

WORLDNET: APPLYING TRANSPORT MODELLING TECHNIQUES TO LONG DISTANCE FREIGHT FLOWS

Sean Newton

NEA Transportonderzoek en Opleiding, Zoetermeer, Netherlands.

1. BACKGROUND

WORLDNET – Worldwide Cargo Flows – is a research project funded by the European Commission (DG-TREN), within the Sixth Framework programme. The objective of the project is to extend and refine the European Commission's freight transport policy knowledge base, focusing upon improving the representation of medium and long distance freight flows, the multi-modal aspects, and the relationship between trade and the development of trans-national transport 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 will be 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 will be IPR-free and developed according to TRANSTOOLS specifications.

WORLDNET is the result of collaboration between NEA, Ocean Shipping Consultants, IWW-Karlsruhe University, MKmetric, TINA Vienna, and DEMIS.

This paper discusses the methodologies used to produce the freight origin-destination matrix.

2. INTRODUCTION

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 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 transshipment 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, models of 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 in Europe 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; the problems of lorries on roads, deliveries in cities, congestion and so on, the industry takes a broader view; the global supply chain, the development of mega-ports, 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, and a network model 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 paper 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.

3. METHODOLOGY REVIEW

3.1 Overview

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.

3.2 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.

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 transshipment 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.

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.

3.3 STEMM/GBFM

TRANSTOOLS, ETIS-BASE, and NEAC are characterised by their use of national demand data to derive transport chains in the base year. 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 transshipment 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.

3.4 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.

3.5 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.

4. WORLDNET 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.

4.1 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.

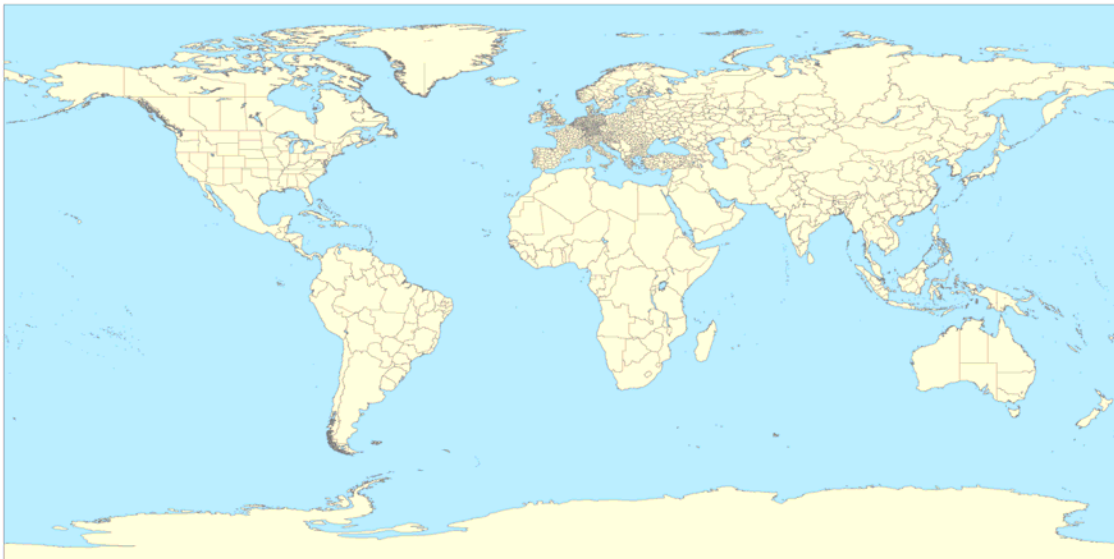
Outside the core area, all countries are included as partner regions, so their trade with the core area is included, but their national and bilateral flows are excluded.

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

transshipment 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 1: 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.

4.2 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 transshipment 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.

4.3 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.

4.4 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.

4.5 Mode Split/Assignment

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

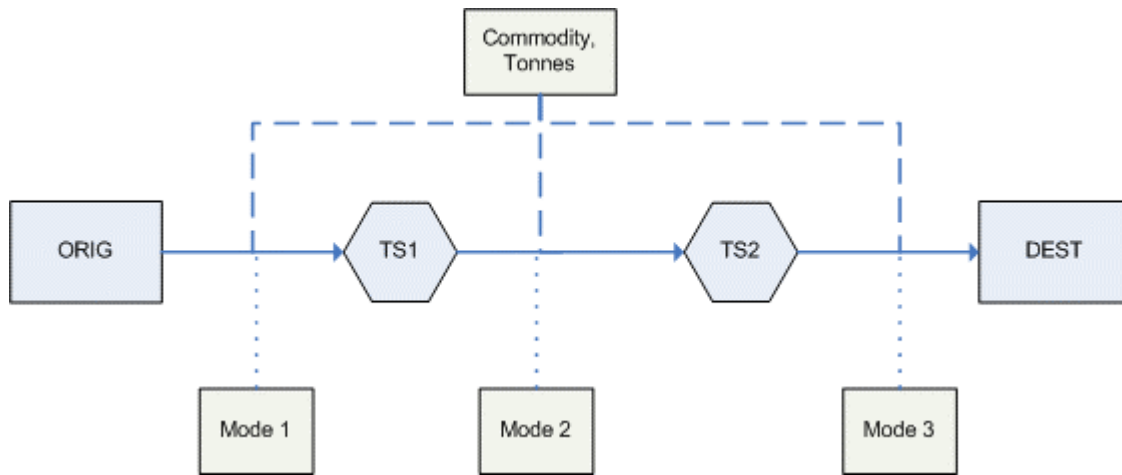
- Cargo Origin – NUTS3
- Cargo Destination – NUTS3
- Commodity
- Tonnage

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

- Cargo Origin – NUTS3
- Cargo Destination – NUTS3
- *Transshipment Point 1*
- *Transshipment Point 2*
- *Mode at origin*
- *Mode between transshipments*
- *Mode at destination*
- Commodity
- Tonnage

This transport chain structure can be visualised as shown below:

Figure 2: 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.

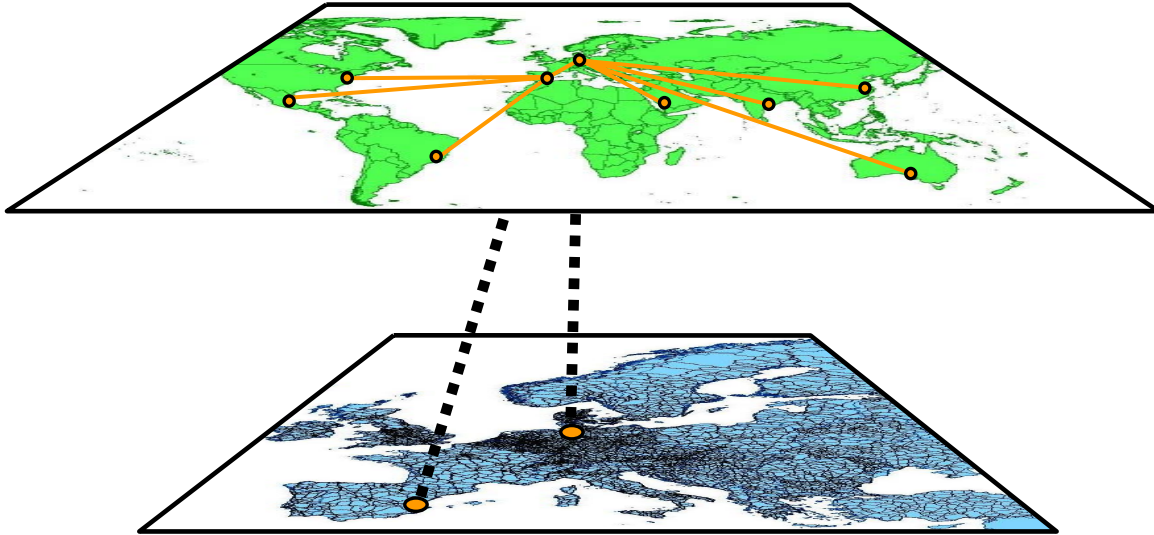
In principle the link objects in this stack could be simple infrastructure connectors (e.g. roads) with head and tail nodes and a simple impedance (e.g. metres) or an abstracted object, itself consisting of a set of infrastructure connectors, and a combination of fixed and variable impedances. This could 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 3: Connecting terminals and networks – multimodal approach

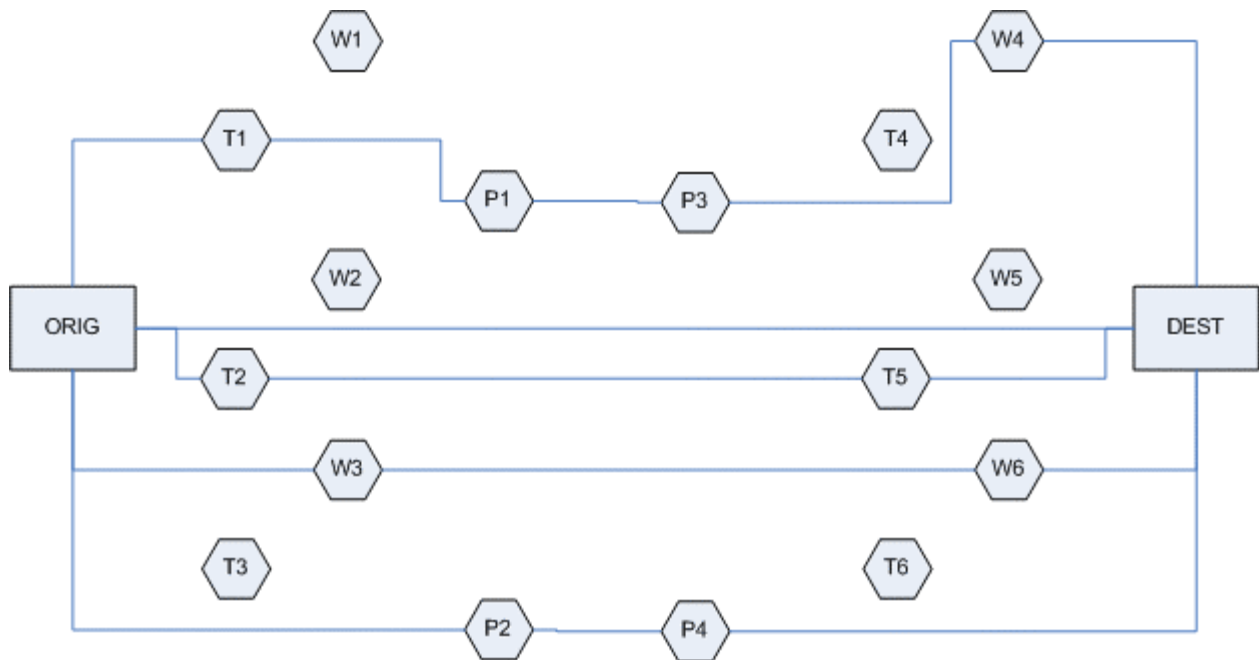


Source: IWW, Worldnet Beijing Seminar, 2008

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 4: 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.

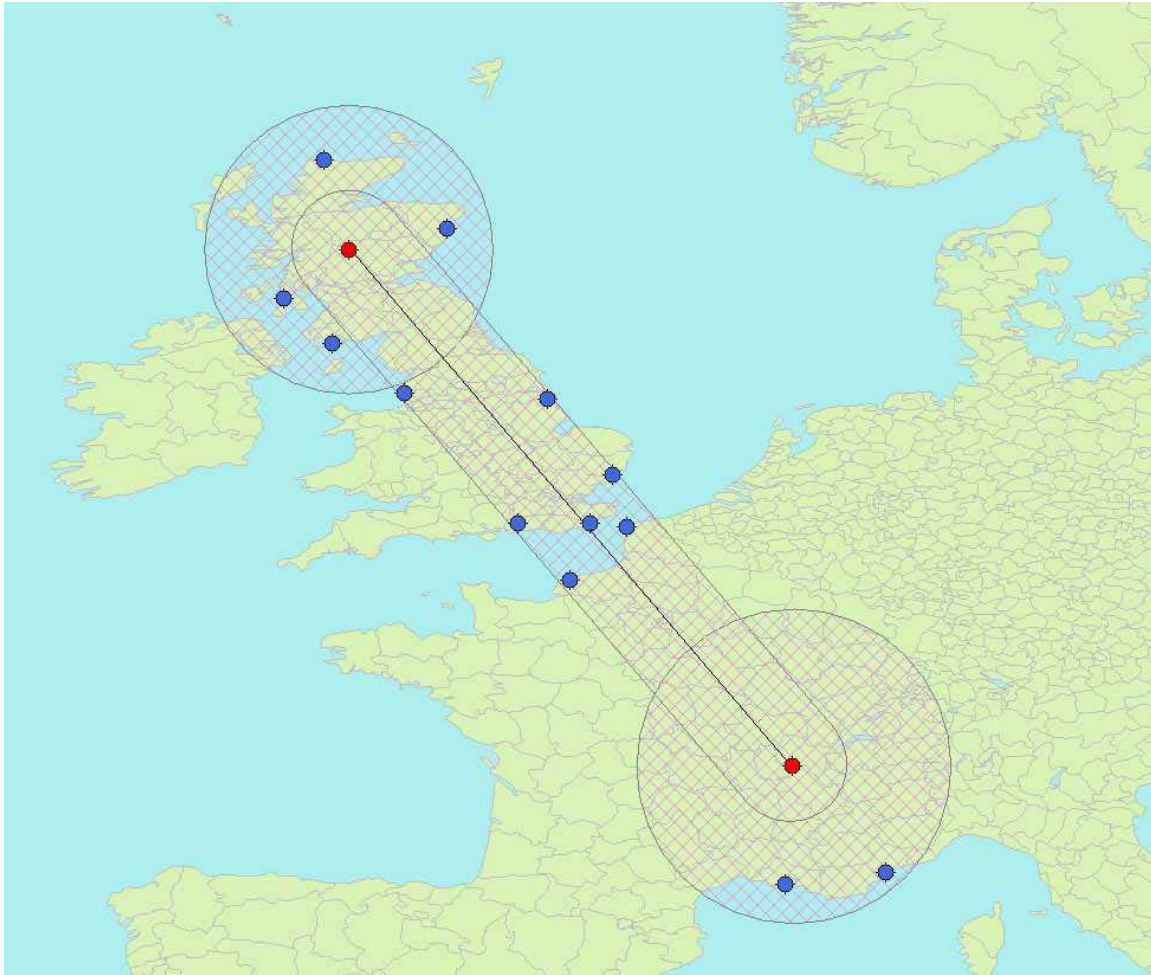
The main value of this approach is that a simplified graph of hyperlinks prevents the feasible path set from expanding beyond a predictable level, and that simplification allows the model to enumerate all the paths, not just the shortest one. The model can then assign to the best 'k' paths, which is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

A related benefit is that the system cannot produce paths with more than five links (four transshipment 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 transshipment 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 5: 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 transshipment 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.

4.6 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.

5. 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.

We have built a adopted 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.

NOTES

1. WORLDNET is funded via the Sixth Framework Programme of the European Commission, DG-TREN.
2. WORLDNET started in Spring 2007 and is due to finish in Spring 2009.
3. All results will be published on <http://www.worldnetproject.eu>
4. The software developed for the work described in this paper was written in Java. No third-party software licenses need to be purchased to build or run these programs.
5. Related developments to develop modelling capability within this field are taking place within the ITREN 2030 project:
<http://www.isi.fraunhofer.de/projects/itren-2030>

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