port throughputs
- It represents an invaluable tool for traffic modelling and impact studies.

In terms of the limitations applicable to its use, there are several key considerations :

- Reliable port data availability is limited for many countries
- There is some blurring of definitions of cargoes handled for some countries
- The information requires regular updating – in terms of port activity and port facilities.

8 WORLDNET – Transport Networks

Work Package 4, **Networks**, had two original objectives:

- To extend the TRANSTOOLS network data for the modes road, rail, sea and aviation to the rest of the world,
- To collect attribute data for the extended network for all the modes in consideration.

The main deliverable for WP4 is a network database.

This section summarises the technical methodology, outcome and conclusions of the work involved in producing the updated database, and will serve as a user guide for the published data.

The results, with approval, will be published via the online database constructed by WORLDNET, and information will be circulated to the WORLDNET contact network built up during the previous months, as part of the communication programme (WP2).

8.1 Road Network Model

The main objecvtive of the road network model extension within WORLDNET has been to create network models

- that are compatible to the TRANS-TOOLS model
- and that allow the assignment of road freight demand flows between European countries and other countries of the world.

Thus, the main aim of this task of WORLDNET has been to extend the TRANS-TOOLS road network model with additional links that are of relevance for freight transport flows between Europe and other countries of the world.

8.1.1 Overview of the methodology

The WORLDNET road network model is based on the TRANS-TOOLS/TEN-CONNECT road network received on February 12th, 2008. The extent of this network is displayed in Figure 76. It covers the whole of Europe, including Western Russia, the Caucasus and Turkey. Updated versions of the TEN-CONNECT network models were received on November 11th, 2008, in which a smaller amount of links and attributes were added.

Figure 76: The TRANS-TOOLS/ TEN-CONNECT road network

Based on this network model, extensions have been made by adding links, which can be expected of being relevant for road freight transport flows between Europe and other countries, under consideration of politically agreed transport axes and of comments received on the WORLDNET Seminars in Istanbul (April 2008) and Beijing (May 2008).

Importance has been attached to keep all extensions consistent with the TRANS-TOOLS/TEN-CONNECT road network model.

8.1.2 Main data sources

Geographical basis

The geographical basis for the WORLDNET extension is provided by the "Digital Chart of the World" as displayed in Figure 77. Relevant links of this network have been selected with the help of further information sources.

Figure 77: The "Digital Chart of the World" road network

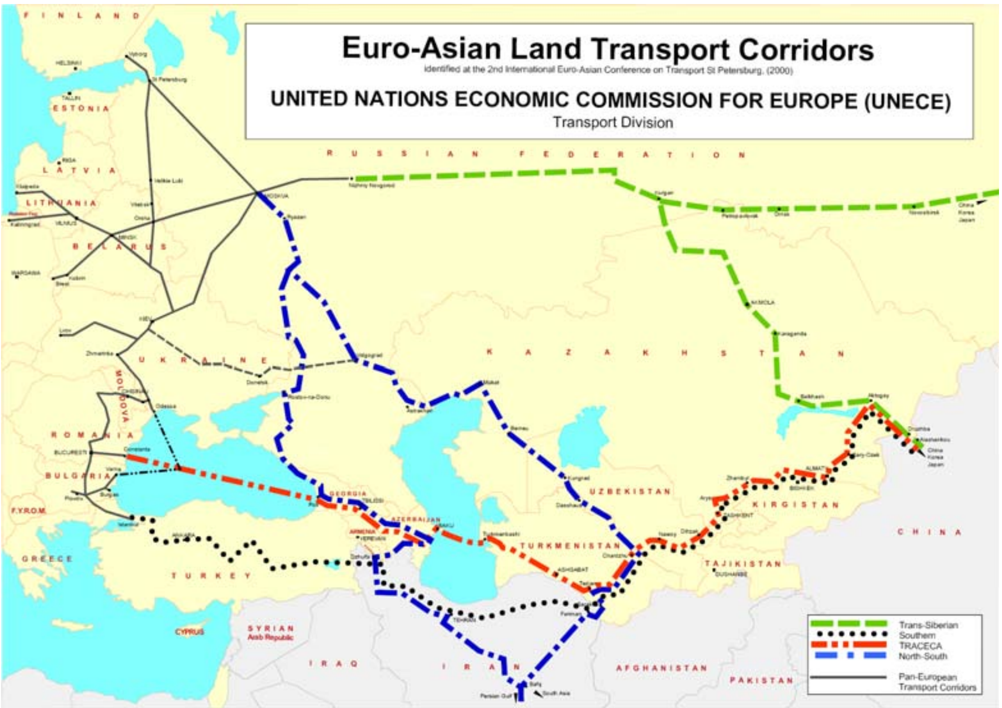
Identifcation of relevant extensions

In order to determine the relevant transport axes for the extensions towards Asia, the political corridors defined by the UNESCAP[1] (see Figure 78) and the scope of the EATL[2] corridors (see Figure 79) have been the most important basis.

Figure 78: The political road corridors defined by UNESCAP

Source: UNECE/UNESCAP

Figure 79: The Euro-Asian Land Transport Corridors



[1] UNESCAP: United Nations Economic and Social Commission for Asia and the Pacific.
[2] EATL: Euro-Asian Land Transport Corridors.

For the African and Middle Eastern part of the extension, corridor alignments drafted by the MEDA TEN-T project[1] have been largely taken into account, as well as regular road maps, given in Table 45.

Table 45 Maps used to define the WORLDNET extension

Maps applied for definition of the WORLDNET extensions		
Name of map	***Publisher***	***ISBN***
Nordwestafrika (741 National)	Michelin	2-06-711606-1
Nordostafrika (745 National)	Michelin	2-06-100286-2
Middle East	Freytag & Berndt	3-85084-219-3

Obtaining information on link attributes

In order to determine the values of link attributes – such as the number of lanes, the link type, speed limits or the road name – various sources have been applied: The road maps listed in Table 45 were used to determine link attributes like number of lanes, the link type and the name of the road.

Other link attributes, like the speed limit (attribute "FreeSpeed"), were obtained from additional sources like the IRU[2]. Missing data was estimated by applying proxy values available for similar countries or by exploiting further information from the Internet.

For the attributes "LaneHCFor" and "LaneHCBack" - denoting the link capacity - values were estimated based on the contents of the TRANS-TOOLS/TEN-CONNECT road network model, where a correlation is assumed between link type and capacity. This correlation is shown by Table 46.

Table 46 Capacities for Road Links

LinkTypeID	***LaneHCFor, LaneHCBack***
1	2 200
5	1 800
6	1 200

A considerably number of new ferry links has been implemented into the road network model, particularly in the Mediterranean Sea between Europe and Africa, the Black Sea and the Caspian Sea. Information on these ferry routes have been collected from various websites given by

[1] See http://www.euromedtransport.org.
[2] IRU: International Road Transport Union.

Table 47 Data Sources for Ferry Link Attributes.

Data sources for ferry link attributes
http://caspianferry.ru
http://directferries.co.uk
http://salamisinternational.com
http://www.aferry.to
http://www.fergun.net
http://www.ferrylines.com
http://www.freightbyferry.com
http://www.freightferries.co.uk
http://www.sncm.fr
http://www.trasmediterranea.es
http://www.turkeytravelplanner.com
http://www.ukrferry.com

The attributes "FreeSpeed", "FerryFreq", "FerrySailingTime" and "TollCostTR" have been obtained or calculated from data available from the websites listed above. Missing data have been estimated, e.g. under application of region-specific regression functions computing user costs as a function of sailing distance/sailing time. For links where no sailing distance/sailing time could be found, e.g. in the Caspian Sea, ferry vessel specifications were available, and the sailing time was estimated under application of maximum speed values of ferry vessels.

The attribute "FerryWaitingTime" was set to a value of "30", the most common value for ferries links in the TRANS-TOOLS/TEN-CONNECT road network.

8.1.3 Main outputs

The final version of the WORLDNET road network model is depicted by Figure 80, and – as a thematic map by link types – in Figure 81.

Figure 80: The final WORLDNET road network

The road network model consists of 40 attributes. These attributes and their meanings are displayed by Table 48.

For all non-ferry links, a new attribute, "WNZoneID", has been introduced, which informs on the identifier of the WORLDNET zone[1] a road link is located in.

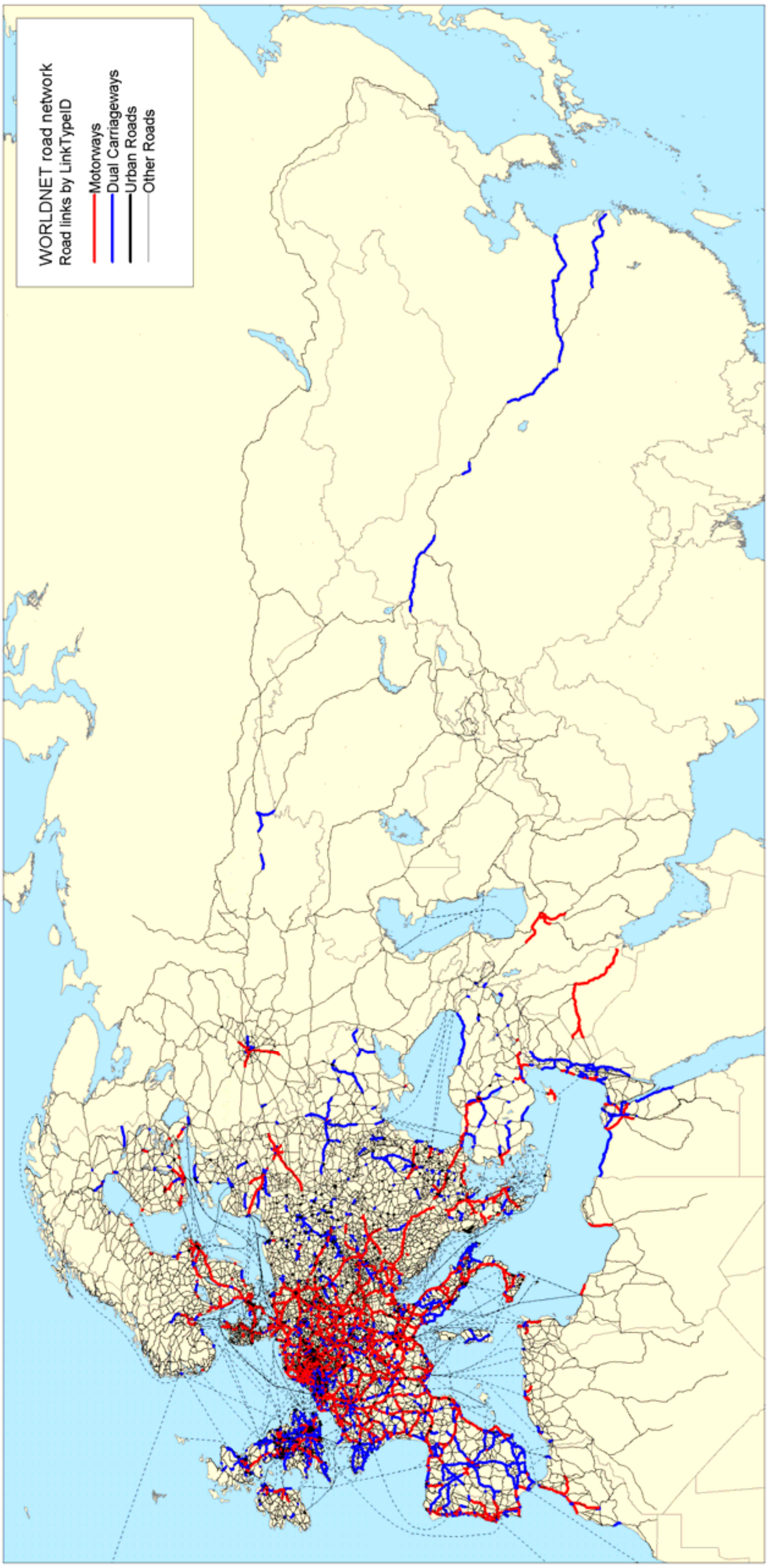
Table 48 Attributes of the Road Network Model

Attribute	***Definition***
ID	Unique identifier of the link
FromNodeID	'From node' of the link
ToNodeID	'To node' of the link
OpenFor	Road link open for traffic in forward direction (yes=1, no=0)
OpenBack	Road link open for traffic in backward direction (yes=1, no=0)
FreeSpeed	Speed in free flow conditions (km per h)
QueueSpeed	Minimum speed on the link – The model uses the maximum of the speed found on the speed-flow curve or the queue speed (-1 to always use speed-flow curves)
LanesFor	No. of lanes in forward direction
LanesBack	No. of lanes in backward direction
LinkTypeID	Link type defining speed flow curve (1=motorway, 5=rural road with separate directions, 6=rural two-lane road, 9=urban road, 90=ferry)
LaneHCFor	Hourly traffic capacity per lane in forward direction (-1 if not applicable)

[1] The WORLDNET zoning system applied refers to the geographical layer "wn_regions_008".

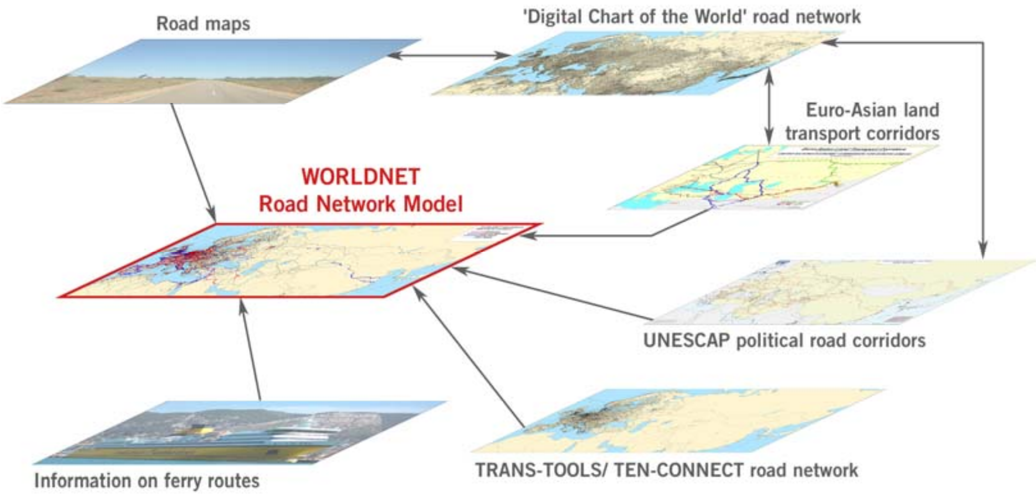
LaneHCBack	Hourly traffic capacity per lane in backward direction (-1 if not applicable)
Active	Link to be used in calculations (yes=1, no=0)
Length	Length of link for non-ferry links (Meters)
LinkLength	Length of link (Meters)
NationalName	National name of road
Euroname	European name of road
RoadClass	Link road class (OE=Other European road, O=Other road, ME=European motorway, M=Motorway, D=Dual carriageway, DE=European dual carriageway, F=Ferry)
FerryFreq	Number of ferries per day (-1 for non-ferry links)
TollCostPC	Toll cost for passenger cars
GenericCostPC	General country wide toll costs for passenger cars
TollCostTR	Toll costs for trucks
GenericCostTR	General country wide toll costs for trucks
CountryBorder	Link located on critical border used in calculation of LoS (yes=1, no=0)
Country	Country within which the link is located
Urban	Link is located in urban area (yes=1, no=0)
ZoneID	Model zone the link is located in
ZoneBorderCrossing	Link located on a zone border (yes=1, no=0)
WNZoneID	WORDLNET zone the link is located in
PreLoadFor	Preloaded short distance traffic in forward direction from table ShortDistancePreload
PreLoadBack	Preloaded short distance traffic in backward direction from table ShortDistancePreload
LinkCostPC	Total toll costs for passenger cars
LinkCostTR	Total toll costs for trucks
FerrySailingTime	Sailing time for ferry links
FerryWaitingTime	Average waiting time for ferry links
FuelCostPC	Fuel costs for passenger cars
PublicRevenuePC	Part of the toll, generic and fuel costs paid to public budgets for passenger cars
PublicRevenueTR	Part of the toll, generic and fuel costs paid to public budgets for trucks
Shape_Length	ArcGis link length

Figure 81: Overview of the WORLDNET road network model by link types



The main data sources applied for the construction of the WORLDNET road network model are summarised and displayed by Figure 82.

Figure 82: Main data sources applied for the development of the WORLDNET road network model



8.2 Rail Network Model

The main objecvtive of the rail network model extension within WORLDNET has been to create network models

- that are compatible to the TRANS-TOOLS model
- and that allow the assignment of freight demand flows between European countries and other countries of the world.

Thus, the main aim of this task of WORLDNET has been to extend the TRANS-TOOLS rail network model with additional links that are of relevance for freight transport flows between Europe and other countries of the world.

8.2.1 Overview of the methodology

The WORLDNET rail freight network model is based on the TRANS-TOOLS/TEN-CONNECT rail freight network model received on February 12th, 2008. This network covers the whole of Europe, including Western Russia up to Moscow and Turkey. Updated versions of the TRANS-TOOLS/TEN-CONNECT network models were received on November 11th, 2008, in which the rail freight network in Russia was extended beyond Moscow. The updated TRANS-TOOLS/TEN-CONNECT rail freight network model can be seen in Figure 83.

Figure 83: The TRANS-TOOLS/ TEN-CONNECT rail network

Based on this network model, extensions have been conducted by adding links, which can be expected of being relevant for rail freight transport flows between Europe and other countries, under consideration of politically agreed transport axes and of comments received on the WORLDNET Seminars in Istanbul (April 2008) and Beijing (May 2008).

It has been made sure that all extensions are consistent with the existing TRANS-TOOLS/TEN-CONNECT rail freight network model.

8.2.2 Main data sources

Geographical basis

The geographical basis for the WORLDNET extension of the rail freight network was provided by the "Digital Chart of the World" as displayed by Figure 84.

Figure 84: The "Digital Chart of the World" rail network

Furthermore, the EUROMED rail network[1] as shown in Figure 85 has been integrated into the extended network model (besides the rail network of Turkey).

Figure 85: The EUROMED rail network

Identification of relvant extensions

For the extension of the rail freight network model towards the northern part of Africa and the eastern Mediterranean countries the scope of the EUROMED network has been considered.

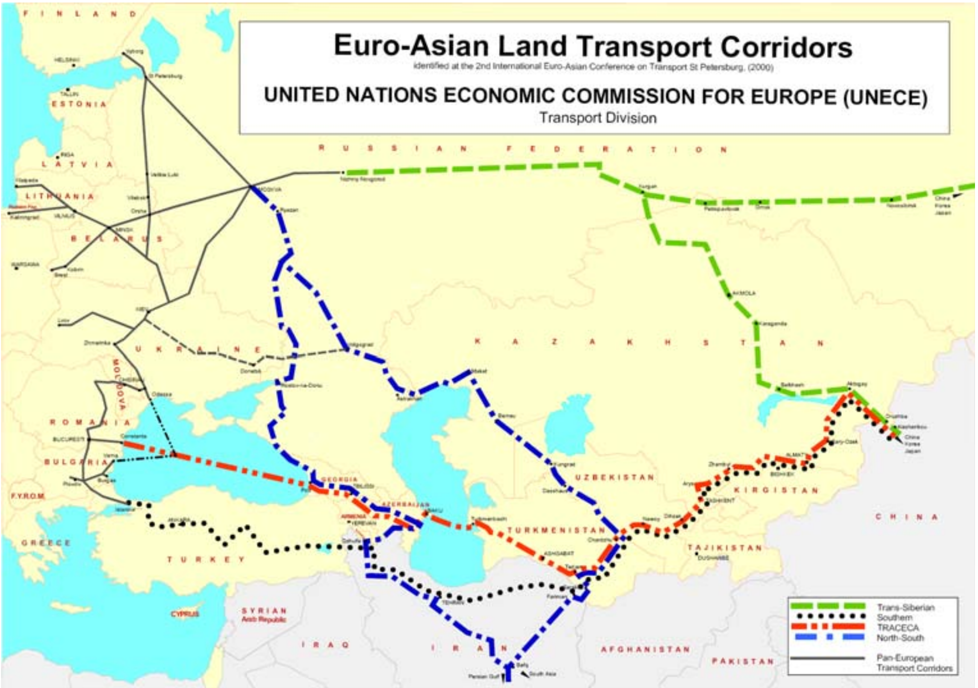
In order to determine the relevant transport axes for the extensions towards Asia, the political corridors defined by the UNESCAP played a major role (see Figure 86), as well as the scope of the Euro-Asian Land Transport Corridors. Most of these corridors were integrated into the extension, with the exception of two parts, located in Kazakhstan and Uzbekistan. These parts of the corridor are not present in other information sources, for instance in maps provided by the UN Cartographic Department[2]. Therefore, these sections of the UNESCAP rail corridors have not been integrated.

[1] See http://www.euromedtransport.org.
[2] See http://www.un.org/Depts/Cartographic/map/profile/kazakhst.pdf and http://www.un.org/Depts/Cartographic/map/profile/uzbekist.pdf.

Figure 86: The political rail corridors defined by UNESCAP

Source: UNECE/UNESCAP

Figure 87: The Euro-Asian Land Transport Corridors



Obtaining information on link attributes

Data for attributes of the links has been gathered from various sources. For instance, the number of tracks has been taken from the websites given in Table 49. For the links in China, information for the attribute “FreeSpeed” has been derived from the average speed given in an OECD publication[1]. The speed on the Trans-Siberian railway corridor has been estimated from distances and carriage

[1] See http://www.oecd.org/dataoecd/12/3/34566769.pdf, p.15.

times investigated by Gong and Wang (2008)[1]. For other links without any data availability on speed, proxy values have been applied from other, similar countries.

Table 49 Sources for the Number of Tracks of Rail Links

Data sources applied for rail link characteristics
http://www.parovoz.com/maps/supermap/index-e.html
http://www.nordling.nu/schaefer/chinamap.gif
http://en.wikipedia.org/wiki/Jinghu_Railway
http://en.wikipedia.org/wiki/Lanxin_Railway
http://en.wikipedia.org/wiki/Image:Iran_railway_en.png

A few ferry links were added in the Black Sea and the Caspian Sea. The attributes of these links were either given or estimated from data found on the websites given in Table 50.

Table 50 Data Sources for Ferry Link Attributes

Data sources applied for rail ferry link attributes
http://www.railservice.ru/eng/service_n.html
http://www.ukrferry.com/eng/services/ferry.asp

8.2.3 Rail Network Model Output

The final version of the WORLDNET rail network model is illustrated by Figure 88, and – as a thematic map by link types – by Figure 89.

Figure 88: The final WORLDNET rail network

[1] See Gong, L. and Wang, J. (2008): "Die Transsibirische Eisenbahn - ein zukünftiger Korridor für Güterverkehr zwischen Europa und China?", p.18.

The rail network model consists of 19 attributes, which are listed by Table 51, together with their meaning.

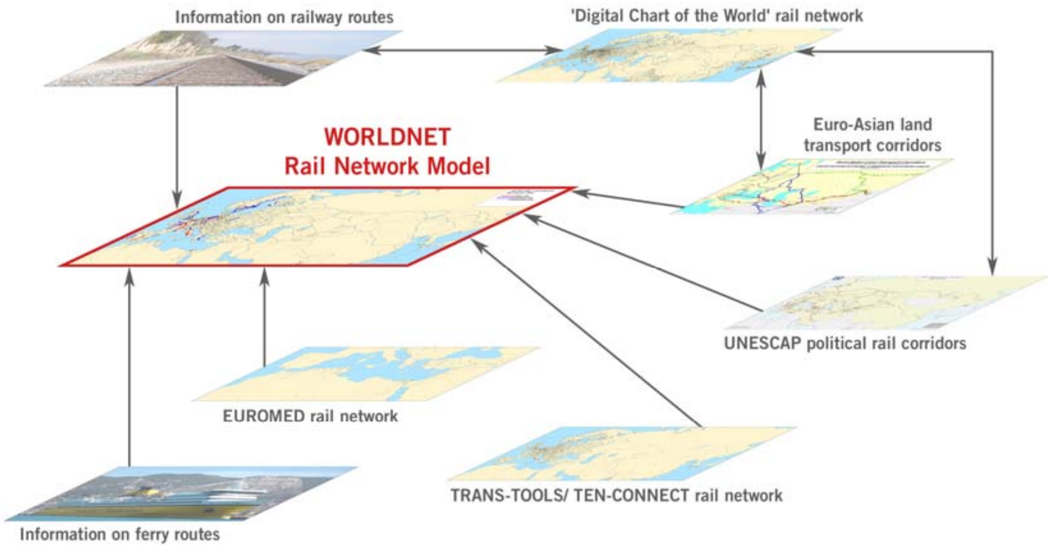
Table 51 Attributes of the Rail Network Model

Attribute	***Definition***
ID	Unique identifier of the link
FromNodeID	'From node' of the link
ToNodeID	'To node' of the link
OpenFor	Road link open for traffic in forward direction (yes=1, no=0)
OpenBack	Road link open for traffic in backward direction (yes=1, no=0)
FreeSpeed	Speed in free flow conditions (km per hour)
QueueSpeed	Not applicable (-1)
LanesFor	No. of tracks in forward direction (1 if single track)
LanesBack	No. of tracks in backward direction (1 if single track)
Tracks	Total no. of tracks
LaneHCFor	Not applicable (-1)
LaneHCBack	Not applicable (-1)
LinkTypeID	Link type (1, only one type used)
Active	Use link in calculations (yes=1, no=0)
Length	Length of link (Meters)
CountryBorder	Link located on critical border crossings used for calculation of LoS (yes=1, no=0)
Class	Link type (CL=conventional linke, UL=upgraded line, NL=new line, FE=ferry)
Country	Country within which the link is located
Shape_length	ArcGis length

Figure 89: The WORLDNET rail network

The main data sources applied for the construction of the WORLDNET road network model are summarised and displayed by Figure 90.

Figure 90: Main data sources applied for the development of the WORLDNET rail network model



8.3 Air Cargo Network

The infrastructure of air transport does not consist of links like highways or railway lines as in the modes road and rail but of nodes (airports), which – in principle – can all be connected to each other directly. In addition there are several types of ‘flights’ carrying cargo and finally it has to be noted that air cargo is per se an intermodal type of transport and therefore the aviation infrastructure has to be linked to the land based modes which is considered by the main access/egress mode of truck transport.

Therefore the network model for air transport provided copes with different forms of cargo transport and intermodality whereby it is reflected by an aggregated network. In addition the network has to mirror the dominance of intercontinental flow patterns considering the underlying regionalisation within WORLDNET, with about 500 traffic zones representing the world outside Europe and more than 1.500 for Europe (NUTS3-level).

8.3.1 Methodology and data sources

The air network delivered within this project consists of three files
- airport nodes
- aggregated connections between airports
- road feeder connecting the regions to the airports.

The following sections describe how the files have been prepared (including intermediate steps).

8.3.2 Airports

Flights are connecting airports, meaning for the air links mentioned in the following section, a corresponding set of airports must exist, for each airport consisting of

- identifier code (TLC = Three Letter Code) of the airport
- city code of the airport (e.g. the London airports like Heathrow or Gatwick all have the same city code “LON”)
- airport name
- Latitude / longitude information to display airports
- Minimum transhipment times between flights
- Loading / unloading times
- Country and WORLDNET Region in which the airport is situated.

The first four of these attributes are available e. g. from internet sources like www.worldaerodata.com, for transhipment and loading/unloading times an internet research among multiple airports and airlines has been undertaken, as this information - different to passenger services with applying minimum-connecting times, was not available from the OAGMAX (www.oag,ax.com) data source. This research led to the following general assumptions:

- the minimum time for transhipment at airports from truck to a domestic flight is 90 minutes,
- the minimum time for transhipment at airports from truck to a domestic flight is 120 minutes,
- the minimum time for transhipment at airports from truck to a domestic flight is 90 minutes,
- the minimum time for transhipment at airports between flights of the same airline or flights of different of airlines belonging to the same cargo alliance is 180 minutes,
- the minimum time for transhipment at airports between flights of different airlines not belonging to the same cargo alliance is 360 minutes and,
- the maximum time for transhipment at airports between any flights is 1440 minutes.

Note: Between flights of different airlines which are formally not part of the same alliance but which have code share agreements, transhipment times apply like they were within the same air cargo alliance.

These transhipment times were complemented by connecting all airports under the same “city code” with additional transhipment times (i.e. trucking between these airports) to ensure that the building of flight connections which require an intermediate airport change is possible in the modelled network.

In the real world only in a very few cases the transhipment of cargo between truck and a plane actually is done within the defined 90 or 120 minutes, as air cargo in general is collected by truck in the distinct regions of origin for several flights starting from the same airport at different times, as the specific cargo volume from a region for a distinct flight is too small to be carried separately.

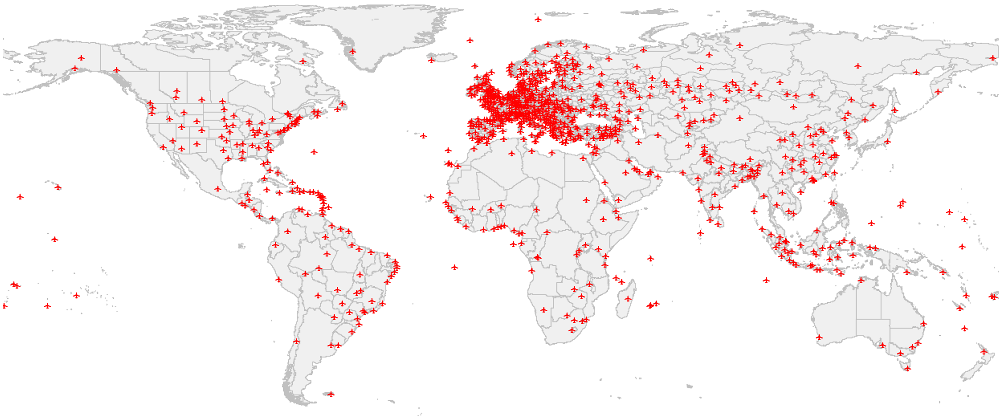
For this reason these transhipment times between truck and plane at airports is neither included in the connector links (for the impedance between a region and an airport) nor in the transport times of the air cargo flight paths linking airport pairs. Depending on the model used, one is free to add times for the intermodal transhipment road to/from air, in line with the needs of the specific transport model.

As there are nearly 10,000 airports/airfields all over the world, for which a TLC is defined and which in principal all can be connected among each other with direct flights, this huge number of airports has to be condensed significantly, to be handled in a network model as airports of origin or destination according to the regionalisation. So in a first step all airports/airfields for which no cargo flights or passenger flights with indicated cargo capacity or link specific cargo statistics exist for 2005 were omitted. In a second step the number of airports to be considered which are situated within the same traffic cell used in WORLDNET became limited to one or in some cases to two airports. The latter especially applied when there was no airport with cargo flights at all in a neighbouring region. For Europe this means almost every airport where cargo carrying flights existed in 2005 was chosen and for other continents, where the detailness of the underlying regionalisation was not on the NUTS3-level (or similar), selected airports were used.

So this selection is a well defined repeatable process, which can cope with changes in regionalisation and the existing flights if an update of the network for a more recent year than 2005 should be required in future.

The following map shows the airports used for modelling air cargo in WORLDNET.

Figure 91: Overview of the airports used for the WORLDNET Air Cargo Network



There are 746 airports actually used in the air cargo network, either as an airport of origin or destination (730 airports) or at least as an intermediate airport for transhipment (16 airports).

8.3.3 Transhipment times at airports - cargo alliances

As the membership of an airline within a distinct air cargo alliance is vital for the underlying minimum-transhipment-times at airports between flights of different airlines, these cargo alliances and their members have been identified for this project. The alliances and the members differ from the alliances known in the passenger transport.

In the year 2005 the following air cargo alliances existed:

- Federal Express (Fedex)
- Skyteam Cargo
- WOW Cargo Alliance
- Cargolux.

The 1st alliance "Federal Express" in fact is the world largest cargo airline with the same name. Together with its subsidiaries or co-operations this "alliance" consists the following airlines:

Table 52 Alliance members of "Federal Express"

FedEx
Mountain Air Cargo
Wiggins Airways
Empire Airlines
Morningstar Air Express
Air Contractors
Merlin Airways
Air Tahoma
Baron Aviation Services

Note: some of these airlines run some or all of their flights under the code FX of FedEx.

The 2nd alliance Skyteam consists of:

Table 53 Alliance members of "Skyteam"

Korean Air
Air France
Delta Air Lines
Aeromexico Cargo
Alitalia
KLM
Northwest

Note: This is only a subset of all airlines belonging to the alliance Skyteam for passenger services. E.g. The Russian Company Aeroflot is part of Skyteam only for passenger services.
The (regional) co-operation partners of these Skyteam members like Comair (partner of Delta Air Lines) were taken into this alliance additionally.

The 3rd alliance WOW Cargo Alliance consists of:

Table 54 Members of "WOW Cargo Alliance"

Lufthansa Cargo
SAS Cargo
Singapore Airlines Cargo
Japan Airlines

Note: This alliance consists not only of Airlines which are members of the "STAR Alliance" – Japan Airlines belongs to the "OneWorld" alliance for air passenger transport. The (regional) co-operation partners or subsidiaries of these WOW members like JAL Express (subsidiary of Japan Airlines) were taken into this alliance additionally.

The membership of Lufthansa in this alliance is inactive since the beginning of 2008, and started co-operation with two other carriers (Jade Cargo International and AeroLogic).

The 4th alliance Cargolux consists of:

Table 55 Alliance members of "Cargolux"

China Airlines
Cargolux

Note: These two airlines are integrated into Skyteam since 8/2008.

The changes within the alliances mentioned mean for future updates of an air cargo networks one has to redefine the existing alliances, add additional Cargo Alliance and cease the Cargolux Alliance. As data sources one can consider the websites of the alliances mentioned and corresponding wikipedia articles. The content of the latter should be checked weather they are up to date by visiting of the airlines websites which are considered to be in a specific alliance.

8.3.4 Aggregated air links

Between airports air cargo is transported by four types of flights:

- scheduled passenger flights, which carry additional cargo
- scheduled pure cargo flights, for which specialised cargo aircraft (often converted from older passenger aircraft) is used
- pure cargo flights on charter base and
- "flights" operated by trucks on a scheduled base, e. g. for connecting the distinct airports of one town to each other (e. g. trucking is used to connect flights at London Heathrow with those at London Gatwick).

A perfect data base including all these flights (beside trucks) would have been Eurocontrol, where all flights to or from any European airport are monitored. Due to data privacy – we were told this flight information belongs to the airlines running these services, and the dissemination of these data would imply to obtain the allowance of each airline monitored – a commercial database enriched by additional flights implemented by a heuristic approach was chosen as a source for the necessary information.

8.3.5 Scheduled flights

Concerning scheduled flights the most comprehensive source is offered by OAG (www.oagmax.com), which claims to contain scheduled passenger and cargo air services. It is freely available on a commercial base.

The following extract from this data source shows how flights are documented within this source:

Table 56 Flight data extracted from OAGMAX

Carrier1	FlightNo1	DepAirport	ArrAirport	LocalDepTime	LocalArrTime	LocalArrDay	LocalDaysOfOp
4R	7917	AGA	MUC	1325	1810	NULL	1
SQ	286	AKL	SIN	1400	2025	NULL	1234567
NZ	4386	AKL	SIN	1400	2025	NULL	1234567
BR	76	AMS	BKK	1135	430	1	7

EffFrom	EffTo	FlyingTime	SpecificAcft	Seats	Freightons	Km	DistKM
02.01.2006 00:00	31.12.2006 00:00	345	73G	148	68	2688	2688
19.03.2006 00:00	25.03.2006 00:00	1025	744	375	50.8	8406	8406
19.03.2006 00:00	25.03.2006 00:00	1025	744	375	50.8	8406	8406
29.10.2006 00:00	29.10.2006 00:00	1055	74E	272	54.5	9173	9173

Each flight covered comes with data describing:

- the carrier
- the specific flight number
- the airport of departure and of arrival
- the scheduled flight times
- the days of operation
- the period in which a flight is operated
- the effective flight time
- the type of aircraft used
- the freight capacity offered and
- the flight distance.

The information about the cargo capacity of a flight (marked in red in the table above) was also foreseen to be used within the air cargo matrix building process. For details please refer to the D7 report.

So extracting all the flights (for passenger as well as for pure cargo) from this data source which ran within a “typical week” (for which the third week of June of a year was found to be the best available representative) with an available freight capacity larger than 0 tons, forms the base for the “scheduled” part of the air cargo network. This base consists of 438,316 specific flight entries.

There may exist scheduled flights which are not covered by this data base but which are – in respect to the cargo volume transported by them – relevant to be considered in a network model for air cargo. Therefore in a first step additional nonstop-flights which existed only outside this typical week on such airport pairs with significant cargo volume reported by Eurostat have been transferred to the typical week so that they became part of the air cargo network. This procedure led to additional 2,171 flights.

Other scheduled flights which could not be covered by this procedure, were dealt like charter flights, as described in the following section.

8.3.6 Charter flights

Beside scheduled air transport of air cargo, a numerous number of charter flights is operated as well. The only central data base, where data for all flights to or from European airports are collected is at Eurocontrol. Unfortunately these data are considered as confidential by Eurocontrol and therefore where not available for this project.

For this reason we opted for another way to enrich the base of the model network offered by the scheduled flights from OAGMAX with an approach via the air cargo statistics offered by Eurostat, which are freely available from their website and which are also needed to set up the air cargo matrix.

Assuming that air cargo “on flight” statistics published by Eurostat include all relevant flights which actually transported air cargo and were not already extracted from the OAGMAX data source, we enriched the network by adding flights for all airport pairs for which cargo volumes were reported but did not have any scheduled flights in the OAGMAX. These flights were designed (schedule, aircraft, airline, operating days etc.) using a representative heuristic which bases on an analysis of existing flights between airport pairs, according to its distance and the cargo volumes documented for each of those pairs. This led to 6,734 additional flights which complemented the flights database.

In total the set of air cargo flights provided can be considered as complete for modelling purposes. The final set of flights consists of 447,221 entries for air cargo flights, connecting 2,057 airports on 23,819 OD-pairs all over the world. (Note: This set of flights is superior to the number of airports connected than those used as airports for origin and destination, as the remaining more than 1,000 airports in principle qualify to be used as transhipment airports.)

8.3.7 Road feeder links

The final “ingredient” which complements the elements of the air cargo network already mentioned in the sections before are road feeder links connecting the traffic zones used in WORLDNET with the airports. These feeder links were computed by IWW.

Due to final changes of the regionalisation and bearing in mind the deadline of delivery for this report some feeders on intercontinental scope have been added by MKm through generic impedances which have been estimated on base of the ones provided by IWW. The following sections describes the preparation of the feeder links undertaken by IWW.

8.3.8 Feeder links from the road network

For regions where comprehensive network data can be accessed to, the region-to-airport impedances were naturally computed via the network. This is the case for the whole of Europe, North Africa, the Middle East and several other Asian countries. The network data are based on the WORLDNET network which is an expansion of the TEN-CONNECT network. In the following the most important network data with regards to the calculation of network impedances from the regions to the airports are summarised and described.

Link type

The network links are differentiated by five link types being listed in the table below. Each type has been assigned to a speed class. For a selection of countries the corresponding speed figures are listed in the following table.

Table 57 Network-Links differentiated by type

Link_Tpe_ID	***Road_Type***	***Applied Speed Class***
1	Motorway	M
5	Rural road with separate directions	D
6	Rural two-lane road	O
9	Urban road	B
90	Ferry	F

Speed

The speed data stem from the database of the International Road Transport Union (IRU) and are classified by the speed categories listed in Table 57. The following table shows these data for a selection of European, African and Asian countries. Although the data are differentiated by type, the speed figures are still computed average values, since most countries distinguishes further between the weighting categories of the different transport vessels in determining the speed limit.

The ferry type is not explicitly listed in the table, since the speed value was set to 30 km/h uniformly.

Table 58 Speed limits (in km/h) in a selection of countries (based on data from IRU)

Country	Country_Code	B	O	D	M
Arab Republic of Egypt	EG	50	80	80	90
Austria	AT	50	70	70	80
Azerbaijani Republic	AZ	60	70	70	90
Belgium	BE	50	75	90	90
Bosnia and Herzegovina	BA	50	100	100	100
Bulgaria	BG	50	80	80	100
Croatia	HR	50	75	75	75
Cyprus	CY	50	90	100	100
Czech Republic	CZ	50	80	80	90
Democratic and Popular Republic of Algeria	DZ	50	80	80	90
Denmark	DK	50	70	70	80
Estonia	EE	50	90	100	100
Finland	FI	50	80	80	80
France	FR	50	80	85	90
Georgia	GE	60	70	90	100
Germany	DE	50	70	70	80
Greece	GR	50	70	80	90
Hashemite Kingdom of Jordan	JO	40	70	100	100
Hungary	HU	50	70	70	80
Ireland	IE	50	80	85	90
Italy	IT	50	75	75	80
Kingdom of Morocco	MA	50	80	80	90
Latvia	LV	50	85	85	85
Lithuania	LT	50	80	85	90
Luxembourg	LU	50	75	75	90
Moldova	MD	60	80	90	90
Netherlands	NL	50	80	85	85
Poland	PL	50	80	90	95
Portugal	PT	50	80	85	95
Republic of Albania	AL	40	90	90	90
Republic of Armenia	AM	60	90	90	90
Republic of Belarus	BY	60	80	90	100
Republic of Iraq	IQ	50	80	80	90
Republic of Kazakhstan	KZ	60	90	90	90
Republic of Tunisia	TN	40	80	80	90
Romania	RO	50	80	90	100
Russian Federation	RU	60	70	70	90
Serbia	RS	60	75	75	75
Serbia and Montenegro	ME	50	75	75	75
Slovakia	SK	60	80	80	80
Slovenia	SI	50	75	75	75
Socialist People's Libyan Arab Jamahiriya	LY	50	80	80	90
Spain	ES	50	70	80	90
State of Israel	IL	50	80	80	80
Sweden	SE	50	70	80	90
Switzerland	CH	50	80	80	80
Syrian Arab Republic	SY	40	60	80	80
The Former Yugoslav Republic of Macedonia	MK	50	75	75	75
Turkey	TR	50	50	80	90
Ukraine	UA	60	70	90	100
United Kingdom	UK	48	70	90	100

Nodes

In order to compute the impedances from a region to an airport, it is required to assign both the region and the airport to network-nodes. These assignments look like as follows:

Airport nodes

The nearest network node in terms of minimum air distance was chosen to represent the access point from the airport to the road-network.

Region nodes

The computation of the population centre of gravity that is not the geographical centre of gravity but a centre taking into account all cities and their belonging population yielded to a point representing the region.

The gravity is the higher the bigger the city in terms of number of inhabitants. The resulting population centre of gravity was then assigned to the nearest network node (in terms of air distance).

Based on these data/assumptions the shortest paths[1], these are paths with the minimum travel time between the assigned region-nodes and airports-nodes, were computed. Adding the direct air distance and travel time (which was set to 50 km/h) from the airport-node to the airport itself resulted in the impedances from the regions to the airports. Since the catchment area of an airport is limited to a certain number of regions depending on the travel time to the airport, the impedances between regions and airports were only determined on relations with a travel time of less than 10 hours.

It is important to mention that the resulting impedances (in terms of travel time and distance) are theoretical and potential values respectively speed limits (i.e. upper limits) were used for their computation. In other words the calculated travel times are in most cases significantly higher than the actual travel times.

8.3.9 Generic feeder links

In order to compute impedances in regions where no network data were available, a generic approach was developed. All of these WORLDNET-regions have been assigned to at least one major airport. The determination of an average access and egress impedance to/from the airports without modelling the road-network of the regions explicitly can be briefly summarised with the following points:

- Determination of the average air distance
- Determination of an average detour factor and
- Computation of the average travel time.

Determination of the average air distance

In order to obtain the average distance to the airport, cities (belonging to the region the airport was assigned to) with a population above 50,000 people were identified in a first step[2]. In a second step, the spherical air distances from each city i in that region r to the airport k have been computed. Weighting these city-to-airport distances $dist_{ik}^{air}$ with the belonging population pop_i resulted in the average air distance to the regional airport ($avg\_dist_{rk}^{air}$). This was done by assuming that economic activities/markets leading to air cargo flows are bundled/located especially in major agglomerations even beside the fact that these flows are eventually collected in distribution centres outside these agglomerations. The determination of the average air distance can be exemplified as follows:

[1] Using the Dijkstra-Algorithmus

[2] In those regions without cities with a population above 50,000 either all cities were taken into account or the geographical centre of gravity was determined.

$$avg\_dist_{rk}^{air} = \frac{\sum_i pop_i * dist_{ik}^{air}}{\sum_i pop_i}$$

r	WORLDNET region
i	city in region r (population > 50.000)
k	airport assigned to region r
pop_i	population of city i
$dist_{ik}^{air}$	air-line distance from city i to airport k
$avg\_dist_{rk}^{air}$	average air-line distance to the airport k in region r

Determination of the average detour factor

However, the average air distance is only the lower bound of the actual average distance via the road-network. In order to get a more realistic distance measure an average detour factor was determined. This detour factor can be interpreted as average distortion which is caused by travelling via the road-network rather than travelling as the crow flies and can be determined as follows:

$$d\_factor_r = \frac{\sum_i dist_{ik}^{network} * pop_i}{\sum_i dist_{ik}^{air} * pop_i}$$

pop_i	population of city i
$dist_{ik}^{air}$	air-line distance from city i to airport k
$dist_{ik}^{network}$	air-line distance from city i to airport k
d_factor_r	average detour factor in region r

For setting up the detour factor, a sample of city-to-airport relations was drawn[1]. For example, in the US the sample size amounts to 250 relations all across the country. The comparison between the real distances out of the sample and the air distances finally yielded to an average detour factor of 1.23.

In countries where no real data were collected an average detour factor of 1.35 (which is approximately the mean of all sample relations) is considered to be appropriate.

However, it is important to note that the average detour factor differentiated by countries is very much influenced not only by the network density but also by the geographical realities.

Computation of the average travel time

With these detour factors on hand and an average free flow speed limit for each country, straightforward computations (as can be seen in the following formula) resulted in the region-specific average travel time and distance to the airport.

[1] Data sources: Google Maps, Microsoft Live Search

$$avg\_tt_{rk} = \frac{avg\_dist_{rk}^{air} * d\_factor_r}{speed_r}$$

$avg\_dist_{rk}^{air}$	average air-line distance to the airport k in region r
d_factor_r	average detour factor in region r
$speed_r$	average free flow speed limit in region r
avg_tt_{rk}	average travel time to the airport in region r

8.3.10 The resulting air cargo network

From the data described in the sections before the airports file and the road feeder links are two components which are part of the resulting network without any further adaptation. The feeder links – which in fact are impedances between a region and an airport have a code plan as follows:

Table 59 Code plan of Air cargo Feeder Links

Wn_ID	***TLC***	***time[minutes]***	***distance[km]***
101010101	BEG	441	544

The files contains of 17,386 data sets consisting of:

- Code of Worldnet Region connected to an airport
- Three-Letter-Code of an airport connected to the region
- Transport time by road in minutes and
- Transport distance by road in minutes.

The third component of the resulting air network are aggregated air links between airports on base of the flights data base.

Together with the airport file the flights data base were used by an in-house connection builder to calculate all possible connections for all pairs of airports chosen as an origin or a destination for a flight path within the typical week (2nd week of June) following the rules for connecting flights derived from minimum-transhipment and maximum transhipment times as described in a previous section. All connections with identical routing (i.e. with the same intermediate transhipment airports) found within the typical week were aggregated to flight paths for each airport pair of origin and destination including:

- the airport identifier codes for the airport of origin, the airport of destination and for intermediate transhipment airports (if applicable)
- the corresponding total transport time for the flight path, including the time needed for transhipment at intermediate airports, calculated on base of real flight schedules
- the distance for the distinct flight path on base of the sum of the great circle distances for each segment of the path and
- the frequency available when using the distinct flight path on base of real flight schedules.

An example for such flight paths is shown in the table below:

Table 60 Extract of flight paths built

From	*To*	*Via1*	*Via2*	*Time [minutes]*	*Distance [km]*	*Frequency [flights/week]*
AAL	AAR	CPH	---	280	379	5
AAL	ABJ	CPH	CDG	1638	6137	6
AAL	ABQ	CPH	ORD	2413	8874	3

Due to the complexity of connection building this procedure does only cover airport pairs for which connections are possible by nonstop-flights, with one or in maximum with two intermediate airports where cargo has to be transhipped between the flights. With this limitation more than 392,000 flights paths have been computed, which are about three quarter of all airport pairs which are possible in principle, when calculating with 730 airports used as an origin or a destination of a flight path. The airport pairs for which flight paths have been constructed cover all airport pairs between which air cargo has actually been transported in 2005.

In case a full coverage of all airport pairs is needed for modelling purposes, one can combine distinct flights paths delivered and add a transhipment time for connecting them to receive flight paths and transport times for the remaining airport pairs. On base of the traffic zones this has been done within this project. For details we refer to the section “Air Cargo Impedances Region to Region” in the D9 report.

8.3.11 Potential applications / limitations

The resulting network allows to be used for assignment purposes as well as for building impedances either between airports or also between regions, using (time) shortest path algorithms or route choice models. For assignment procedures it is advised to opt for route choice models or to use a successive assignment process, as air cargo often is not carried strictly along time shortest paths.

In case for updating the network for a more recent year in the future it is not only necessary just to buy the latest version of the OAGMAX data. One further has to monitor the development of the air cargo alliances as the co-operations between airlines may vary from year to year.

Rail feeder to airports do not play any relevant role for multimodal transport chains where air transport is involved for the time being.

This might change in future (a first pilot for this has been inaugurated this year at the airport of Frankfurt, Germany). For this reason the approach chosen should incorporate rail feeders in case of a future network-update.

Another topic where more accurate information is required concerns the transhipment times between flights of distinct airlines at the specific airports.

This could be done by a survey among the biggest air cargo airports and as well airlines.

Another field where an improvement concerning the modelling of air cargo should be taken into account, is the introduction of costs for air cargo. For the time being, air cargo is about ten times as expensive as sea shipping, so that only very specific groups of goods qualify for air cargo due to their value. As the latest trend in worldwide transport is to split up the transportation of a specific good to both, sea transport and air cargo, to bring a (small) part of goods as soon as possible to the markets for marketing purposes, the biggest part of a delivery will be done by sea transport. So introducing air cargo into a modal split model for distinct commodity groups is a future field in modelling freight transport. The challenge one faces here is the huge price variation for air cargo transport depending on:

- the relation specific available cargo capacity and demand (e. g. Asia -> Europe vs. Europe –> Asia), as carrying even empty aircraft is quite expensive
- seasonal change of demand
- specific commodity groups of carried cargo (perishables different to spare parts), i.e. to consider air cargo as an own commodity group is not feasible any more when introducing prices in modelling air cargo and
- different routings in intercontinental air cargo implies to implement a route choice model which includes prices.

As outlined in section 8.3.6 air cargo statistics from Eurostat or national statistics have to be used to enrich the air network with additional flights not covered by the OAGMAX data. For that reason, an improvement of the statistical data concerning the number of routes data are collected and also published helps to improve the air cargo network.

Finally it has to be stated that not all air cargo flights are reported in the published commercial schedules, e.g. cargo charter, so that such supply information gaps are a significant burden for the modelling and validation process. To overcome this unpleasant situation one should quote upon the memorandum concerning cooperation between the European Commission and Eurocontrol to e.g. exchange technical information and data which can be used here for such purposes like the matrix generation. Due to air navigation purposes any flight is monitored at Eurocontrol and are at hand already so that the information (e.g. origin-destination airport, aircraft type, airline, departure time and day, type of flight) could be extracted easily without any major effort whereby the exact flight routings need not to be deployed.

8.4 Maritime Network

This section is an analysis of the pattern of sea trade movements – in terms of vessel type and vessel size for all major trades to/from EU member states.

The main aim of the deliverable is to provide an extension of the TRANSTOOLS geographical network data for sea transportation, and to collect attribute data for that network.

8.4.1 Methodology

The methodology underlying this work package comprises the following stages and processes:

1. Port identification – different vessel types served
2. Port identification –volumes for individual main cargo types
3. Analysis of transshipment operations at EU and neighbouring ports
4. Analysis of ship sizes used on main hauls to/from Europe – for different shipment types
5. Analysis of trends in ship sizes for different shipment types
6. Indication of vessel charter rates.

These are outlined and discussed below:

i. Port identification – different vessel types served
Involves examining port facilities at each port, and recording if the port handles the specialist vessel types:

- dry bulk
- liquid bulk
- container
- ro-ro.

ii. Port identification –volumes for individual main cargo types
Involves examining cargo statistics for each port, and recording cargo volumes for the specialist cargo types:

- dry bulk
- liquid bulk
- container
- ro-ro.

iii. Analysis of transshipment operations at EU and neighbouring ports
The transshipment of cargo is often an important part of the transport chain, especially for cargoes transported over long distances. In the EU context, there are currently minimal transshipment operations in the dry bulk, liquid bulk and ro-ro sectors. For container shipping however, the nature of vessel sailing patterns (on a fixed liner schedule basis) often favour the use of transshipment centres.

All such operations in and around EU member States have been analysed through examination of port volumes, and differentiation between local import/export cargo and transshipment cargo. The transshipment ports have been listed separately, and such cargo analysed in terms of the percentage of total container trade at each port.

iv. Analysis of ship sizes used on main hauls to/from Europe – for different shipment types
Involves examining the profile of ship sizes actually used on key dry bulk and liquid bulk trades. This involves the tracking of port calls for large

representative samples of the respective fleets, identification of laden hauls, and analysis of likely cargo carried on those hauls. This analysis is checked against other indications of ship size deployment on specific routes – e.g. published trip charter information.

For containerships, it is not possible to track containerised cargo flows on a route basis (due to the typical multi-port calls liner profile of vessel sailing patterns, and the lack of available information on the cargo volume [in terms of tonnage or TEU]). The best indication of vessel size utilisation is via analysis of published schedules for specialist (fully cellular) container vessels, and the derivation of indicative vessel sizes used on main trades – this is incorporated into the analysis.

v. Analysis of trends in ship sizes for different shipment types

Recent years have witnessed extensive changes in the sizes of ships serving world trades, including shipments to/from EU markets. This has been particularly evident in the containership market, where a trend towards a new generation of larger vessels is currently underway, causing dramatic changes to ship size profiles witnessed on individual routes.

It is important for any modelling exercise involving potential ship movements to take such trends into consideration. The analysis undertaken therefore includes an examination of potential fleet development for the main specialist shipping types – whilst this is not designed as a forecast for individual shipping routes (this will ultimately depend on the combination of several factors – including port facilities, haul length, cargo volumes, vessel deployment patterns etc), it provides a useful indication of the scale of potential ship size development within the specialist sectors over future years.

vi. Indication of vessel charter rates

It is important for any modelling exercise to consider the relative costs of transport. In the case of the maritime movements within the Worldnet project, the complexity of the number of potential trade routes, cargo sizes, cargo types, and individual ports of call, effectively preclude the use of any single cost per unit cargo or tonne-mile, as is often used in simple alternative shipment mode assessments.

Furthermore, to maintain the relevance of the Worldnet model for future planning purposes, it is essential that the integrity of the model is not compromised by the inclusion of time-specific shipping costs (this is especially relevant amid the recent and current charter rate volatility).

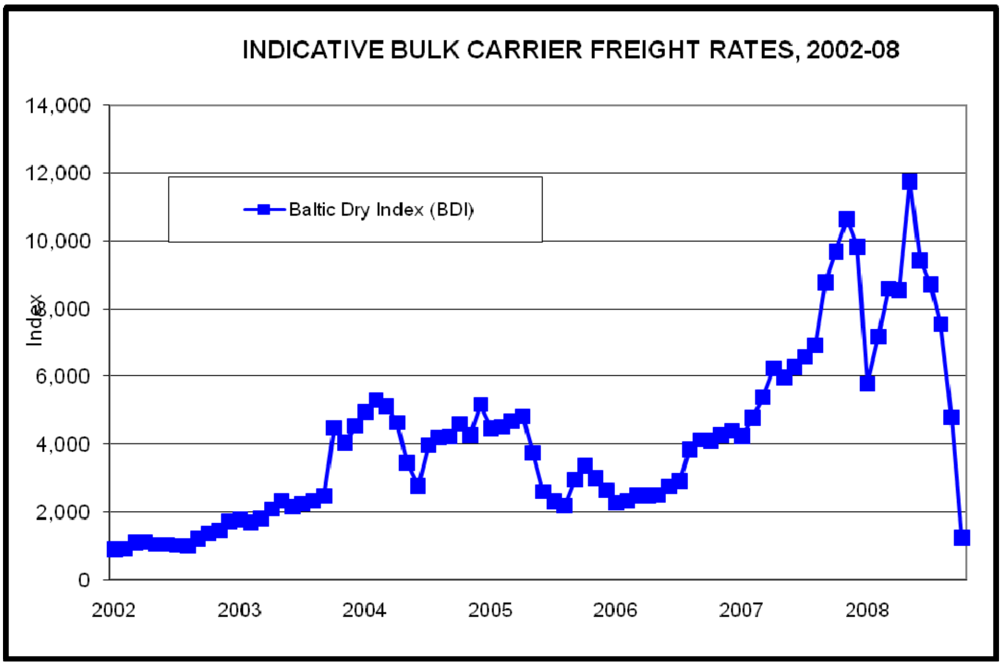
As a result of these considerations, it is considered prudent to provide indicative charter rates for a cross-section of vessel sizes within the major ship types – the appropriate (time-specific) level of charter rates can then be utilised in conjunction with considerations of port factors, ship size utilisation, vessel specifications, fuel consumption, and fuel prices (again time-specific), to evaluate the comparative costs of using different vessel types/sizes on specific routes.

This will then enable the model to be usable for shipping/transport cost comparisons without the results being compromised by out-of-date vessel charter rates and/or fuel prices. The user would simply select the level of charter rates applicable at that time, together with the prevailing bunker prices, and evaluate the indicated costs through consideration of factors such as ship size and fuel consumption.

As an example of the volatility of vessel charter rates, Figure 92 presents the monthly profile of the Baltic Dry Index (BDI) since 2002. The BDI is a composite daily index, calculated by the Baltic Exchange, of the shipping costs for a number of key dry bulk carrier shipping routes, and spans a range of vessel sizes. Effectively therefore, it provides a useful single guide to the relative health of dry bulk carrier charter rates.

It is clear from the graph that the BDI enjoyed almost continuous strong expansion over the 2006-08 period, but after peaking around mid-2008, the BDI has fallen by approximately 90% – from around 12,000 in May 2008 to 1,200 in October 2008. This movement in the Index directly reflects the movement in actual vessel charter rates. It is clear therefore, that by simply incorporating a single bulk carrier cost or shipping rate into the Worldnet model would be completely inappropriate for a Model which is to be utilised over a period of time. Thus, as indicated in the Index development, the relevance of any cost estimates calculated at end-2008 based on mid-2008 charter rates would be negligible.

Figure 92: Indicative Bulk Carrier Freight Rates 2002-08



Source : Baltic Exchange

8.4.2 Outputs

The data has been compiled using a number of sources, cross-referenced where possible.

These include :

i. Within the port database, and for each port, the existence of specialist facilities to handle the principal types of cargo shipping (container, dry bulk, liquid bulk, ro-ro, general cargo) is analysed in terms of a simple Y (yes) or N (no) entry.

For example, an extract from the database for the ports of Morocco :

COUNTRY	*PORT*	*LATITUDE*	*LONGITUDE*	*CONTAINER*	*DRY BULK*	*LIQ. BULK*	*RO-RO*
		[S= "-"]	[W= "-"]	Y/N	Y/N	Y/N	Y/N
MOROCCO	AGADIR	30.26	-9.38	Y	Y	Y	Y
MOROCCO	CASABLANCA	33.36	-7.37	Y	Y	Y	Y
MOROCCO	ESSAOUIRA	31.31	-9.46	N	Y	N	N
MOROCCO	JORF LASFAR	33.07	-8.38	N	Y	Y	Y
MOROCCO	MOHAMMEDIA	33.43	-7.22	N	N	Y	N
MOROCCO	PORT NADOR	35.16	-2.56	N	Y	Y	N
MOROCCO	SAFI	32.19	-9.14	Y	Y	Y	N
MOROCCO	TANGIER	35.48	-5.48	N	Y	Y	Y
MOROCCO	TARFAYA	27.56	12.56	N	N	N	N

This enables instant information to be derived from the database on whether a port handles specific types of vessel.

It should be remembered however, that the existence of specialist handling facilities can, and does, change over time for individual ports – indicating that this is an area requiring regular updating.

ii. Within the port database, and for each port, the most recent volumes of cargo throughput by type (container, dry bulk, liquid bulk, ro-ro, general cargo) is analysed [see discussion in D7 Report].

iii. The incidence of transshipment in the port region under study is limited to a number of ports handling container transshipment traffic.

It should be noted the incidence of transshipment activity at a port is a function of several factors, principally :

- Capacity
- Waterdepth
- Productivity
- Location
- Costs

- Handling Facilities.

The increases in vessel size and demand levels in recent years have acted as a catalyst to the development of transshipment operations. The linking together of the scale economies available from the introduction of larger vessels on long haul high volume trades with final delivery to local ports in smaller vessels, has been the main choice for trade development. Further, even where port investment has been rapid, the pace of transshipment demand has remained equally dynamic, with this indicating a further increase in the complexities of transportation networks.

Transshipment has a central place in the global market and its share is expected to continue increasing. The major lines will continue aiming to serve port regions by as few direct calls as possible, and thus the role of hub-and-spoke container distribution will continue to strengthen. In addition, relay demand is also an increasingly important aspect of the business. In addition to the development of major hub ports (e.g. Algeciras in the Mediterranean), this has led to the development of regional hub ports serving a clear local market (e.g. Constantza in the Black Sea).

It is important to be aware of several factors relating to the transshipment activity that could potentially distort cargo analysis:

- The measure is TEU (twenty feet units; a forty feet container counts as 2 TEU) not tonnes, so translation from TEU to tonnes can be distorted by the handling of empty containers, and the relative weight/density of the product handled. The tonnage capacity of a container is dictated by the maximum weight that can be handled by the container floor. In the case of a container laden with cargo light in weight, the amount of cargo is more restricted by volume considerations, whilst in the case of heavy industrial machinery, weight is the key issue – the implication is that 1 TEU of lightweight cargo may have a very different tonnage measurement than 1 TEU of heavy cargo. This factor applies to all container traffic handled at ports.

- Many ports blur the distinction between transshipment and transit traffic - this can inevitably distort the volume and significance of transshipment activity for any port. Transit traffic is here defined as cargo handled via a port in one country for transport overland to another country.

- The volume of transshipment activity at any port is highly cost sensitive. The cost relates to the overall costs to the shipping line of using that port as a port of call, relative to alternatives. This relative cost can be highly dynamic, with the direct implication that the significance of individual ports as transshipment centres can change markedly in a relative short time period. It is important therefore, to use up-to-date information on transshipment activity for individual ports if any detailed potential traffic analysis is to be undertaken.

- The extent of transshipment activity is often related directly to the pattern of ship size utilisation in a particular region and on main routes. Thus, for example, on cargo hauls from China to Scandinavia, the haul length and cargo volume support the use of very large containerships, but the number of individual destination ports to be served, and their limited available waterdepth, support the high significance of transshipment on such hauls at a number of North European major container ports. If the main features of the trade were different – e.g. the utilisation of smaller ships on the main haul, or increased waterdepth availability at the destination ports, the significance of transshipment activity might change markedly.

iv. Analysis of vessel sizes utilised on the principal dry bulk and liquid bulk trades to/from Europe is presented in the WORLDNET D8 Report.

For dry bulk shipments, the very different profile of ship sizes used for the main individual commodities dictates the separate consideration of the ship size profile for these commodities. With Europe a large-scale net importer of these commodities (and European exports heavily dominated by intra-Europe shipments), attention is concentrated on European imports.

The information is presented in tabular form in the following manner :

a. Iron ore : shipments by source region and by size category (<60,000dwt, 60-100,000dwt, 100-200,000dwt, >200,000dwt)
b. Coal : shipments by source region and by size category (<60,000dwt, 60-100,000dwt, 100-200,000dwt, >200,000dwt)
c. Grain : shipments by source region and by size category (<60,000dwt, 60-100,000dwt, 100-200,000dwt, >200,000dwt)
d. Bauxite/Alumina : shipments by source region and by size category (<60,000dwt, 60-100,000dwt, 100-200,000dwt, >200,000dwt)
e. Phosphate Rock : shipments by source region and by size category (<60,000dwt, 60-100,000dwt, 100-200,000dwt, >200,000dwt)
f. Other Commodities : shipments by source region and by size category (<60,000dwt, 60-100,000dwt, 100-200,000dwt, >200,000dwt).

For liquid bulk shipments, the ship sizes utilised tend to have a wider range (larger vessels) and the pattern of cargo movements is very different from dry bulk – in that European trade includes a high volume of imports and exports. The information is therefore presented in tabular form in the following manner :

a. Liquid Bulk (Oil) : shipments to Europe by source region and by size category (<80,000dwt, 80-120,000dwt, 120-200,000dwt, >200,000dwt)

b. Liquid Bulk (Oil) : shipments from Europe by destination region and by size category (<80,000dwt, 80-120,000dwt, 120-200,000dwt, >200,000dwt).

For container shipments, the undertaking of analysis similar to that discussed above for dry and liquid bulk is impossible due to the unavailability of information on actual movement volumes from/to individual regions. Thus, given the multi-port and multi-regional calling patterns of large containerships (e.g. a China-Europe sailing might include calls at several S/E Asian, Middle East and African ports, between China and Europe), the origin/destination of specific volumes of containers is not clearly definable.

Of more significance in this regard therefore, is an indication of the range of vessel sizes deployed on European sailings. This information has been identified for the following main routes for fully cellular (container) ships :

a. Far East – S. Europe
b. Far East – N. Europe
c. N. America – Europe
d. C+S. America – Europe
e. Middle East – Europe
f. Africa – N. Europe
g. Africa – S. Europe.

Also included in this analysis is the identification of a typical vessel size deployed on each route – i.e. the size most prevalent. This information relates to 2007-08 sailing schedules.

For ro-ro and general cargo vessel shipments, information of ship size deployment by route is not available. Also, the size range of these vessels is far smaller than for dry/liquid bulk and container vessels (e.g. general cargo vessels are typically below 30,000dwt), thereby rendering the inclusion of a similar broad size profile for these vessel categories virtually redundant.

v. All of the ship size profile analysis has been undertaken using the most up-to-date information available. It is important to note however, that the world fleet is currently undergoing significant change in terms of vessel sizes within the fleet, most especially in the container sector where vessel size is undergoing a radical up-scaling.

Analysis has been undertaken of the trends in ship size for the dry bulk, liquid bulk, containership and ro-ro vessel categories (for the general cargo sector, no discernible change is expected). The information is presented in tabular form in the following manner :

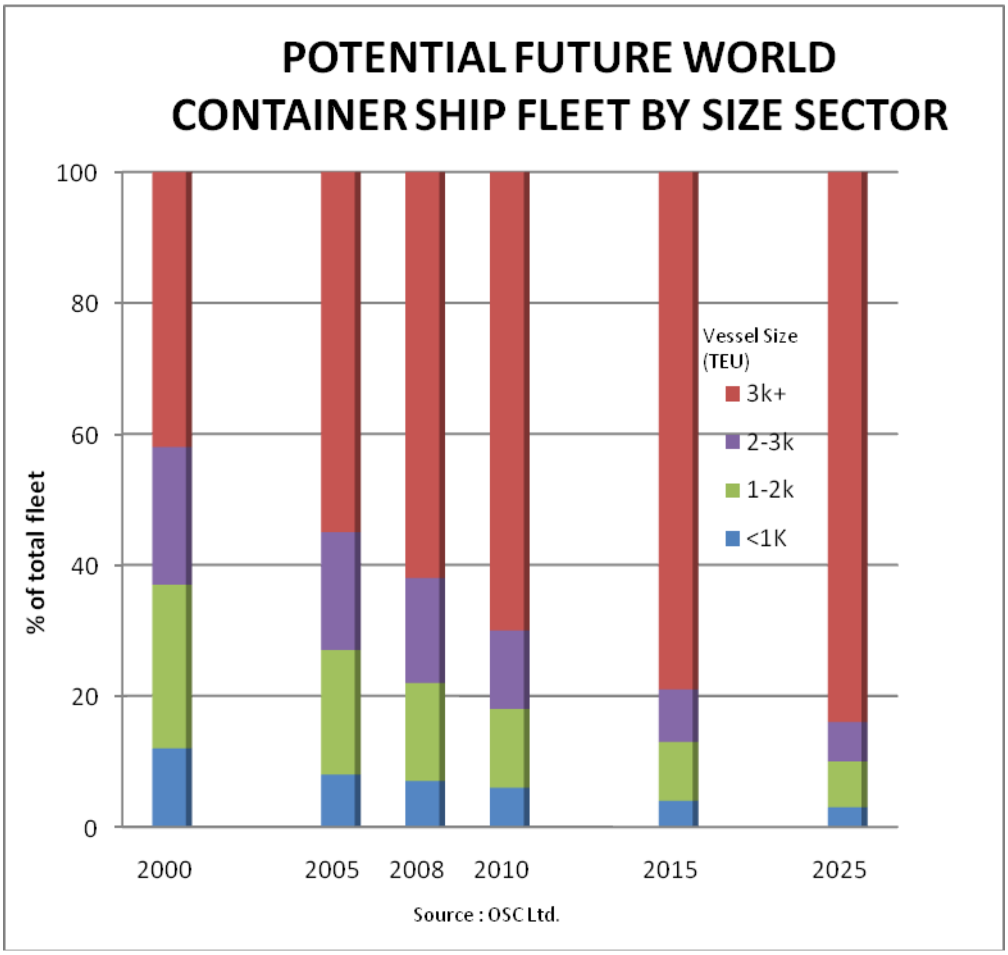
a. Dry Bulk Carrier Fleet Composition for 2000, 2005, 2008, 2010, 2015, 2025 by size category (10-40,000dwt, 40-60,000dwt, 60-100,000dwt, >100,000dwt)

b. Tanker Fleet Composition for 2000, 2005, 2008, 2010, 2015, 2025 by size category (10-60,000dwt, 60-120,000dwt, 120-200,000dwt, >200,000dwt)
c. Containership Fleet Composition for 2000, 2005, 2008, 2010, 2015, 2025 by size category (<1,000 teu, 1-2,000 teu, 2-3,000 teu, >3,000 teu)
d. Ro-ro Vessel Fleet Composition for 2000, 2005, 2008, 2010, 2015, 2025 by size category (<5,000dwt, 5-10,000dwt, 10-15,000dwt, >15,000dwt).

It should be noted that these should only be seen as broad indications of market trends, with the actual future developments dependent on a number of market variables.

An indication of the current/recent and projected ship size profile within the containership fleet is presented in Figure 93.

Figure 93: Potential Future World Container Ship Fleet by Size Sector



Background to these developments is presented in terms of analysis of the current age profile of the main fleet sectors. With the average age of vessels scrapped tending to fluctuate around 25 years for the majority of commercial shipping sectors – lower in poor freight market conditions, higher in strong freight market conditions – it is possible to derive an indication of likely vessel scrapping profiles in the future. For vessel additions to the fleet, this will continue to be linked with freight market conditions, with the time lag between vessel ordering and delivery varying broadly within a 1-3 year range, depending on the size and type of vessel.

vi. For vessel charter rates, summary charts are provided to show the typical rates applicable for a selection of vessel sizes over recent years.

The charts presented (see Appendix B of the Worldnet D8 report) are summarised as follows :

a. Average annual charter rates ($/day) for a selection of dry bulk carrier size categories for the 2002-08 period
b. Indicative average monthly charter rates ($/tonne) for specific sizes of dry bulk carriers on specific routes for the 2007-08 period
c. Average annual charter rates ($/day) for a selection of tanker size categories for the 1998-08 period
d. Average annual charter rates ($/day) for a selection of containership size categories for the 2002-08 period
e. Average annual charter rates ($/day) for a selection of gas (LPG) carrier size categories for the 1998-08 period.

Corresponding charts for typical daily charter rates for general cargo and ro-ro vessels are not included, as these sectors are typically not chartered on a time charter basis, and cargo shipment costs are highly route-specific. The chart indicating actual freight rates on specific routes for dry bulk carriers has been included to show the direct linkage between daily charter rates and actual route-specific prices.

Also included in are the following analyses :

f. Average marine bunker prices ($/tonne) for fuel oil and diesel oil for the 1995-08 period.

It is clear from the bunker price chart that volatility is also noted in this sector, thereby highlighting the importance of using appropriate unit cost levels in any transport analysis, rather than simply using a figure from a specific time in the past.

The graphs showing the development of average charter rates and bunker prices serve to highlight the volatility inherent in these sectors, as well as providing a guide to the range of costs witnessed in these sectors in recent years.

Included are indications of typical vessel specifications (maximum length, draught, beam) associated with size categories of the different vessel types of relevance, as well as a guide to typical fuel consumption levels for these vessel categories. This information can easily be used to derive estimates on comparative shipping costs for any specific route. The information is presented in tabular form, and comprises :

a. Typical vessel specifications (maximum vessel length, draught, beam) for a variety of ship sizes within the main vessel type categories
b. Typical rates of daily fuel consumption for a variety of ship sizes within the main vessel type categories.

8.4.3 Data sources

The data has been compiled using a number of sources, cross-referenced where possible.

These include :

- Port Authorities (websites, publications, direct contacts)
- Eurostat database
- OSC database
- Industry contacts
- Published vessel port calls information
- Shipping company websites
- Shipyard websites
- Ship-brokers (for charter rate information).

8.4.4 Potential applications / limitations

The model and information has been compiled and formulated to maximise its potential use. There are several key areas of potential application, including :

- To examine the impact of higher trade volumes on the number of vessel calls (and distribution) at European ports
- To determine the viability of transport alternatives
- To determine the relative competitiveness of specific ports to handle certain cargo on certain routes
- To determine the extent to which transmodal shifts (e.g. from road to sea) can be effected
- To examine the impact of changing ship sizes on port volumes and competitiveness
- To examine the potential for specific ports to become regional distribution centres
- To examine the potential impact of new port development in the region
- It represents an invaluable tool for traffic modelling and impact studies.

In terms of the limitations applicable to its use, there are several key considerations :

- The model can only reflect the quality of the data included – it is important to input only reliable information for use
- Given the volatility witnessed in shipping markets, the usefulness of the

model is time-specific and is very dependent on the appropriate data being input (especially for vessel charter costs, fuel prices) for modelling purposes

- The information requires regular updating – most especially in terms of port activity and port facilities
- Updating is also required in terms of the relevant ship size profiles for individual trade routes.

9 Integration with TRANSTOOLS

WORLDNET was conceived with the objective of expanding and improving the European Commission's transport model, TRANSTOOLS. In particular, the project has focused upon updating the freight components, extending them geographically and adding detail. During the course of WORLDNET several projects have been contributing to the development of TRANSTOOLS, and in December 2008 and official new release has been made, the Version 2, developed by TEN-Connect.

With the new TRANSTOOLS model in place, the next challenge is to merge the WORLDNET deliverables, designed for the original model specification into the new model.

A related issue involves the calibration of the WORLDNET data. During the matrix estimation, it has been necessary to calibrate the estimated transport volumes, by country and by mode. A traffic assignment step has been required to produce a set of results that can be compared to published data. One of the unknown factors has been whether the WORLDNET assignment methods, using the NEAC model would be a suitable test-bed, since ultimately the production runs need to be made with the assignment routines built into TRANSTOOLS.

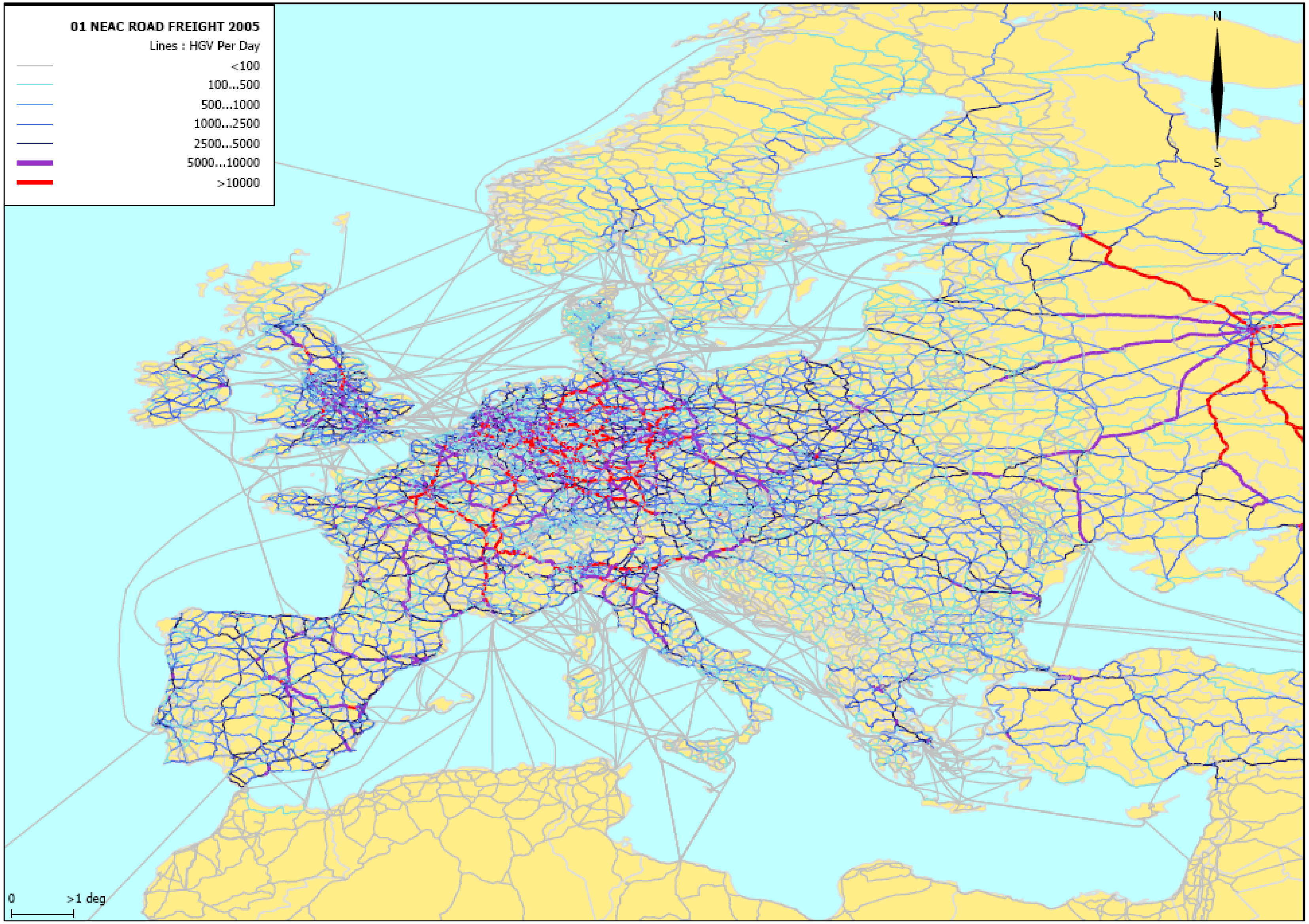
The uncertainty arises due to differences in the assignment method. The NEAC approach is designed to be fast and repeatable, i.e. identical starting conditions should always produce the same outputs. Only freight flows are assigned, no congestion is taken into consideration, and each network node is a loading point. In TRANSTOOLS, both freight and passenger traffic are assigned, and a stochastic approach is used, requiring iteration, and underlying differences exist, for example, in the parameters used for the cost functions and the choice algorithms.

One method of reducing the risk that the WORLDNET data calibration might not replicate conditions in TRANSTOOLS, has been to refer to an additional traffic assignment model which has been optimised for European networks. For this, the VACLAV model has been selected. However, there has been a draw-back since the WORLDNET and VACLAV network models are not the same, and that there are some differences in the way that intra-zonal trips (which constitute a realtively high share) are treated.

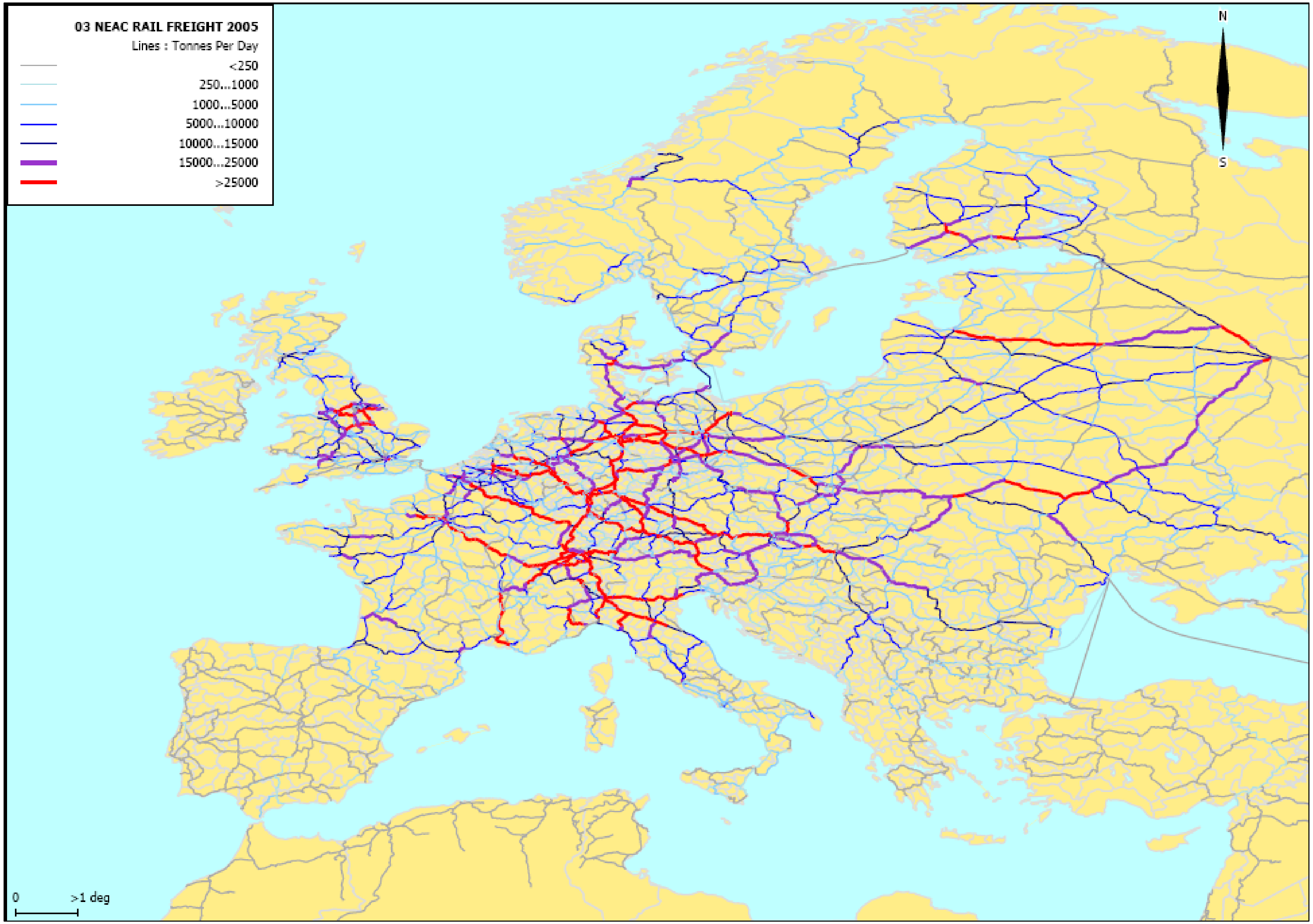
Therefore, three sets of traffic assignment for road and rail have been attempted, using:

- NEAC (internal matrix testing by NEA)
- VACLAV (auditing the NEAC results by IWW), and
- TRANSTOOLS (production run by RAPIDIS).

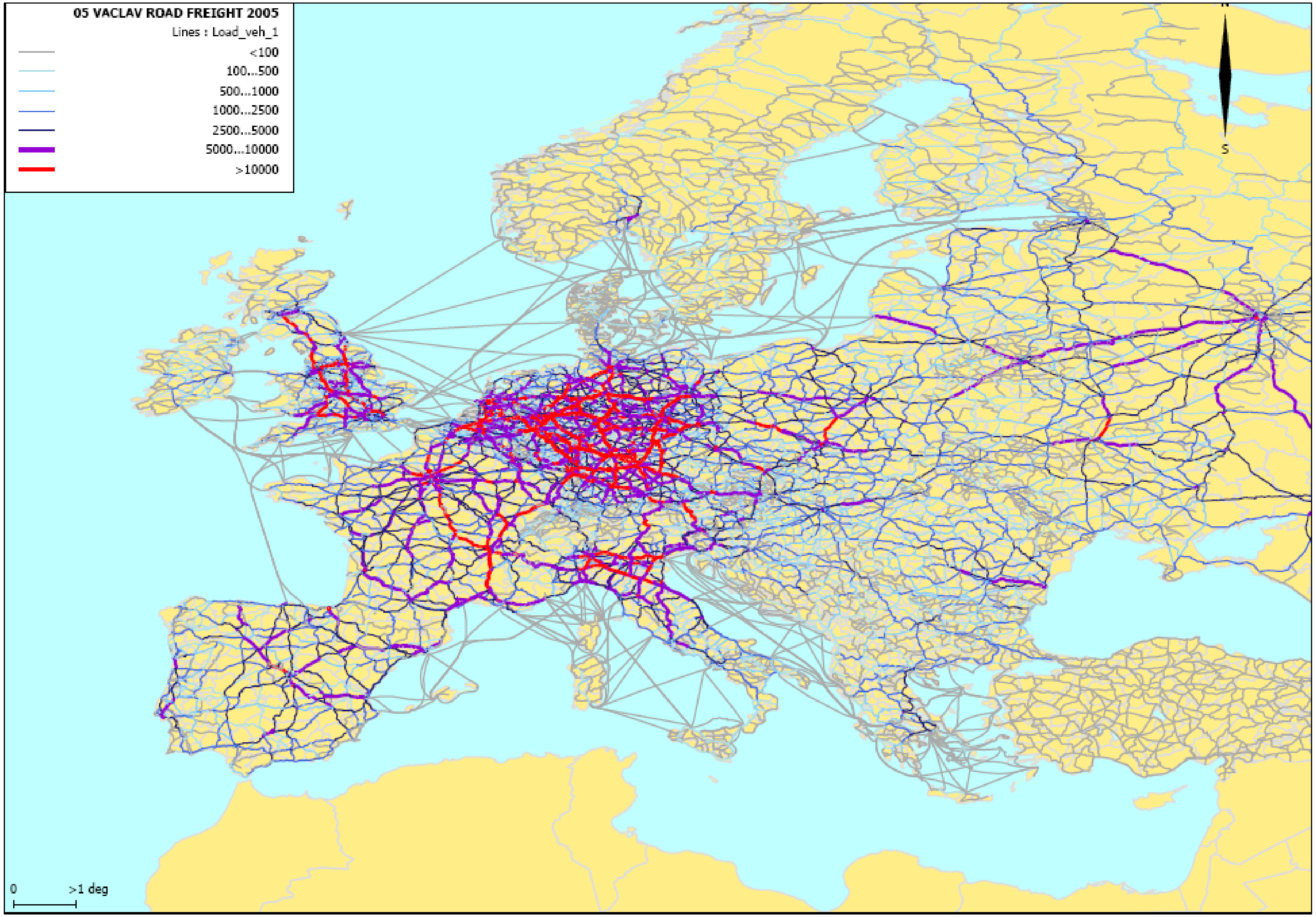
9.1 NEAC Results: Road Freight



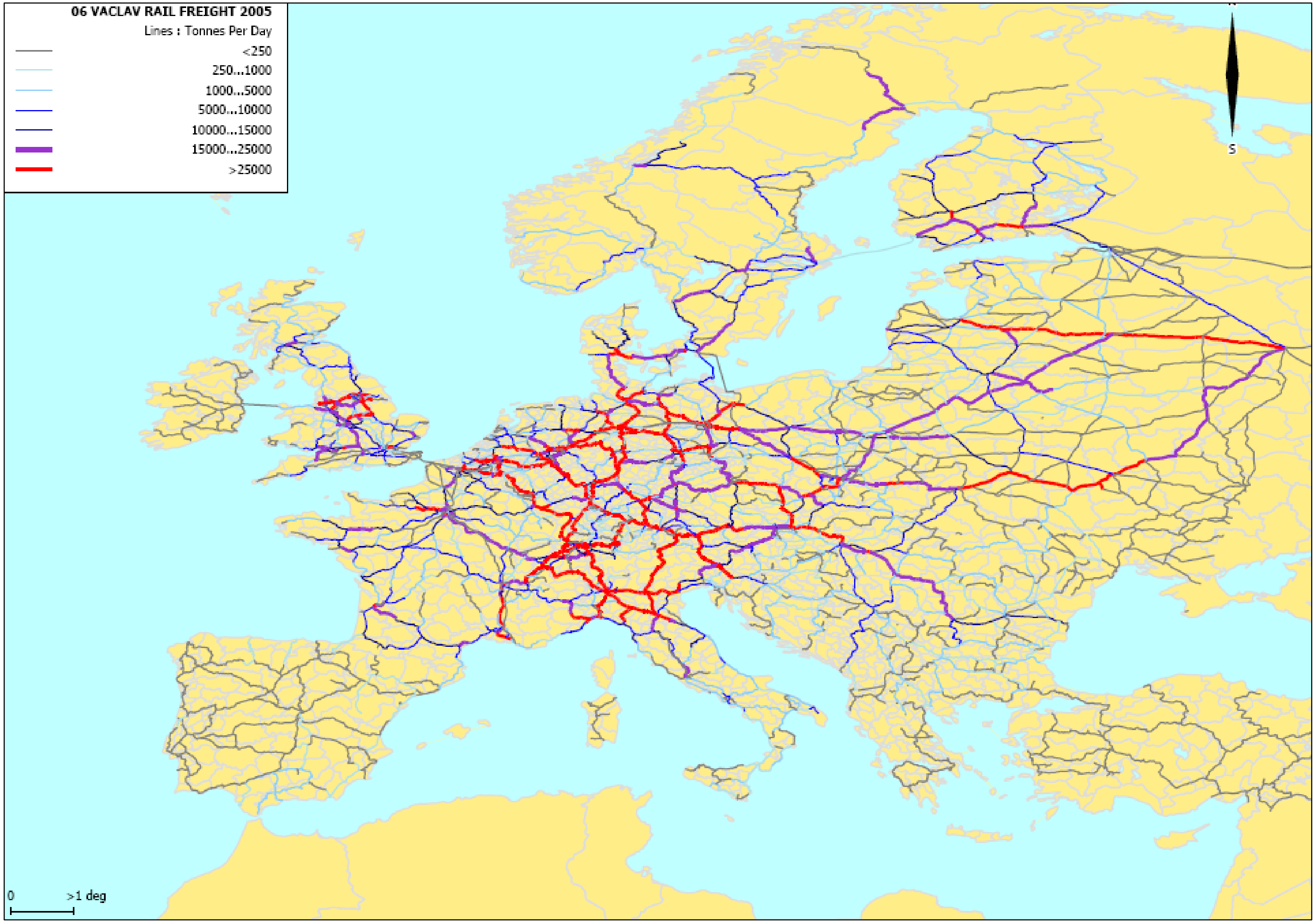
9.2 NEAC Results: Rail Freight

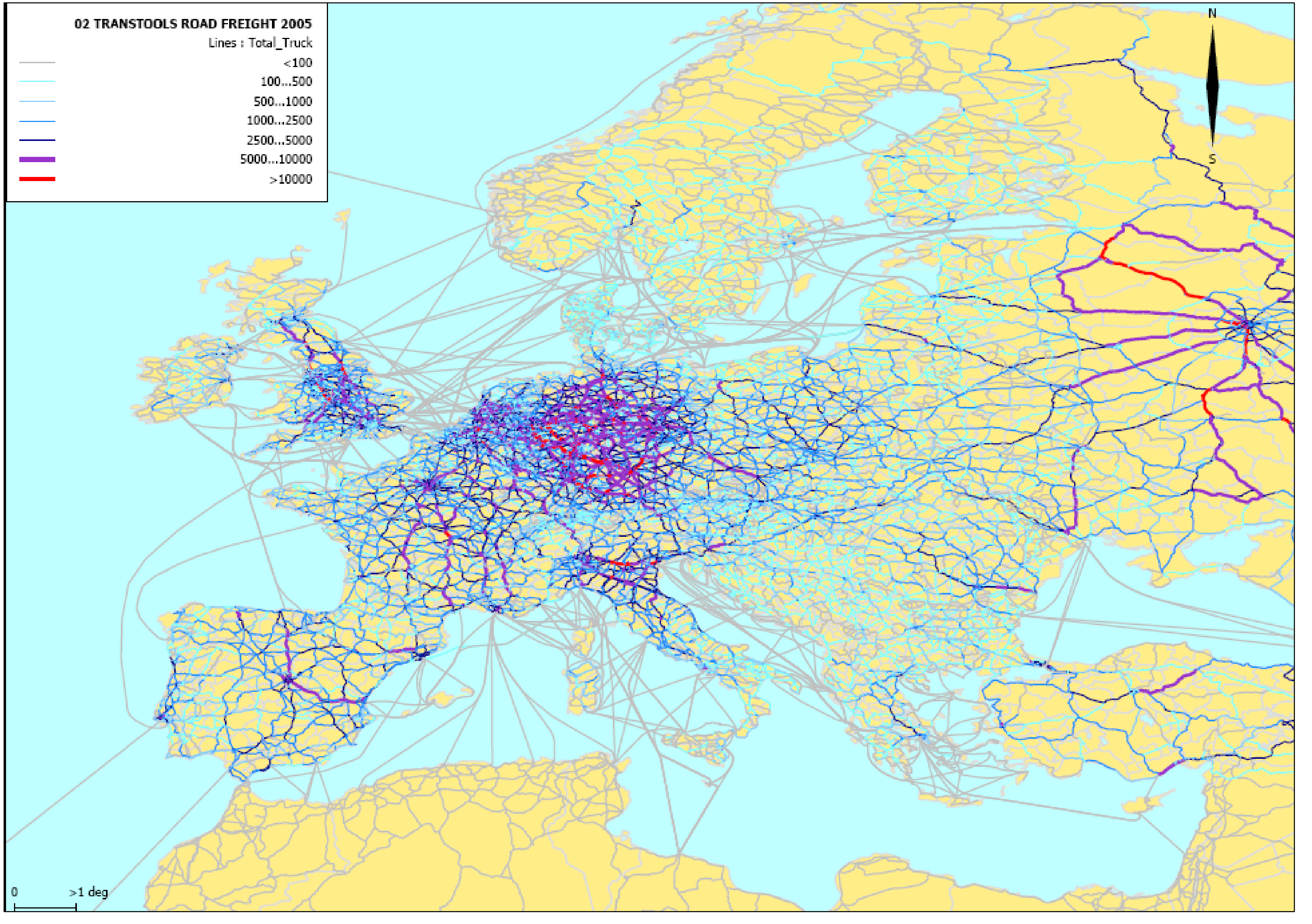


9.3 VACLAV Results: Road Freight



9.4 VACLAV Results: Rail Freight




02 TRANSTOOLS ROAD FREIGHT 2005
Lines : Total_Truck
<100
100...500
500...1000
1000...2500
2500...5000
5000...10000
>10000
N
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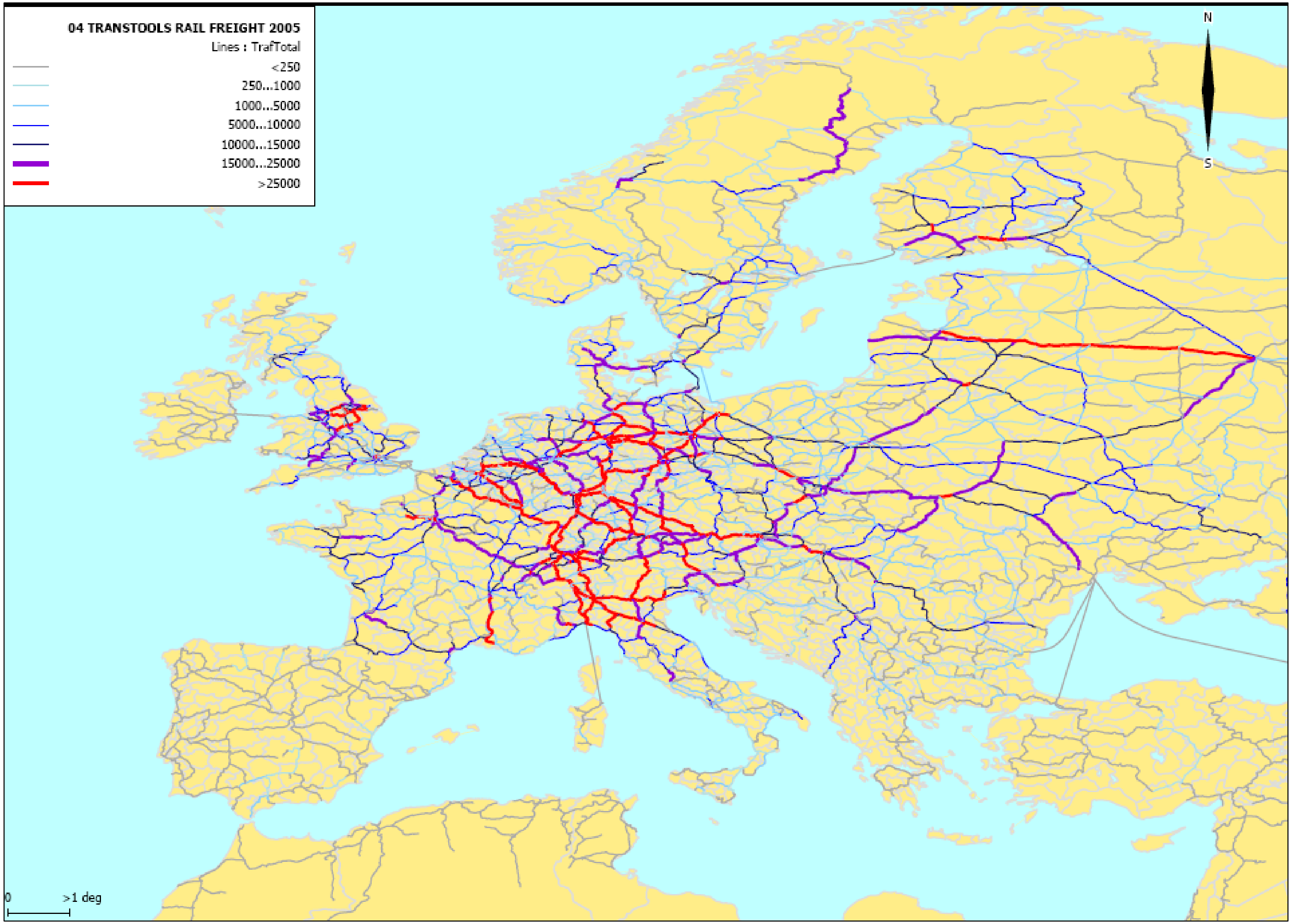
9.6 TRANSTOOLS Results: Rail Freight



9.7 Observations

These maps indicate that despite significant differences in the different modelling techniques, the results are broadly equivalent, and therefore that the systems developed for WORLDNET are capable of estimating calibrated matrices for TRANSTOOLS without the need for adjustments arising from the differences in the assignment method,

All the assignment maps have been built using the February 2009 (version 6) of the WORLDNET O/D matrix (D7), as described in this document. The mode chain structures have been converted into modal O/D matrices, and the annual tonnages have been converted into daily HGVs (for road) and daily tonnes (for rail freight). Differences in the estimation of average HGV loads have been adjusted for in the maps above. In all cases, NUTS3 is the basis for the zoning in the assignments, and no artifical disaggregation is needed.

The modal O/D data has been prepared by NEA for the base year 2005. The TRANSTOOLS trade, mode split and logistics modules are not required for this. Data for assignment has been sent to RAPIDIS/DTU (DK) for testing and running within TRANSTOOLS. The zoning has been checked and compared against TRANSTOOLS. Zoning changes have been coordinated between projects, so no problems have emerged here.

The WORLDNET road and rail freight networks have also been set up for use within TRANSTOOLS. WORLDNET has taken care within WP4 and WP5 to build the networks to the same specification as the final TEN-Connect networks, and to incorporate all the changes produced by that project. This transition from TEN-Connect to WORLDNET to TRANSTOOLS has been reported as a success.

Finally, the WORLDNET data has been assigned to the WORLDNET networks using TRANSTOOLS (without modification). The results have been returned to the WORLDNET consortium by RAPIDIS/DTU using the MS-Access based storage medium adopted by TRANSTOOLS.

9.8 Use of WORLDNET data within TRANSTOOLS

In future, two options for integrating WORLDNET into TRANSTOOLS seem possible. Currently there are obstacles to be overcome within the mode split and logistics modules before NUTS3 zoning can be used throughout the freight model. Therefore to make use of these model stages, the WORLDNET data can be aggregated to NUTS2 zoning, and used as a replacement for older equivalents. During aggregation, some important details are lost, and the NUTS2 to NUTS3 splitting can only partially replace this.

An alternative approach could be based on the methodology followed here. The WORLDNET O/D NUTS3 data can be combined with the TEN-Connect trade model (CAU) and with an updated mode split model to produce NUTS3 matrices directly for assignment within the normal TRANSTOOLS mechanism, avoiding therefore the components which are not yet properly integrated.

Attention is also focused here upon the satisfactory calibration of the base year O/D matrix which defined the mode split in the base year. By combining the WORLDNET trade and transport data with the new maritime database of demand and supply in the European ports sector, additional accuracy is now possible. By correctly registering the flows at the European seaports, the orientation of the transport chains within the database is likely to improve. Furthermore, since a high proportion of both rail and inland waterway freight is port related, this also aids the estimation of traffic within those modes.

As part of the data dissemination process, these additional calibration steps will be undertaken.

A by-product of these comparisons has been the question concerning the translation of tonnages into vehicle loads for traffic assignment, and area which may have been somewhat overlooked within TRANSTOOLS, and an area which is (a) relevant for policies such as adoption of mega-trucks, and (b) an important link between the estimation of goods flows and the estimation of vehicle flows and the externalities arising from them.

During ETIS, a formula was adopted linking vehicle choice to commodity type and trip length. It would be advisable to include a formal tonnes to vehicles conversion before traffic assignment, based on similar criteria.

The traffic assignments also indicate a further possible flaw related to the balance of zone size (and trip generation) and network density. With Russia now added to the model, there is a highly visible contrast with Germany. Large differences are to be expected, but it is difficult to compare the results given that several Russian regions are as large as many Western countries, but contain only one or two network links.

Beyond the short term it is also evident that further extensions of TRANSTOOLS can be made as a result of WORLDNET, in relation to maritime and air cargo, but these outputs cannot be modelled under current setups.

10 Dissemination via the Internet

Work package 6, **Exploitation and Dissemination**, has two main objectives:

- To disseminate and exploit the project results through publications, presentations at scientific conferences and other events and through the conferences organised in this project;
- To develop and maintain a WORLDNET internet site during the project, which will be part of the dissemination. This web site includes the development of web tools for (network) data visualization and editing.

The main deliverable of WP6 is the active web site at www.worldnetproject.eu and the web tools in it.

This section summarizes the dissemination web tools and in particular, the user manual of the WorldNetter on-line GIS application for visualizing and editing of the TRANSTOOLS network data collected in the project. This section provides an introduction to WorldNetter and the terminology used in 9.1, describes the basics of the WorldNetter user interface in 9.2, explains the visualizations options in WorldNetter in 9.3 and the network editing options of WorldNetter in 9.4.

10.1 Getting Started

10.1.1 What is the WorldNetter?

The WorldNetter is a web based software tool that allows for viewing and editing of network related data on the internet. It is an on-line GIS that can be used by a community of users for network editing. It could be described as a network Wiki. Within WORLDNET the WorldNetter is to gather, update, validate and complete network related TRANSTOOLS data.

For understanding the user guide, it is imperative that the terminology such as described in the frame below is well understood:

Frequently used terminology
Network objects: the collection of objects of the type network links, nodes and (link) points.
Network link: a segment in the (road or other) network, that connects two nodes. The trajectory of the link is defined by the network points that form the network link. The network link can be of the type rail, road or ferry and has a great number of attributes.
Network node: a point where two or more network links meet. The network node is related to the type of network links it connects.
Network (link) point: a point on a network link that determines its trajectory but has no additional attributes.

Attribute: a characteristic of a network link or node. Attributes are dependent on the type of the object; for instance rail and road links have different attributes (see Annexes A and B of the Worldnet D10 report).

Trajectory: the exact path that a network link follows, which is determined by the placement of the network link points.

10.1.2 Starting up WorldNetter

To run the WorldNetter tool you need to have a PC that has:

- A web browser installed
- Macromedia Flash player 9 or better installed
- A fast internet connection (ADSL or better).

If you do not have Flash installed, you can go to the WorldNetter web address, where a message will appear automatically that asks if you want the required plug-in (Flash) to be installed. Click yes here and Flash will be installed and run automatically within a matter of seconds. Depending on your specific settings you may have to give a few additional confirmations.

There are currently two WorldNetter versions: the live version and the test version. These must be approached by the following URLs respectively:

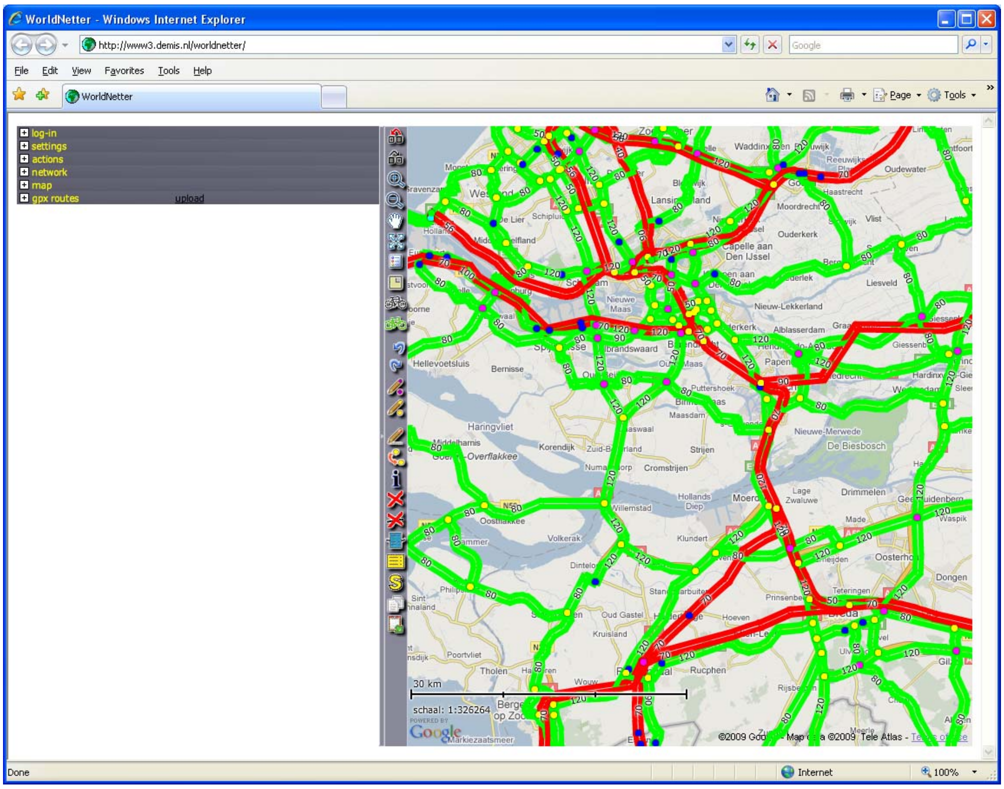
Live version: http://www3.demis.nl/worldnetter/
Test version: http://www3.demis.nl/worldnettertest/.

After having entered the URL, you will be asked for a username and a password. This information has been distributed to you separately by NEA. After entering your username and password you will need to click on the log-in link for logging in. Once you have logged in, the navigation tree becomes visible with options for showing and manipulating the (objects in the) map. To be able to view network nodes and links, you must first zoom in to the appropriate level in the map by using the scroll wheel on your mouse. This is described in more detail in paragraphs 10.2.3 and 10.2.4.

10.2 Basic WorldNetter User Interface Concepts

WorldNetter consists of a Navigation Tree (left), a vertical Toolbar (centre) and a Map client area (right). These areas are side by side as can be seen in the screenshot in **Fout! Verwijzingsbron niet gevonden.**.

Figure 94 WorldNetter with the navigation tree collapsed



10.2.1 Navigation tree

The navigation tree is used for:

Log-in To log in or out as a user. It requires you to enter a user name (usually an e-mail address) and a password. If you have no user name or password please contact worldnet@nea.nl.

Settings To change application settings such as for example the scale when you are allowed to edit or see the network, you can activate the map cursor position, activate mouse tooltips, store the current configuration for later use or store the current map extent for later use.

Actions To define which actions are active for the keyboard shortcuts or the mouse.

Network To set visualization options for the network node and links. Here you can set for either links or nodes the color appearance, the size appearance, the text appearance and the visibility options.

Map To select which map (layers) to show in the map client area. In WorldNetter currently the Google Map background is used so no selection of map layers is possible.

GPX Routes To allow uploading and visualization of GPX routes. This option is not used in WorldNetter.

A more detailed description of the navigation tree and its practical use can be found in chapter 10.3 for the visualizations options in WorldNetter and chapter 10.4 which describes the network editing options of WorldNetter.

10.2.2 Vertical toolbar

The vertical toolbar is used to access functions directly. This is provided as an alternative to the Actions \ Mouse menu in the navigation tree. The actions supported in WorldNetter are shown in Figure 95.

Figure 95: WorldNetter toolbar options

- Zoom to the previous map view (if available)
- Zoom to the next map view (if available)
- Zoom in (not used in WorldNetter)
- Zoom out (not used in WorldNetter)
- Move the map
- Show full map
- Show or hide the map layer legend
- Show or hide the overview map
- Not used in WorldNetter
- Not used in WorldNetter
- Undo last action (if available)
- Redo last action (if available)
- Add point (for a trajectory)
- Add node
- Add link
- Move a node or point
- Show information on the selected node or link
- Remove a node or point or link
- Remove a node or point or link and join remaining network items
- Link properties table (for editing the attributes)
- Node properties table (for editing the attributes)
- Set same value to one object after another
- Copy
- Paste

10.2.3 Working with settings

After logging in, the navigation tree will show a number of extendable nodes that contain a great number of options. Specifically the scale settings contained within the settings node are important for visualization of network data in the map client area.

These are represented by the following scale bars:

- **Visible from…**: this allows changing the visibility of the network at a certain view level. The default setting is 1:400000. By zooming in to the appropriate level in the map area by using the mouse wheel, the network will become visible. Should the user wish to adjust the level of visibility, it can be set here;
- **Edit mode from…**: this allows changing the level at which the network can be edited, which is set by default to 1:50000. When editing large network links or wanting to be able to view a larger area when editing, the edit mode can be adjusted to the desired level.

Adjusting the scale settings may be used to visualize and edit network nodes and links at a higher level. The user should be aware however that this may significantly reduce the speed of the visualization. The zoom in and out option alternatively could be used to set the appropriate level in the map client area.

10.2.4 Map client area

The map client area is where the real work is done. What you see in the map client area depends on:

1. The current scale of the map. The network remains invisible as long as the scale shown in map client area (bottom left) is less than the “visible from” value in the Settings \ Scale \ navigation tree item. To solve this you can either change the “visible form” value or zoom-in.
2. The visibility options set in the navigation tree under network for links and for nodes. Here you can completely hide or show all links and all nodes, but you can also have specific links or node visible through the visible appearance options in the navigation tree.
3. The map that is selected under the map menu. This currently is not activated in WorldNetter.

What happens in the map area depends on the action(s) you have selected via mouse, keyboard or toolbar. The action that is selected from either the actions menu of the navigation tree or in the toolbar is connected: selecting an option in the toolbar will highlight the mouse action in the navigation tree and vice versa. Some actions will have an immediate effect, such as moving the map or undoing / redoing specific actions (these are mostly keyboard actions). Other actions merely set the stage for performing actions, such as edit actions, which are primarily mouse actions.

When moving over the map and specific objects on the map, the tooltip will show the current action that is available. This will also be shown in the action menu: the available options are shown in black text for the short cut keys and for the current action the explanatory text is shown in black.

Figure 96, Figure 97 and Figure 98 show an example of this mechanism:

- When for instance the move option is selected from the toolbar, three options become available: P (add point), M (move) and O (move map);

- Depending on the object you are hovering over, the relevant option is highlighted in the navigation actions menu: move map when you are not over a network node or link, move when you are over a node and add point when you are over a link;
- In the case that the action relates to a specific object (node or link), this object is highlighted in the map area.

Figure 96: Move map

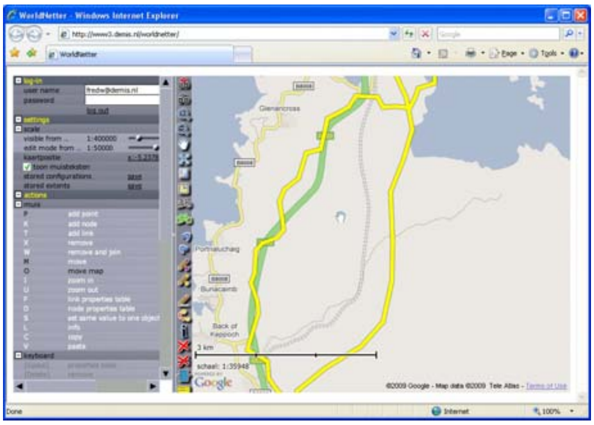


Figure 97: Move point

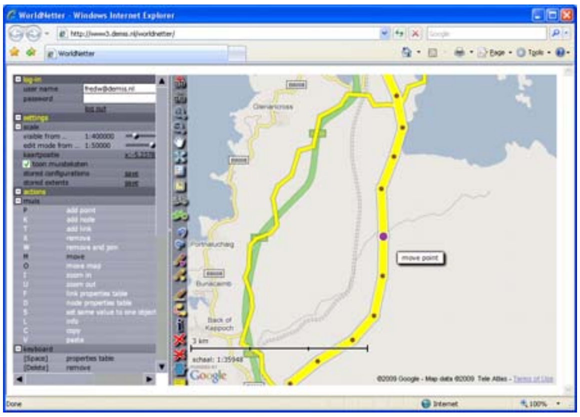
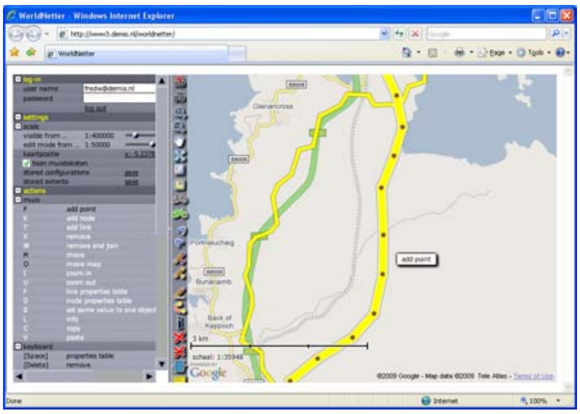


Figure 98: Add point



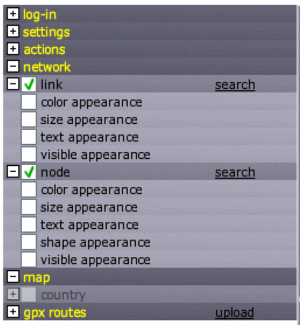
10.3 Visualization Options in WorldNetter

The first important step in working with the WorldNetter is to be able to visualize and navigate through the network data. The visualization of network links and nodes can be set separately in WorldNetter. Both settings are available under the network menu item in the navigation tree and will be described subsequently.

10.3.1 Visualization of network links

Visualization of network links can be organized by using the appearance options of color, size, text or link visibility as shown in Figure 99. The selection of a specific attribute is limited to a set of attributes for which the appearance option is deemed useful. Annex A of the Worldnet D10 report shows a full list of link attributes and the availability for appearance options. For instance ‘road type’ is available for the color appearance, but not for size appearance for which it would be less distinctive. The links in the map area are only shown when the link check box is selected. If no specific appearance is selected, all links are shown without distinction.

Figure 99: Selection of network link or node appearance



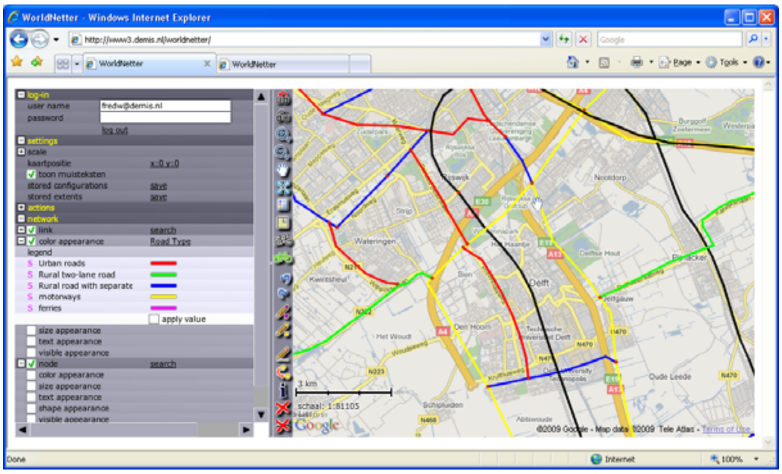
When selecting a specific appearance, a legend is shown containing the values of the property of the network link. Any (one) property can be selected and a legend is automatically constructed based on the available values. This can vary from a simple yes / no value to a list of predefined values such as road numbers.

Color appearance

When selecting the color appearance, automatically the last selected link property that was used is shown here. In Figure 100 the road type is shown as a useful example of applying the color appearance on a property. When links are drawn in black, the selected property of the link has not been given a value. In the case of the road type, this may be caused by the fact that the link concerns a rail link or that it concerns a road link that has not been assigned a road type value.

When selecting a specific appearance, also the *‘apply value’* box becomes visible. This allows for assigning a specific value to the links by selecting them. This is a specific edit action, which will be described more elaborately in chapter 9.4.

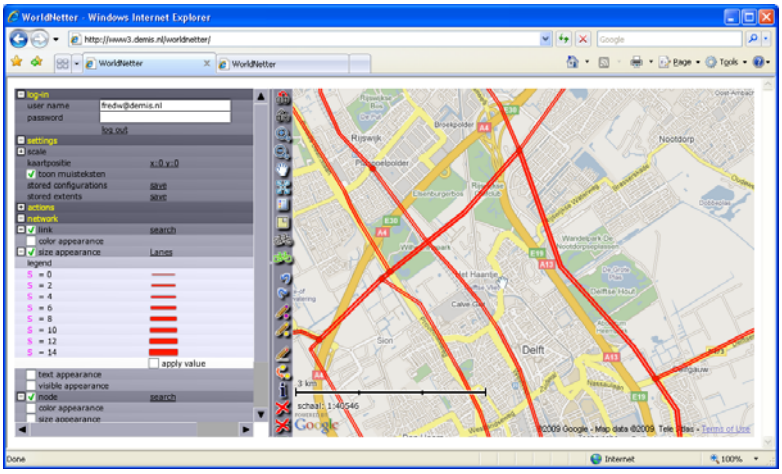
Figure 100: Road type displayed by color



Size appearance

The size appearance can be assigned similar to the color appearance, where a quantifiable property is displayed by the size of the link. This is quite useful for properties such as capacity or other link property that signifies a value within a certain range. In Figure 101 the number of lanes is selected as property for the size appearance.

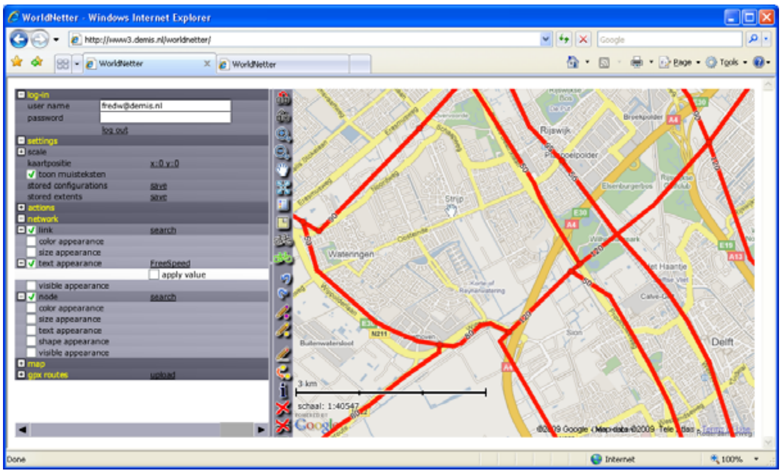
Figure 101: Number of lanes displayed by size



Text appearance

The text appearance can be assigned similar to the color or size appearance, where the value of the property is shown as text on the link itself. Since this is a free form field, there are few limitations to the properties that can be shown this way. The text itself is less distinctive in presentation than the color or size appearance, but may well be used in addition to the before mentioned appearances. In Figure 102 an example of the free flow speed is shown.

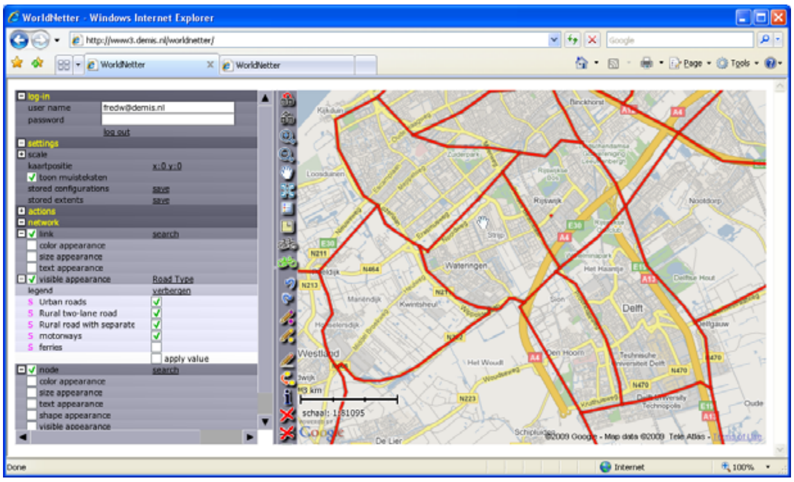
Figure 102: Free flow speed displayed as text



Visibility of links

The visible appearance is a means of restricting the visibility of links when not conforming to a specific property value. For a specific property, the full list of values is shown with a check box that determines the visibility of links with that value. Also the *'hide all'* option is available to hide all links that have a value for this property. This may be useful when making a selection of all road types, where rail and ferry types should be hidden, as shown in Figure 103.

Figure 103: Road types visibly displayed



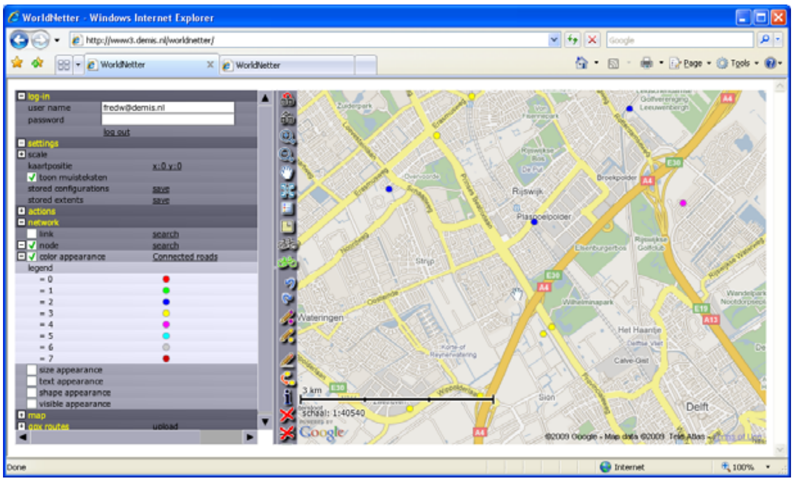
10.3.2 Visualization of network nodes

Similar to visualizing the network links, the network nodes can be organized by way of a specific appearance selection. In addition to the appearances that are available for the network links, also the shape appearance is available for network nodes.

Appearances also occuring in links

The same basic principles are applicable to the nodes as to the network links. The color, size, text and visibility appearance are similar to the link appearances. In Figure 104 an example is shown of the color appearance for the number of connected roads to the node.

Figure 104: Number of connected roads for nodes



Shape appearance

The shape appearance is an appearance specifically applied to network nodes. In the current version of the WorldNetter network the shape appearance has no significant added value, since most nodes are road related and non-specific. If the network however contained various types of nodes, such as road / rail nodes, airports, train stations and so on, the differences in shape appearance could be quite useful.

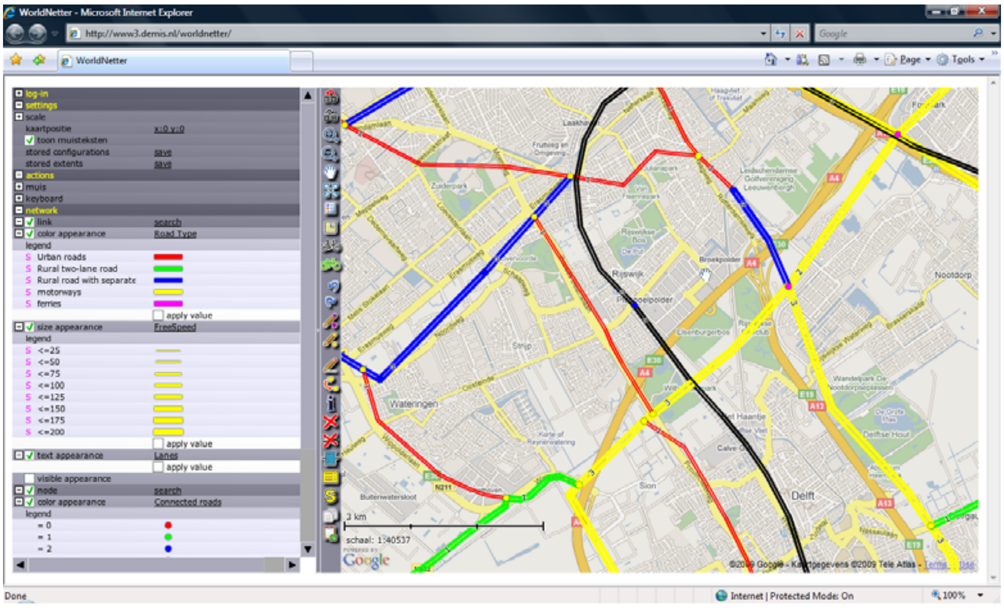
10.3.3 Combinations of link and node visualizations

Showing a single property of the network node or link is usually too limited for the user's purpose. WorldNetter specifically supports showing multiple network properties that can be chosen by the user. Below two examples are given to demonstrate this feature.

Example 1: Combination of road property appearances
When combining some appearances mentioned in paragraph 10.3.1 and using a few additional ones, the overview of Figure 105 is acquired. On the left in the navigation tree the specific appearance selections are shown, combining:

- Link color appearance: road type (black links are non-road links)
- Link size appearance: free speed (free flow speed of lane)
- Link text appearance: lanes (the number of lanes in a single direction)
- Node color appearance: connected roads (number of connections).

Figure 105: Combination of road properties

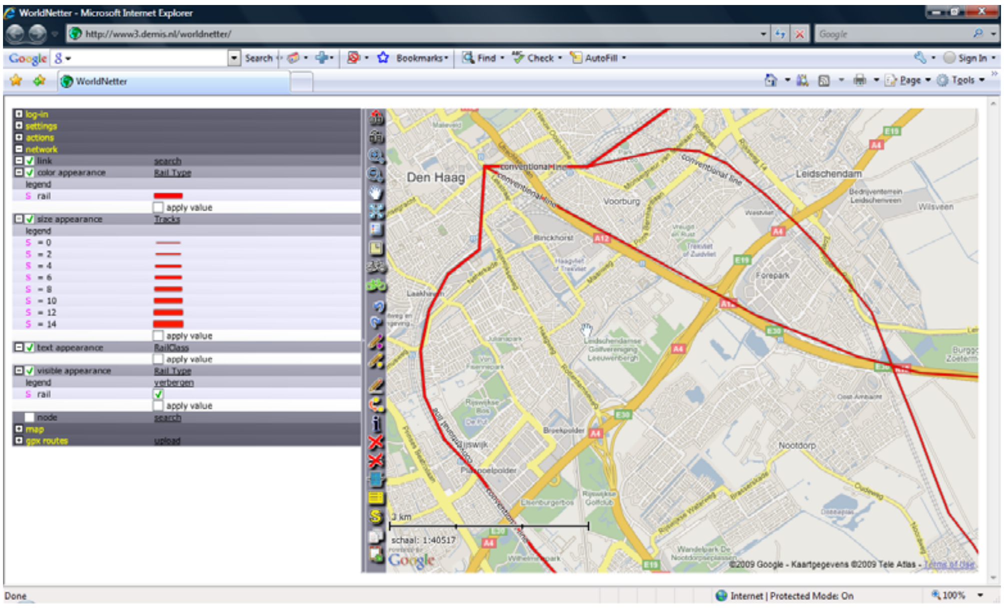


Example 2: Rail related link appearances

WorldNetter contains rail related data as well, although this may not be as detailed and complete as the road data. In Figure 106 a few rail related features are shown, that combine the following settings in the navigation menu:

- Link color appearance: Rail type (here only presented as *"rail"*)
- Link size appearance: Tracks (number of tracks)
- Text appearance: RailClass (class of rail line)
- Link visible appearance: Rail type, because of which only rail is shown
- Node appearances are not turned on (node check box is not checked), so these are not shown at all.

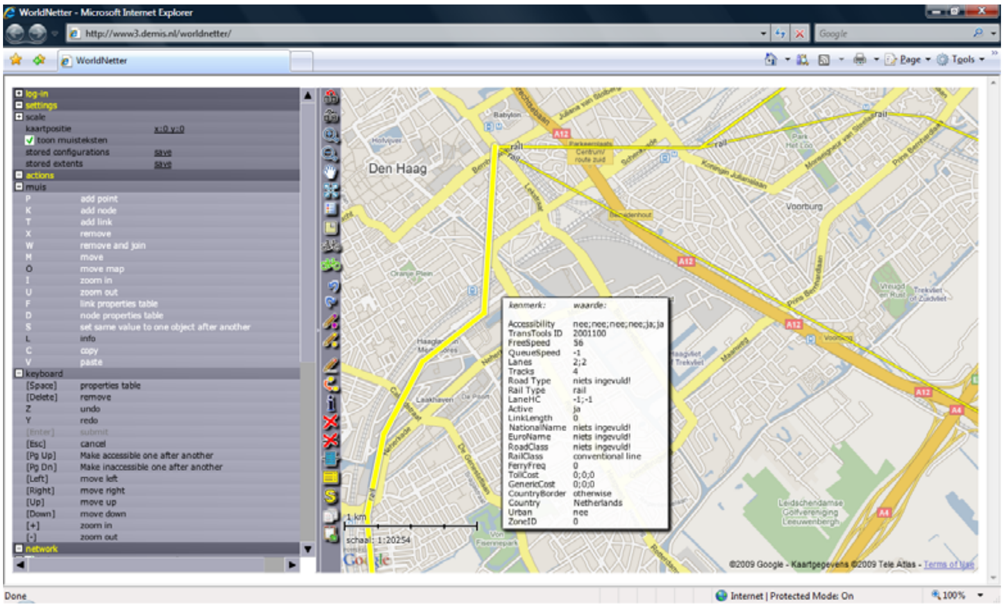
Figure 106: Combination of rail related properties



10.3.4 Showing attributes of a single network link or node

Using the appearance selections in the previous paragraphs basically enables showing one (or more) properties of all visible links or nodes. It may also be required to show or edit all attributes of a single link or node. When hovering for a second over a specific link or node in the map area there will be two effects: the link or node is highlighted and the full list of link or node attributes automatically pops up. This gives an immediate overview of the attribute values of the specific link or node. Figure 107 illustrates the principle. Changing the values of attributes for a specific link or node is described in paragraph 10.4.2.

Figure 107: Showing all attributes of a specific object (link or node)



10.3.5 Navigating with the WorldNetter

In the actions menu, several mouse and keyboard options are available for navigating the map. The specific actions are also supported in the toolbar and can be activated by selecting the option either way. Although most of these actions are intuitive, they are described here for purpose of completeness.

Figure 108: Navigation related toolbar options

Zoom to the previous map view (if available)
Zoom to the next map view (if available)
Zoom in
Zoom out
Move the map
Show full map

Figure 108 shows the following actions as they occur in the vertical toolbar:

- Zoom to the previous map view (if available): the map views the user creates are stored in memory, allowing to return to a previous zoom.
- Zoom to the next map view (if available): as above.
- Zoom in: this option (in the form of drawing a window to zoom in to) is not available when the Google maps overlay is shown. It is however also available in the scroll wheel of the mouse by scrolling up.
- Zoom out: this option (in the form of drawing a window to zoom out of) is not available when the Google maps overlay is shown. It is however also available in the scroll wheel of the mouse by scrolling down.
- Move the map: this is the default setting: grabbing the map and moving it in the desired direction will move the map and redraw the attributes.
- Show full map: in the case that the full world map needs to be shown, this option allows the full zoom. It can also be a remedy in the case the undesirable effect of a locked map occurs (where the user is unable to move the map).

10.4 Network Editing Options in WorldNetter

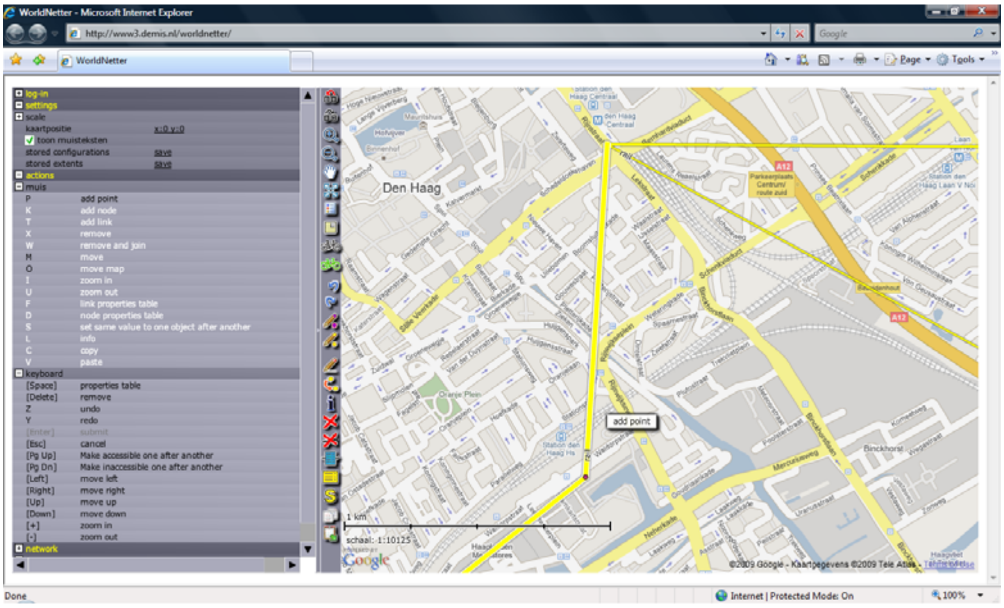
This chapter discusses the various actions that can be applied when editing network objects (links and nodes) or their attributes. First the available actions at any given moment are explained. Next the various editing actions are described: editing network attributes, editing the network topology and editing the link trajectory.

10.4.1 Specifying which edit action(s) are active

When moving the mouse over the map area, the actions that can be applied at that moment will change depending on the network object (if any) over which the mouse is hovering, as was briefly addressed in paragraph 10.2.4. The action(s) that is (are) available, are always the most logical ones given the selection of a specific functionality. When an edit function is selected, the most logical function is suggested when hovering over an object, which may not be the selected function. The active action is always shown in black text, such as *'add point'* in Figure 109. For example:

- When *'add point'* is selected, this generally creates a new (link) point when clicking on a link. When hovering over a point or node, instead the function *'move point'* or *'move node'* is available. When not hovering over any object, the default function *'move map'* becomes available;
- Instead of the *'add point'*, also *'move point'* or *'move node'* may be selected from the toolbar. It has the same effect on available functions;
- The *'remove'* action is more generic: it can be applied to each object that may be removed.

Figure 109: Options (in left navigation menu) when the mouse is over a link



10.4.2 Editing network attributes

There are three functions to edit the attributes of a network link or node, depending on the type of change you want to apply (see toolbar options in Figure 110):

- Using the properties table to edit one or more attributes of a specific network object (link or node): this allows for the user to open a table with all attributes of a specific object and edit any attribute presented there
- Set same value to one object after another: this allows assigning the same value for a specific attribute to any object that is subsequently selected
- Copy and paste all values of an object: use the copy and paste functionality to copy all values of one object to another.

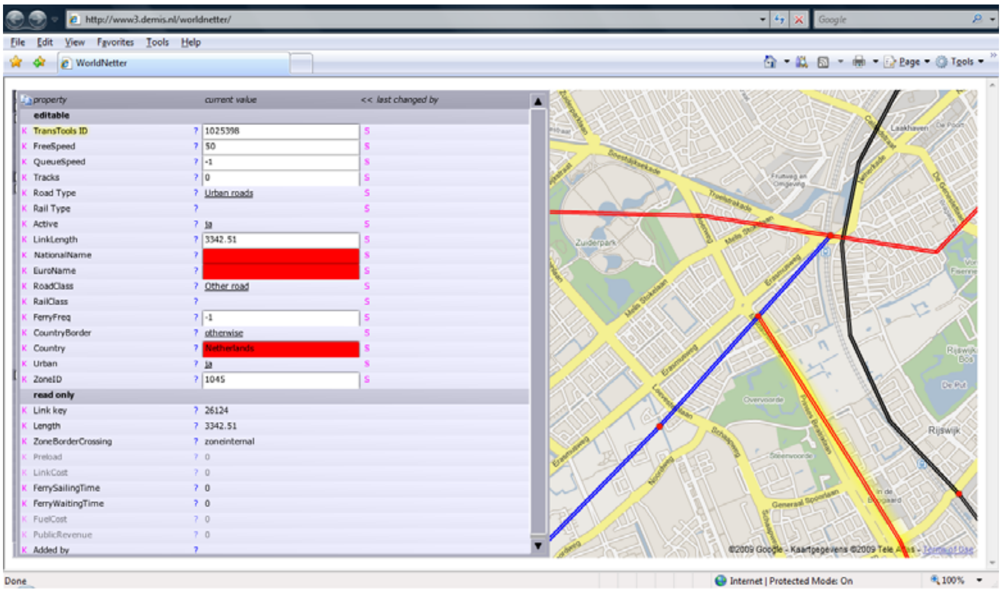
Figure 110: Options for editing network attributes

	Link properties table (for editing the attributes)
	Node properties table (for editing the attributes)
	Set same value to one object after another
	Copy
	Paste

Using the properties table

To edit one or more attributes of a specific network link or node, the option for editing attributes through the properties table can be selected. This allows for the user to open a table with all attributes of a specific object and edit any attribute presented here. The network link attributes table is shown in Figure 111.

Figure 111: Edit link attributes through the link properties table



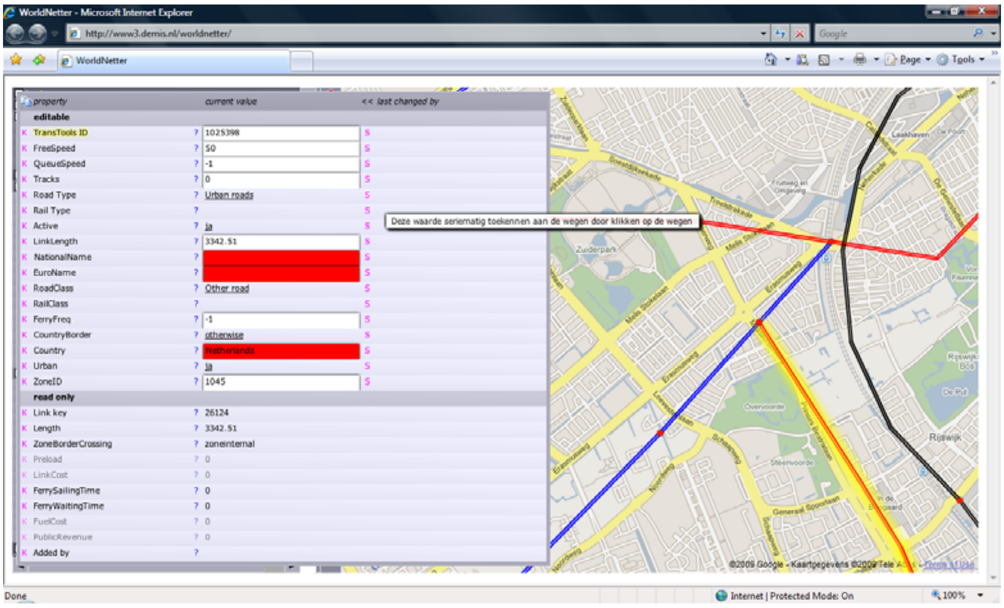
Although this allows the user to edit all attributes, it is not the most practical way to modify values. This is either done by assigning values for one attribute at a time to one (but usually more) objects or by copying and pasting all attribute values from one object to another, which is demonstrated next.

Set same value to multiple objects

The option to *'Set the same value to one object after another'* allows assigning the same value for a specific attribute to any object that is subsequently selected as follows:

- Select the attribute and value in the properties table as shown in Figure 112. Clicking the "S" next to the attribute value allows the use for other objects; the property table will automatically close;
- Alternatively, the "S" is available in the navigation when a certain appearance is active: selecting the "S" shown before a legend value will check the 'apply value' box with the indicated value set to be applied;
- Select any node or link you wish to assign the value to for the chosen attribute. A tooltip will show the effect of the action when hovering over an object of the right type. Having selected a link attribute and hovering over a node will only result in a notice that no action can be taken.

Figure 112: Preparations for assigning values to subsequent objects

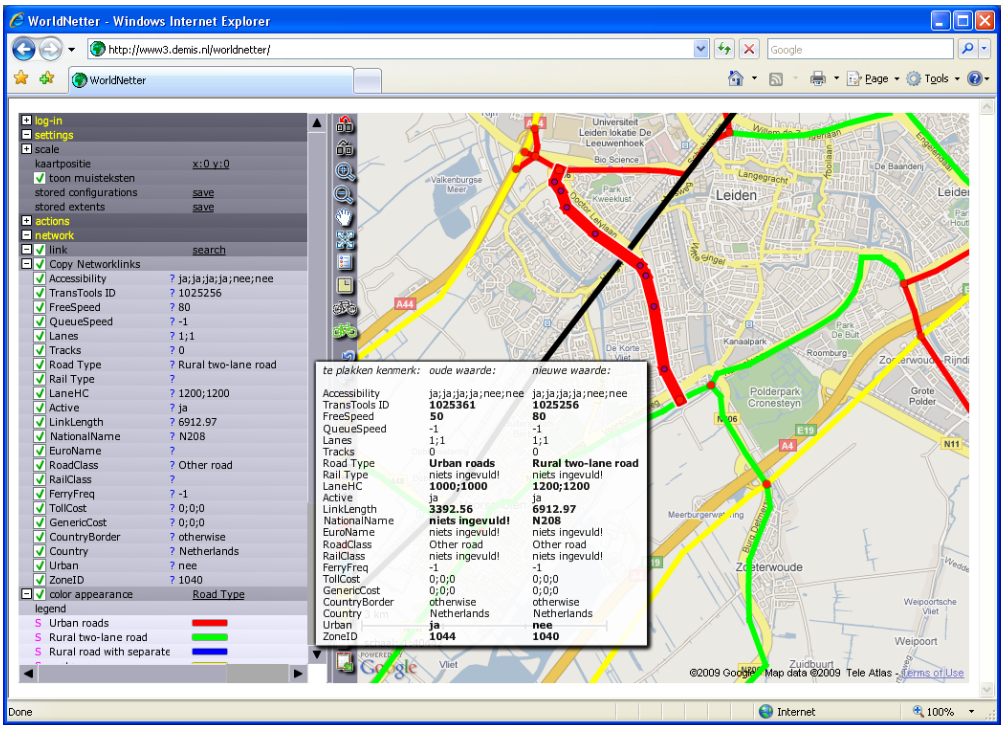


Copy and paste all values of an object

When all attribute values of a certain object are relevant for another object, it is useful to copy and paste the attribute values of this object by:

- Select the *'Copy'* action (or keyboard key C) and the source object
- Select the *'Paste'* action (or keyboard key V) and the target object
- Before applying the paste action, an attribute overview will be shown when hovering over the target object, showing a list of old and new values if the paste action would be executed. This is shown in Figure 113.

Figure 113: Attribute values list of old and new values before pasting



10.4.3 Editing the network topology

Apart from editing network object attributes, where the network topology remains the same, there are several actions where the positioning of nodes and links can be altered or objects can be added or removed. The specific actions designed for editing a link trajectory are described in the paragraph 10.4.4. Here the following actions is illustrated (as shown in Figure 114 from the toolbar):

- Adding nodes or links
- Removing nodes or links
- Moving nodes (and thereby the links).

Figure 114: Options for editing the network topology

Add node

Add link

Move a node or point

Remove a node or point or link

Remove a node or point or link and join remaining network items

Adding nodes and links

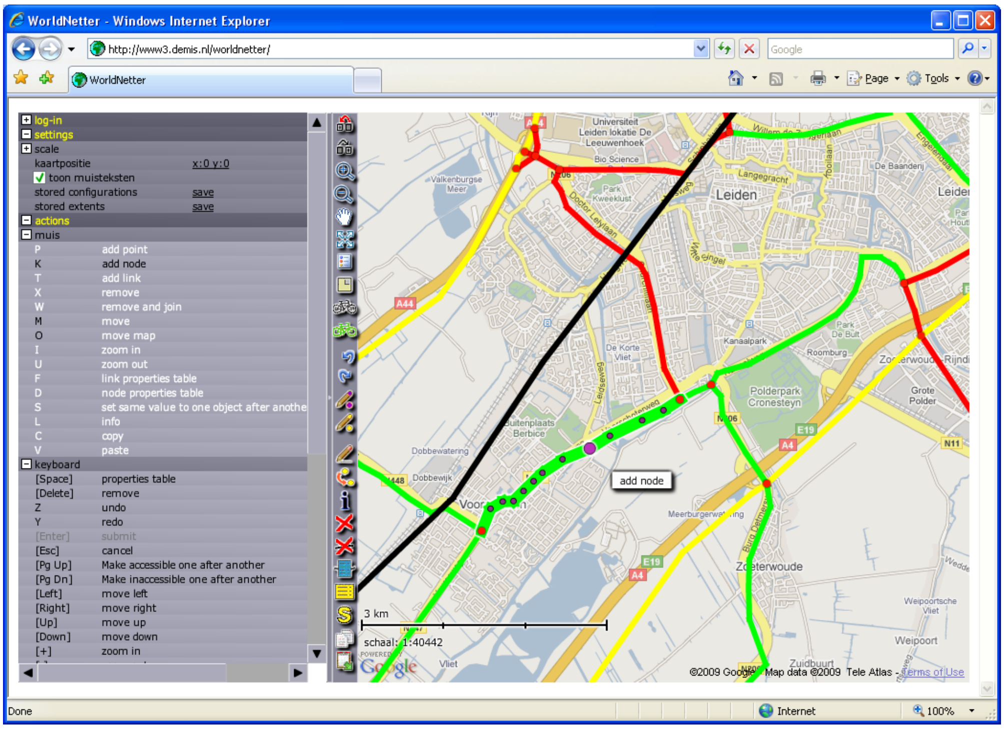
Adding a node to the network can only be done on an existing network link. Either a new point can be created on the link or an existing point can be turned into a node.

In both cases the *'add node'* action (keyboard key K) is used by:

- Select the toolbar action *'add node'* (or keyboard key K); then
- Select a position on an existing link (which may be an existing point, but this is not necessary). The add node tool tip will appear; click the position to add the node (as is shown in Figure 115).

To adjust attributes of the node, you can use the usual mechanisms described in paragraph 10.4.2.

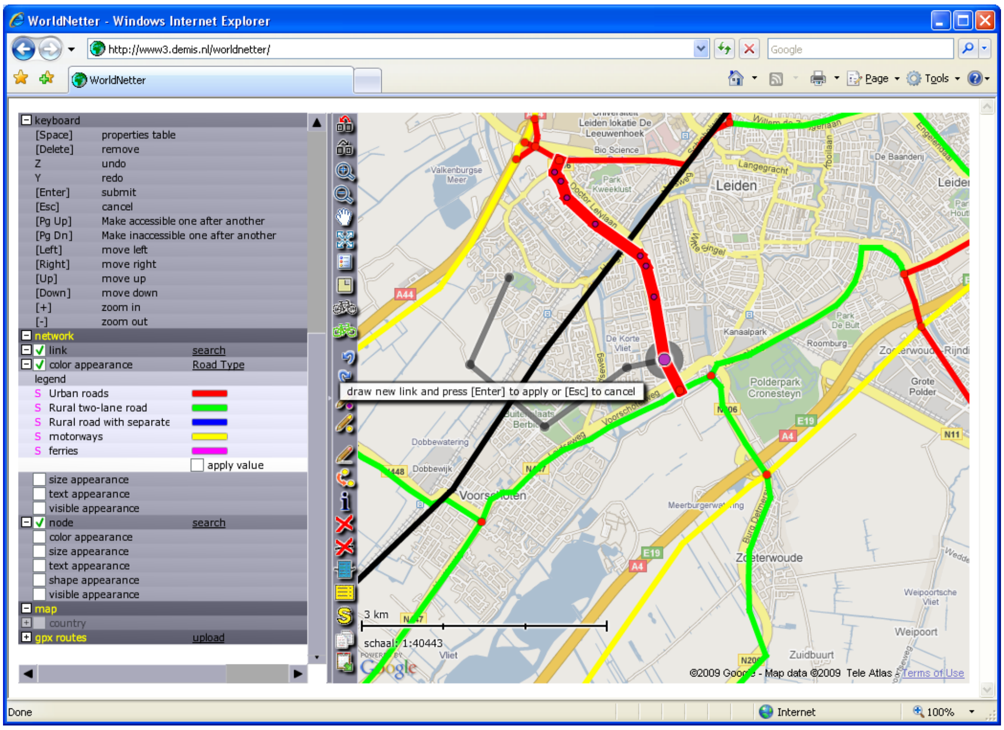
Figure 115: Adding a node to a network link



Adding a link to the network can be done at any position on the map and it is not obligatory (although it is good practice) to connect this directly to the existing network. The following actions are needed to create the new link:

- Select the toolbar action *'add link'* (or keyboard key T);
- Click on the map to select the starting point of the link. Every next click on the map will add points, by which you can determine the trajectory of the link, illustrated in Figure 116. The link is drawn in gray as long as it is not accepted or cancelled, which shows that the editing is in progress;
- When finished with drawing the link, you can either apply the link by pressing [Enter] or cancel by pressing [Esc] on the keyboard. When cancelling the link disappears, when applying the link is drawn in black;
- WorldNetter will automatically turn the begin- and endpoint into a node and all intermediate points into (link) points. When the begin- or endpoint is positioned on an existing link, a node is created and the link will be automatically be split in two separate links with identical attributes;
- After having added the link, it is possible to edit the attribute values as described in paragraph 10.4.2.

Figure 116: Adding a link to the network



Removing nodes and links

The *'remove'* action can be applied to every object on the map: nodes, links and points. It is simply performed by selecting the *'remove'* action from the toolbar (or the keyboard key X) and selecting the object subsequently (which will show the remove object tooltip). Since removing objects can have serious consequences, please take note of the following observations:

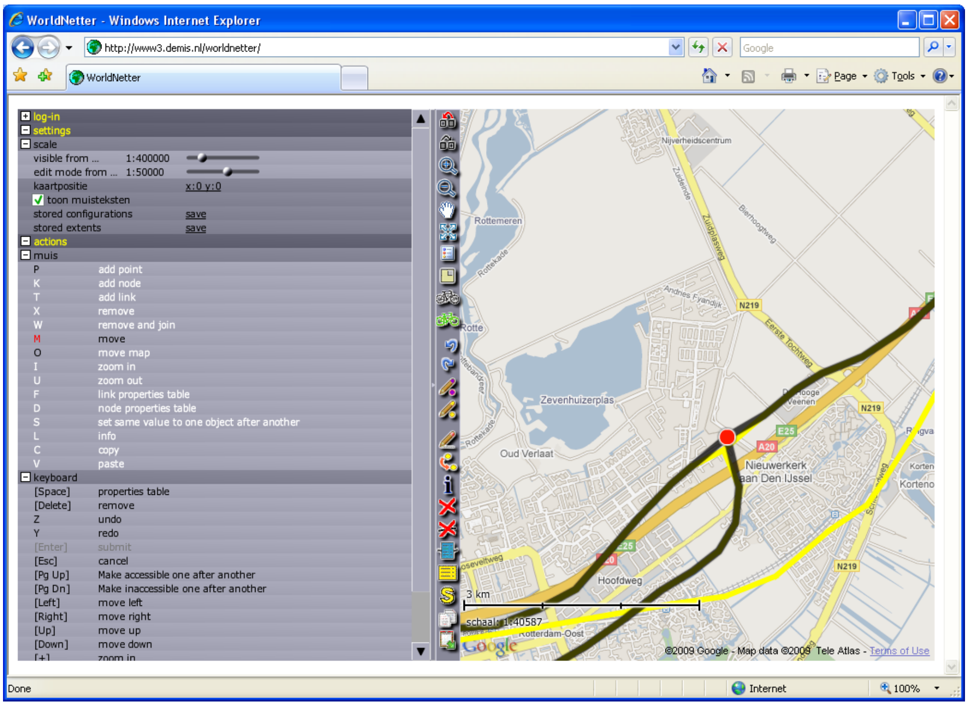
- **Removing a link** will remove the link, all its attributes and points, but the nodes to which it is connection will not be removed;
- **Removing a point** on a link will only remove the point, thereby changing the trajectory of the link, but nothing else. An elaborate description of options for editing the link trajectory can be found in paragraph 10.4.4;
- **Removing a node** will not only remove the selected node, but will also remove all links that are connected to the selected node. Since this may be highly undesirable, the *'remove and join'* action is available, which will be described next.

The *'remove and join'* action is a specific action to remove a network node, but to leave the connecting links intact. This can only be applied to a node that connects exactly 2 links, which furthermore need to posses the same attribute values. If one of these conditions is not met, the action will not be performed and a popup comes stating the reason why.

Moving nodes

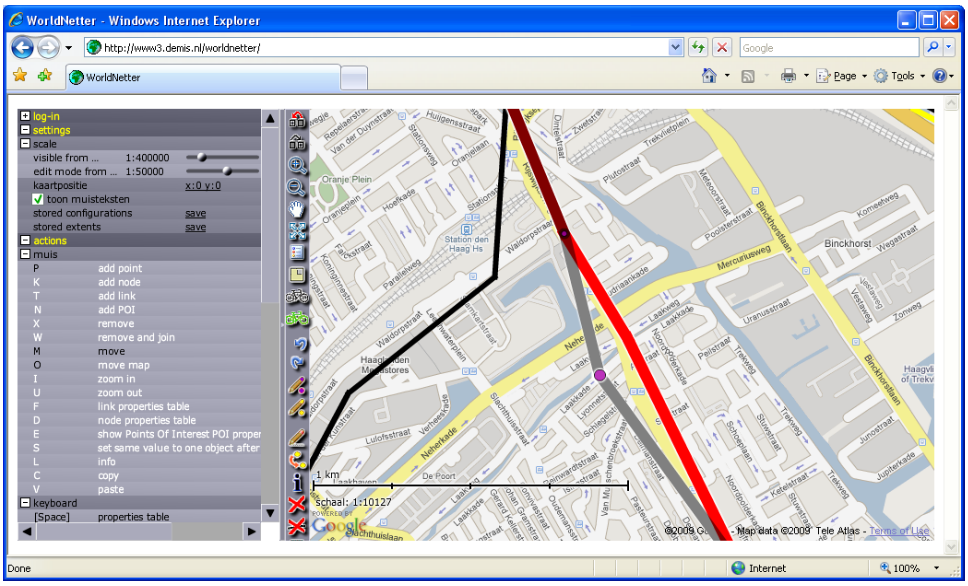
As could be seen in the previous paragraph in the case of deleting, actions on a node has direct consequences for the links it connects. This is also the case when moving a node: when moving a node, the dragging also shows the changes that will be applied to the (trajectory of the) links. This is illustrated in Figure 117, where a node is being moved and the black lines show the new positioning and the underlying yellow lines show the former positioning of the links.

Figure 117: Moving a node and connected links



10.4.4 Editing the link trajectory

Figure 118: Moving a point and the connected link



When a link is not positioned well on the map, the user may want to edit the trajectory of the link using the (link) points. These points have no attributes and are easy to drag and they alter the link position. All actions to the link points are comparable to those used for nodes (add, remove, move), but the consequences of, for example removing a link point, are less severe since it only result in changing the trajectory of the link. Figure 118 illustrates the action of moving a point: the (purple) point is dragged, where the grey line shows the new trajectory and the red line shows the current link trajectory.

10.4.5 Recovery options and logout

When the user has performed an action that was not intended, the Undo and Redo actions can be used to recover from the situation. When the action is selected from the toolbar, a tooltip is shown indicating which action will be performed when undoing or redoing an action. Take note that once the user logs out of the WorldNetter from the login navigation menu, all changes are accepted and cannot be undone after this.

Figure 119: Recovery options in the toolbar

Undo last action (if available)

Redo last action (if available)

The logout action in particular ends a user session, which involves:

- All (last used) settings are saved, so these will be used the next time the user logs in. This includes the scale settings, appearances settings and the zoom of the map area;
- All changes are accepted and cannot be undone or redone;
- All objects that the user has made changes to were locked for other users during his user session (to prevent more users working on the same objects simultaneously). When signing out, these objects are unlocked, so other users can work on them as well.