FINAL REPORT FOR PUBLICATION

EUFRANET

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Project Co-ordinator:	INRETS
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Partnership

The consortium included major research institutes from France, Germany, Netherlands and Spain (INRETS, BVU, IVE, UPM) as well as major railways companies, SNCF, DB, SJ.

The participation of ERRI and SEAFRANCE has been limited to links with INTELFRET project and to a demand analysis of a major maritime company.

INRETS has been the co-ordinator and were significantly involved in the analysis of the results, the definition of scenarios and the assessment of strategies. It’s participation was also significant in the interfacing of different models and the development of the GIS tool.

BVU has been in charge of developing the demand model and in the traffic projections.

IVE was responsible for the supply model as well as in the investigation of alternative solutions for rail.

TNO was involved in the first part of the project relative to the customer survey in order to understand better customer perception of quality of service and calibrate the demand model of BVU.

UPM has developed the evaluation method and structured implementation conditions of the rail strategies.

Executive Summary

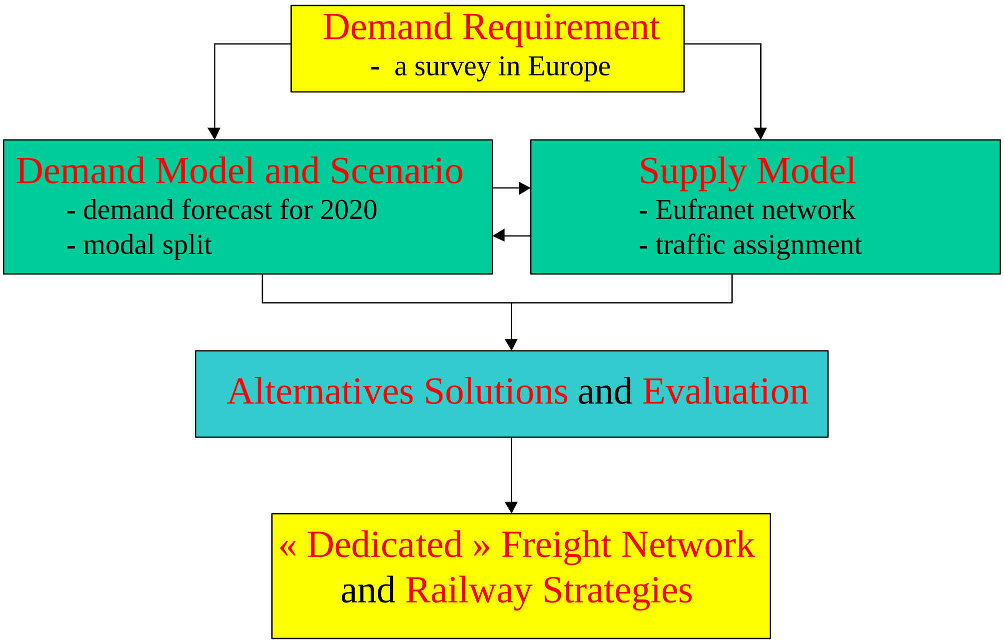
EUFRANET project has developed a new concept of European freight network “mainly dedicated to freight”, which means, with priority to freight trains. To achieve this goal original methodological tools have been developed within EUFRANET. Rail scenarios have been projected at the horizon 2020 and rail strategies were also evaluated.

The methodological tools concerns demand and supply modelling with the introduction of alternatives operating system. The definition of strategies arrived at reversing the declining of rail in Europe.

The EUFRANET consortium was composed of European research institutes and major rail companies under the coordination of INRETS. The executive summary summarised the different steps of EUFRANET projects and gives the main results.

1. Methodology

The EUFRANET methodology includes five elements which are shown by the figure below:



Shipper’s survey: An investigation « face to face » was undertaken on a European sample with two objectives: analyse the strengths and weaknesses of rail supply and future perception, and secondly, collect data with the simulation of shipments in order to measure the model of modal choice / split

Demand model: The demand model is from BVU. The variables of quality have been introduced, next to variables in price (time, reliability, safety and flexibility). The modelling includes two steps: demand forecasting and modal split.

Supply model: The model used was developed by the University of Hanover. The model simulates the form and flow of trains. Using the volume of existing demand (and obviously there is an arbitrage between volume and frequency) the direct train can be developed, except where there is a passage already established by stations.

A dynamic equilibrium process of supply–demand: the interface on the model of supply and demand allows evaluation of traffic and introduces the elements of price/cost into assignment analysis.

Evaluation method: The evaluation method is related to putting the project into practice, and the definition of scenarios and their hypotheses should be used in the application conditions of these hypotheses and not uniquely in the comparison of the simulation results.

2. Transport Requirement of Market

To analyse the shipper's transport requirement, a survey on mode choice was carried out by EUFRANET. The decision criteria used included transport costs, transport time, reliability, the extend of delays, flexibility, capacity, information, damage rate and additional services. A remarkable conclusion is that most companies are satisfied with domestic railway companies, but feel badly treated or even discriminated by foreign railway companies. The general problems are mostly well known.

The first point is ***flexibility***. This refers to the organisation of the railway companies as well as the transport services. Railway companies are organised on a domestic or, even worse, local level. The lack of flexibility in services refer to the very rigid scheme that railways have to follow. If a ship has a late arrival it is not possible for a train to wait. From the point of view of the railways this may look logical and understandable (most routes are full), but it should be kept in mind that road transport is capable to adapt far better to these circumstances. Even inland waterway shuttles have a certain amount of flexibility in their schemes.

The second point is ***reliability and information*** policies. It is not a coincidence that these two points are mentioned together. Reliability of rail transport is low. The most striking point is that customers are hardly ever informed. Almost all companies have to ask for (status) information. Road transport always reports delays directly. The reasons are unclear responsibility and non-harmonised information systems.

Combined transport is not very popular. Most companies think that combined transport is too slow. Another complaint is the high costs and the unreliable pricing policy.

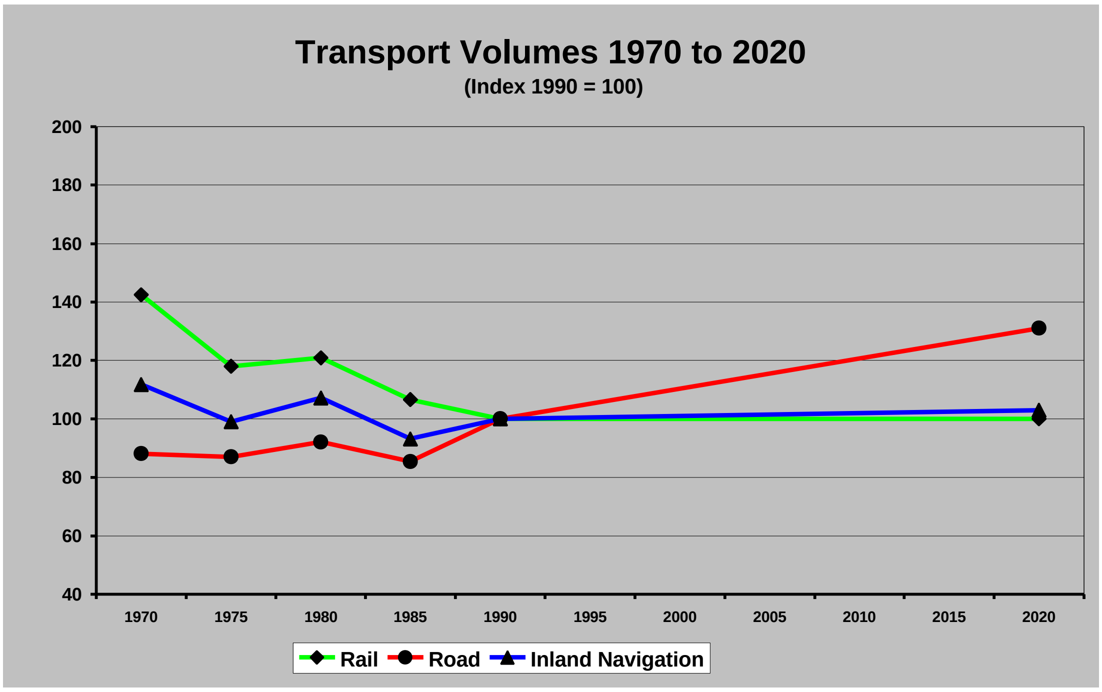
In the interviews ***infrastructure*** has been mentioned only on a few occasions. The bottlenecks in infrastructure are responsible for the lack of reliability of rail transport. It should be noted that this is beyond the view of the interviewed companies. Most of the time they are not informed about delays and never informed about the causes of delay.

The ***logistical developments*** in different segments point in the same direction. Reduction of stocks, more frequent deliveries, smaller shipment sizes and advanced information systems play a key role in production and logistical processes. Rail transport will have to adapt to these trends in different ways. The attitude of rail has to be more commercial and active. In production co-operation between suppliers, producers and clients have been tightened. In transport the same trend can be seen between producers and logistical service providers (mainly road transport). Rail transport is mostly not included in this co-operation.

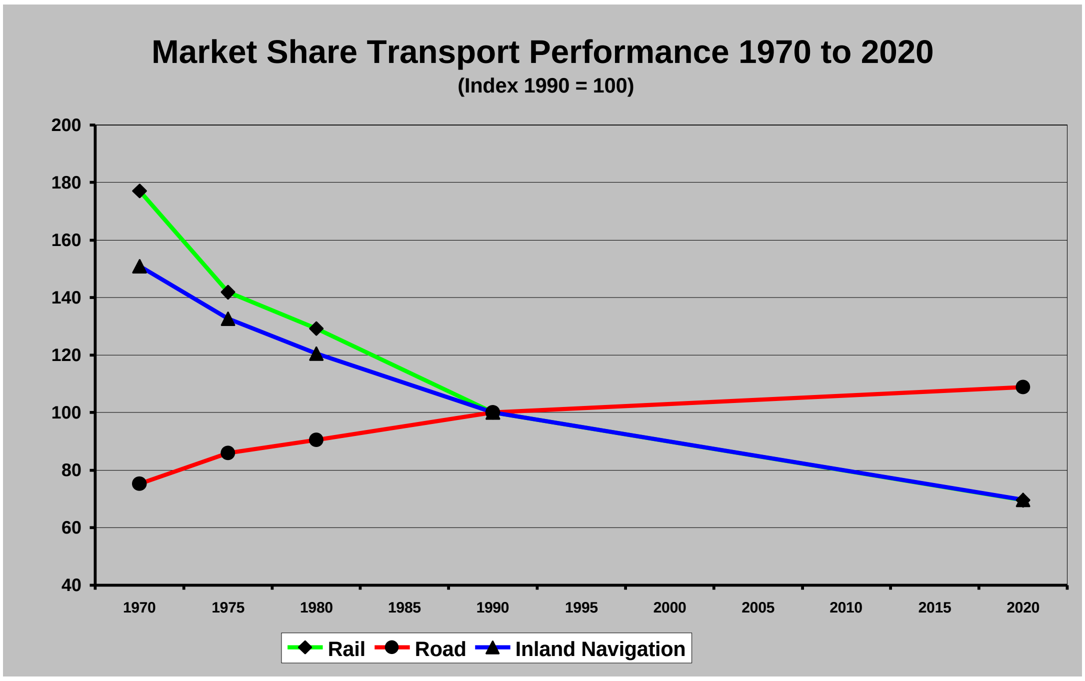
3. Forecasting of transport demand

One of the main objectives of the EUFRANET project is the evaluation of different strategies for the development and operation of an efficient and competitive Trans European freight railway network. Basis for this evaluation is the calculation of market response of rail freight as a function of the new quality levels defined in the different strategies.

The idea of the freight transport demand model is at first to explain the production and consumption of goods as a function of the socio-economic variables of the regions. The figure 1 shows that the expected growth rates are reasonable when compared with the recent development of European freight transport from 1970 to 1990.



In the second step the transport demand 2020 is split into the different modes by applying the modal split-model independently for each OD pair and commodity group. This way the market response depends on the changes in the quality levels of the competitors. The analogous situation for market shares based on the current quality levels is shown in figure 2. Road is increasing whereas rail and inland navigation both for the transport volumes and performance lose market share.



4. Alternatives and Simulation of Supply

In order to define strategic scenarios, a list of technical and operative solutions for a future railway network was created. And to observe the effects of the various possible solutions on the existing network, these solutions were related to the available simulation parameters. The simulation parameters is a basis for the construction of the scenarios and enables the creation of an image of each scenario using the chosen simulation model.

To start a simulation, it is neccessary to deliver the wagon flows on each entry point of a NUTS-Area. According to the railway stations which represent today's important entry-points in each NUTS-Area and marshalling stations, A NUTS-Area in EUFRANET has a minimum of three and a maximum of seven entry points. An entry point can be the crossover point to another network (e.g. road or inland navigation), and can therefore also be considered to be a destination point. These entry points have to be weighted by the traffic passed by them, and then the traffic relationships between entry points can be established. Following the establishment of the station classification and the relationship between stations, the model can make a preliminary distribution of the traffic on the links, taking into account the weighting factors.

To enable the modelling of rail goods traffic the simulation parameters deduced from the technical and operational alternatives, such as train parameters, are entered into the simulation model together with the wagon flow data. The parameters can be varied in order to generate new solutions.

Links which have sufficient volume of traffic will run a direct train without intermediate stops in the simulation model. The remaining links, in which the volume of traffic is not sufficient for a block train, will be covered in a sub-system. In the sub-system the carrier compartments will first of all be assembled in a larger station. Afterwards the assembled trains will be transported to the nearest treatment yard.

The treatment yard is mainly a marshalling or shunting yard, the trains will be dismantled into groups of carriages. Once dismantled the wagons will be sorted according to their destination and the main-line trains will be put together. The newly formed trains then travel on to a distant treatment yard. On arrival the trains will be dismantled again, made into new trains and afterwards in reverse order of transportation the wagons will be sent to the destination entry-points.

5. Dedicated freight network in Europe

The EUFRANET dedicated network not only involves changes to infrastructure components but also a rail operating system intended to improve the utilisation of transportation assets. This will mean more efficient use of the European transportation infrastructure, better service, more convenience, and wider choices for users. With the results of assignment per link derived from BVU and IVE models, the EUFRANET dedicated network for freight has been subdivided into three sub-networks:

Core network*:* The core network is strongly dedicated to freight. In principle, no passenger train will be allowed to run on the core network. On some particular links, special slots will be given to freight trains: details of these will be given at a later stage. A consequence is that this network will have very high capacity for freight trains because of more uniform speed. The quality of transport in terms of reliability and time will also improve, because there will be fewer conflicts with other trains than on the basic network. The core network covers the developed industrial regions of central Europe.

Intermediate Network: The intermediate network is mainly dedicated to freight, but local passenger trains are also allowed to run on it. Freight trains generally have priority, but this is not absolute. The quality of the services will be increased too, but less than on the core network. The intermediate network extends outwards towards the countries on the periphery of Europe.

Diffused network**:** The diffused network can be used by freight trains, but passenger trains will usually have priority. The quality of transport is therefore not as high as on the dedicated networks, and there will be little improvement on the present situation. The diffused network will provide access to all the regions of Europe.

Based on these three types of "dedicated network", an analysis of the attractiveness of the dedicated network has been performed with reference to improvements in transport time. The results show that the traffic on the dedicated network can increase by about 25% and will account for 85% of total traffic. Especially for Belgium, Germany, France, Luxembourg and the Trans-Alpine region (Switzerland) the impact of the dedicated network will be very important, with time savings of between 20 to 30%.

6. Strategic Scenarios of Operating System

Defining the scenarios involved collaboration between the partners in the consortium and representatives of railway companies with the aim of making relevant and realistic hypotheses. Six alternative scenarios were selected, and each scenario combines the following in a different way; the characteristics of operating systems, the length of the trains and the speed on the three network levels. Therefore the impact of the length of the trains, the extension of the dedicated network and the quality of service can be assessed by making comparisons with the results of other alternative scenarios.

The basic indicator for evaluating a scenario is the amount of traffic associated with it, i.e. the amount of extra rail transport the scenario will generate. The core “dedicated network”, short train operation and quality improvements appear to be the most important aspects of rail development strategy, and the impacts of these on rail volume are quite clear; the effects of these hypotheses add up when the “nested” construction of the scenarios is simulated.

The results show a fairly marked impact on wagon load and combined transport traffic. This impact occurs gradually with improvements in rail services, reflecting the sensitivity of the various markets to transport time and quality. The effects on the total volume of rail demand range from 6% or 7% to almost 150% (the figure for combined transport is even higher). This wide range of results shows clearly that rail traffic is very sensitive to changes in supply conditions.

It is important to stress that while international volumes are lower than national volumes when measured in tonnes, in tonne-kilometres international rail traffic exceeds national rail traffic by the year 2020, even if rail transport to ports is counted as national transport; this is particularly marked in the case of combined transport. Most of the anticipated increase in rail traffic will come from international transport. International traffic is therefore more sensitive to supply scenario and differences between countries are significant.

For national traffic In tonne-kilometres the increase in rail's modal share is quite significant in all the scenarios: rail's modal share increases from 8.7% in the basic scenario to as much as 15.6%. With scenarios of this type we can identify situations where rail would not only maintain its present modal share up to the year 2020 but also improve on it and halt the long term decline it has suffered over the last forty years. Introducing quality improvements can almost double rail's modal share, which represents a considerable improvement in its current position with respect to road transport.

Concerning the attraction of the traffic, on the core network it is considerably higher when operating conditions are improved; traffic rises from 42% in the basic scenario to a level of 70%, which remains fairly stable with the various alternative scenarios. The attraction of the intermediate network is also strong, once improvements have been made.

With the results of scenario analysis, the ranking of scenarios was made. The ranking was an interactive analysis where the service and network attributes for each scenario and the interaction between infrastructure, demand and operations were appraised simultaneously. Once the interactive analysis output was optimised for each scenario, the results were then “compared” using a set of screening criteria to determine the best scenario for the European freight transport as regards to the chosen indicators. A final scenario is proposed and shows that it attains the same rail performance previously obtained but has the added benefit of limiting the number of slots required on the most congested links.

7. Implementation of EUFRANET Strategy

The implementation of a dedicated freight network and operating system is composed of numerous actions, it requires the different railways to change their traditional organisational structure and behaviour, in order to adapt themselves to new rules and circumstances. In this respect the major decisions concern infrastructure, rolling stock, operating strategies, commercial policies and capacity management.

Capacity constraints appears to be very tight in certain European areas, as in the cases of crossing the Pyrennées or the Alps. The change of infrastructure implies investment for bottleneck removal and, as a consequence, a variety of actors will have to take the initiative to finance different projects.. Another possible way of solving the problem could be found by means of using “mixed” traffic, particularly, in certain specific high speed lines.

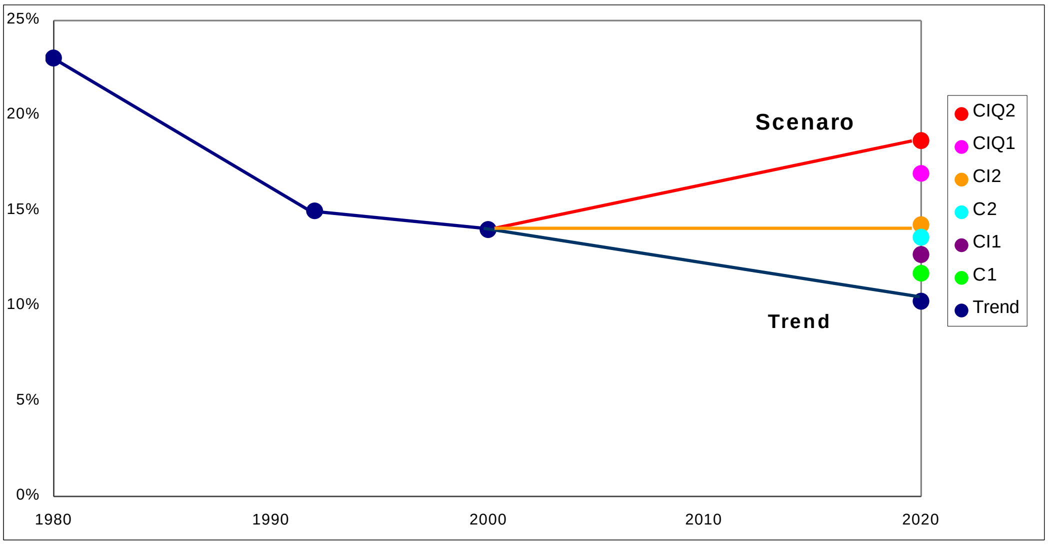
Interoperability is another key problem for the development of international freight transport services on a European scale. Interoperability problems include gauges, rolling stock, train length, traction, signalling, command and control,.… Rolling stock and trains in the different sub-networks must be appropriate for intended quality of service and efficiency. Correspondingly, several standards should be set, such as velocity, power per gross ton, axle load, load per metre, loading gauge, train length, braking conditions, coupling-decoupling system.

Slots available throughout Europe for international services, must be designed in accordance with the specifications adopted for trains (velocity, train length, ...). The decisions to be taken in relation to slot scheduling and assignation include, as a first step, the definition of general criteria for slot design and scheduling: velocities, maintenance policies, traffic priorities, "time windows" for each type of traffic,... ; and, as a second step, the production of specific slot schedules and the corresponding assignation of specific slots to applicants.

Finally the international rail services to be offered will be more valuable for the customer if the commercial systems of the supplying companies manage to achieve some subsystems in common. The most important among these are: the pricing systems, the service information, reservation and selling system and the tracking and tracing system.

8. Conclusion

Rail's modal share has been declining over the last forty years and is expected to continue to do so up to 2020 in the basic scenario. The expected impact of the EUFRANET scenarios shows that rail could reverse the declining trend and reach a modal share of as much as 18% depending on the level of improvement in rail services (see Figure below). Gains in national markets are of the same order of magnitude as gains in international transport, although important differences exist between countries and the potential increase in volume differs considerably from one type of traffic to another.



The EUFRANET scenarios provide opportunities for a considerable volume growth in international traffic which will allow international wagon load traffic volumes to attain the same order of magnitude as national wagon load traffic. This is a considerable challenge for interoperability and rail operation and demands a European approach to marshalling and the organisation of rail traffic. This question has already been raised (but not solved) with regards to inter-modal transport, and international traffic volumes will become much larger than national traffic volumes with a number of major corridors serving ports or crossing natural barriers. In some cases such services are the only means of achieving a significant increase in international trade.

Objectives of the Project

The goals of the EUFRANET project are to contribute efficiently to the economic and social growth of Europe through the improvement of rail transport. It aims to identify and evaluate conditions for the development of a Trans-European rail network mainly dedicated to freight transportation and to establish a global strategy for its implementation.

From the present situation of rail decline, the project proposes concepts and solutions to improve the rail operating system based on a new organisation and new technologies.

To achieve this goal EUFRANET will concentrate on the following three aspects :

- Identification of solutions to employ the system in a more optimal way. Thereby, resolving the problems of traversing saturated zones, studying the development of new routing systems which could reduce utilisation of terminals during peak periods. Also, driving towards improving efficiency which is at present limited by train capacity with a view to achieving optimal costs. With regards to long distances (ie. International transport) the long waiting periods that are often necessary.

- Elimination of bottlenecks that limit transport capacity. The mixture of various types of traffic that causes these conflicts, in particular with regard to dense urban zones and especially during peak times. Other limitations resulting from a temporary concentration of passenger trains departing from large agglomerations in the evenings.

- Development of a strategy at European level. A European strategy is certainly long and difficult to put into practice. At present each railway company is working towards resolving its own national problems. Progress in interoperability will help the development of European strategies and a European freight network provides a concrete framework for implementation of interoperability measures.

The project aims at pursuing these objectives in the most efficient way, meaning :

- ♦ To reduce costs in significant proportions (by 20 to 30% for example); or at least in certain markets under certain conditions where possible. Also, knowing the market share by road (the dominant form of transport) is regularly increasing (at about 1% per year) and continues to do so.
- ♦ To improve quality as regards to the length of time needed to transport, regularity, viability and information circulation.
- ♦ To limit negative impacts on the environment. The railways are already reputed to be the least environmentally damaging but it is still necessary to ensure this point by significant improvements and by considering not only the consequences of transport in the future but also the impact of railway transport in the regions it crosses. The problems of access to railways must also be considered.
- ♦ To benefit from the evolution of technology and the implementation of new operating systems which offer solutions to problems which so far have limited the current potential of rail usage for freight in Europe.

Once these objectives have been accepted it is necessary to emphasised that :

- EUFRANET doesn't look to define a freight network that will double the passenger network in Europe.

- The current problems of infrastructures bottlenecks have occurred with existing lines, and must profit from construction of new high speed lines for passengers. The objectives do not focus on new infrastructure investments for freight although some investments directly concern freight (mountain crossings, access to ports, crossing straits of water etc.

Means used to achieve the objectives

The objectives of EUFRANET have been ambitious. Therefore, the methodology to meet the objectives had to be innovative.

Firstly, it was necessary to develop a projections tool which integrated demand simulation and supply simulation onto the rail network.

Therefore data on existing flows has been collected (NEA source) as well as information on the socio-economic environment (collection of socio-economic data at a regional and national level).

A second step was the construction of a specific survey in order to calibrate a demand model, which could be used at a European level.

From the supply side a GIS for European network has been implemented and railway partners gave the consortium information relative to the circulation rules for the trains.

Among the needs used to achieve these objectives one must indeed mention the strong co-operation with large railways companies from different European countries. These companies were members of the consortium and therefore were directly interested in the conception of the project and the results. They also helped considerably in validating hypotheses and formulating scenarios and strategies for rail.

Therefore a large collection of information and a large mobilisation of experts from the academic world and rail expertise was necessary.

Scientific and Technical Description of the Project

Chapter 1 Shipper's Demand Investigation

1.1 Shipper's survey in Europe

Essential in the Eufranet project is the point of view of the final customer and the potential users of an improved railway system. Therefore a survey was carried out in eleven European countries. The goals of the interviews were twofold. In the first place the opinion of the users or potential users of rail about the rail product and the way this could be improved was important. The second goal was to gather information about the decision making process in mode choice. These aspects were discussed in two parts.

1.1.1 Open interview

In the open interview a small checklist was used. The discussion with the interview partners can be divided in three main parts:

The way the activities of the visited company are organised is very important. Is the production concentrated in one plant, in one country, or world-wide? How is the distribution organised? How important is the international market? What are the logistic requirements of clients?

The transport and logistic characteristics, follow more or less logical from the activities of the companies. In modern companies the transport requirements (reliability, time, costs and other aspects) are directly related to the production process.

The third part is more focused on rail transport. The role of rail transport is discussed. This includes the opinion about future rail concepts.

1.1.2 Stated preference

Stated preference is an interviewing technique in which alternatives are compared. In the Eufranet project two modes of transport are compared. The first mode is the actual used mode, the second mode of transport is the most likely alternative. The transport modes are defined by a number of criteria, such as transport costs, transport time, reliability, damage rate and information. In fact two propositions are made with different costs, transit time, reliability and other criteria. The interview partner is asked to compare the two propositions and choose one. On the basis of the chosen alternative, the computer generates another proposition and the process starts again. After about 12 comparisons enough information is gathered to evaluate the choices. This evaluation takes place in the form of trade-offs. These results was used in building a European freight model.

The program asks for the most important decision criteria. In total 8 criteria have to be valued. Each of these characteristics is rated from 1 (Important) to 3 (Unimportant). In the actual stated preference five criteria were used. 'Transport costs' and 'transport time' was always included. From the other 8 criteria, the three most important were chosen and used in the stated preference.

1.2 Logistic development and criteria of mode choice

1.2.1 Logistic development

In general logistic development have in all sectors the same direction. Reliability and flexibility in transport are becoming more and more important. The forces behind this are production logistics (Just In Time (JIT) delivery, lower stocks, order steered production). Another important development is the closer relation between production and logistic services. The number of logistic service providers has gone down, while the range of activities of service providers has increased (Value added logistics) and information exchange between logistical service providers and production companies will be intensified (EDI). The consequences for the transport requirements of raw materials, intermediate products and consumer products differ, but the tendencies are the same.

1.2.2 Decision criteria and mode choice

In the interviews and the Stated Preference program questions about modal decision criteria have been asked. From these questions a clear view on the modal decision criteria have come forward.

In the interviews the most important decision criteria have been asked for. The results are given in table 1.1. The scores are based on ranking from 1 (most important) to 8 (least important). This means that lower figures imply a better score than high figures.

Table 1.1 Decision criteria in interviews

Criterion	Average	Standard Deviation
Reliability	1,78	1,54
Costs	2,11	1,78
Information	4,33	2,08
Flexibility	4,37	1,78
Speed	4,72	2,70
Frequency	4,72	2,01

For all firms together, reliability is the most important criterion. It also has the lowest deviation. This implies that most firms agree on the importance of reliability. Costs are almost as important. In the light of the above mentioned decision making process this seems rather logical. The difference between the other criteria is remarkably small. Speed doesn’t seem to be important for most firms. However the high deviation shows that the agreement on the role of speed is not the same among all firms.

In the stated preference interviews the decision criteria have also been asked. The procedure was somewhat different. From a total of 10 criteria, the five most important were chosen. Transport costs and transport time was always included, although they were not always valued as important. In table 1.2 the result is shown.

Table 1.2 Assessment of criteria in Stated Preference

	Important	Less Important	Unimportant
1 Transport costs	43	0	1
2 Transport time	38	6	0
4 Suitability of transport capacity	36	7	1
5 Performance of additional service	7	25	12
6 Reliability of transport time	44	0	0
7 Extend of delay	37	7	0
8 Flexibility to individual requirements	31	13	0
9 Risk of damage	37	6	1
10 Announcement of scheduling problems	43	1	0

Source: interviews and BVU analyses

From this table it is very clear that reliability, transport costs and announcement of scheduling problems are the most important criteria. It is at first glance a little bit surprising that transport time is not always mentioned as important. This is however in line with the interviews where it was often mentioned that speed is less important than reliability.

The performance of additional services is the only criterion that is not evaluated as important. Most companies plan precisely what transport services they demand. Additional services are hardly ever necessary.

1.3 Problem of rail transport

The results from the interviews will be given from two different viewpoints. The first is the geographical, or better, the national viewpoint. Although the focus is on international transport, the national points of view play an important role. Most companies have direct contacts with the national railways.

In the results per country information is provided about aspects related to the geographical position of the country. In some cases (e.g. Spain, Sweden), the countries are for their international transport fully dependent on the co-operation with one or more foreign companies.

1.3.1 General problems of European rail transport

The general problems are mostly well known. It is however ever time surprising how little has changed in a number of years. Only a few railway companies are valued as satisfying. Without repeating all points mentioned before, a few aspects need further attention.

The first point is the *flexibility*. This refers to the organisation of the railway companies as well as the transport services. Railway companies are organised on a domestic or, even worse, local level. JIT deliveries require a flexible approach, which is very difficult for railways.

The flexibility in services refer to the very rigid scheme's railways have to follow. If a ship is late, it is not possible to wait for the train. From the point of view of the railways this may look logical and understandable (most routes are full), but it should be kept in mind that road transport is capable to adept to these circumstances. Even inland waterway shuttles have a certain amount of flexibility in the schemes.

The second point is *reliability and information* policies. It not a coincidence that these two points are mentioned together. Reliability of rail transport is low. The most striking point is that customers are hardly ever informed. Even a company like Bahntrans, a 50% daughter of the German Rail, has to ask for information. Road transport always reports delay's directly. The reasons are unclear responsibility and non-harmonised information systems.

The third point is the *attitude* of the railways. Especially chemical companies complain about what they call the arrogance and ignorance of the railways. The knowledge within the companies is far greater than within the railways, where no technical knowledge exists.

Another problems of rail transport is *transport cost and price*. the railway companies have standard tariffs but afterwards all kind of costs is added. The transparency of the tariffs is also very low. You do not know what you pay for and the railways do not know the relationship between different costs and services. Another problem is that on the one hand the tariffs of rail transport every year increase while on the other hand the tariffs for road transport decrease. This means higher pressure on the rail prices.

Another problem is *transport time*. In a lot of EU-countries passenger transport dominates freight transport. This means that goods transport by train is relatively slow, in international transport about 20km/h (including handling, marshalling) which is much to slow to be competitive compared to road transport.

STORA has made an evaluation of European railways. The conclusion is that the quality of European rail is very poor (see figure 1.1).

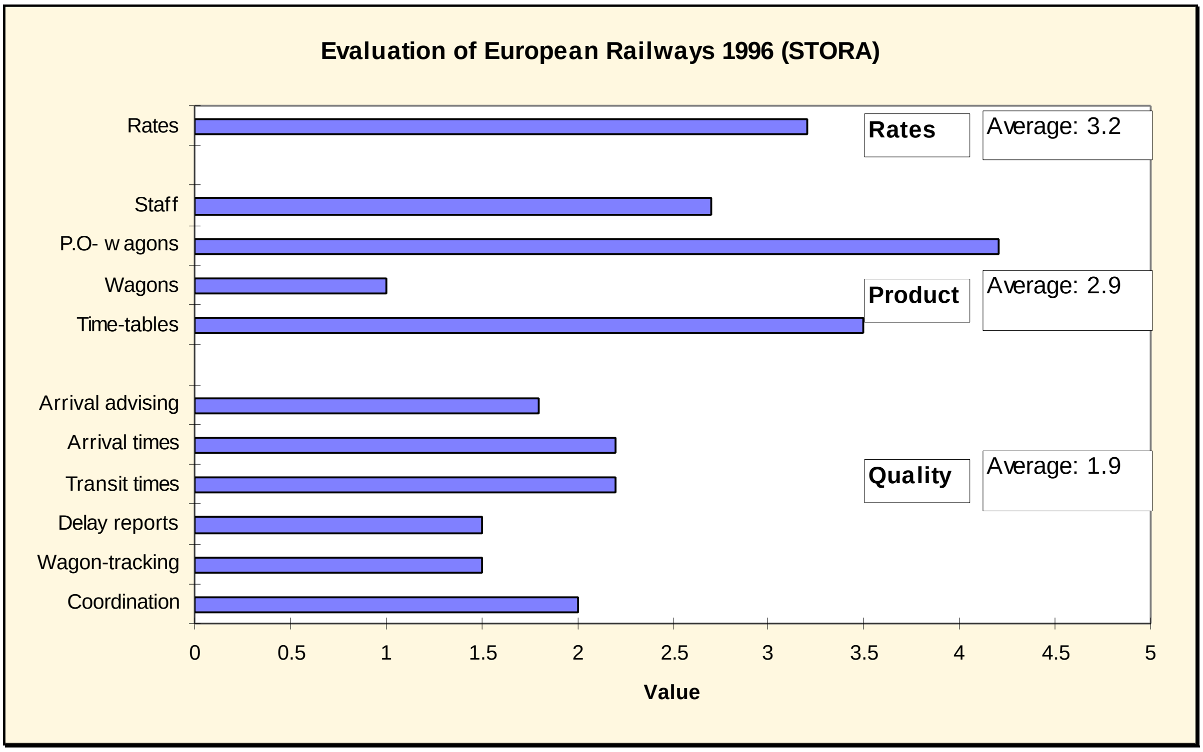


Figure 1.1 quality of European rail

From figure 1.1 it becomes clear that quality is the main problem in European rail transport. Another striking result is the quality of the wagons. The wagons of the railway companies are valued as very bad, while Privately Owned (PO) wagons are rather good.

1.3.2 International rail transport

About international rail transport the companies are less satisfied. The main complaint is the lack of strategic co-ordination in international rail transport. In international rail transport every railway company has its own strategy, both technical as organisational. Many of these strategies are not tuned and sometimes even contradicting. In fact there is no common service. Companies have to negotiate with each specific partner, while they want to speak to one. The railway companies are absolutely not aware of how their clients think about logistics and the performance of rail transport.

Differences exist between European countries in the field of railway track characteristics and technical equipment. This means that sometimes trains have to be recomposed at the border of countries, which means extra delay and costs. The problem of international rail transport is that it is nationally organised. The different national rail transport services have to be combined with each other, but this is very difficult.

Furthermore a bottleneck for rail transport could be that the continental transport flows are too small and too diversified for rail transport and that the sites of the regional distribution centres are not located nearby a railway terminal. Combined transport could probably be an alternative for road transport, but the lead times have to be shortened a lot compared to road transport.

1.3.3 Combined transport

The company wants to stimulate intermodal transport, but the railway companies are arrogant. Companies have to take initiatives. New developments always have literally a high price. The railways kill new initiatives by charging very high prices and an unreliable pricing policy. On certain main routes for combined transport (to southern Europe) prices have gone up with 20 to 30% a year.

The total transport time of rail transport is too long. When the delivery time is very strict and has to be very short, than combined transport is no alternative. Containers can not be traced during rail transport, just the trains. This is an advantage of road transport because these are equipped with satellite communication. Therefore a container identification system would be very helpful.

Apart from environmental advantages, it is very important that the goods are transported and handled very carefully. This could be an extra handicap for combined transport. Loading, unloading and marshalling can damage the high value products. A solution could be: specific terminals and handling facilities for sensitive goods to avoid damage caused by loading, unloading and marshalling, like the car industry proposed.

1.3.4 Logistic problem of product

The logistical process, market opportunities and competition are different in the different chains in the production process. Three kinds of products will be distinguished: raw materials, intermediate products and final products. It should be noted that in general companies have two flows. For the basic industries (for instance steel, paper and chemical companies) the incoming flows are raw materials (iron ore, wood, base chemicals) and the outgoing flows are in general intermediate products (steel products, paper, packaging, and intermediate chemical products). For producers of final products the incoming flows are intermediate products and the outgoing flows are final products.

The logistical developments in the different segments go all in the same direction. Reduction of stocks, more frequent deliveries, smaller shipment sizes, advanced information systems play a key role in production and logistical processes. Rail transport will have to adapt in different directions. For base products capacity and low prices are very important. Intermediate products require high reliability (production processes rely on a high reliability of deliveries) and at the same time flexibility (production is order steered, this means that it will fluctuate). In final products the quality of transport (no damage, reliability, and transit time) are important. In some segments rail transport will no be able to compete in the present market conditions. In future this can be different because road transport will have increasing difficulties in keeping reliable and the costs of road transport are likely to go up. This does not mean that rail transport can wait and see. The attitude of rail has to be more commercial and active. In production co-operation between suppliers, producers and clients has been tightened. In transport the same trend can be seen between producers and logistical service providers (mostly road transport).

1.4 Quality of service and rail transport

Transport costs include all costs related to the shipment. For large customers it was very difficult to give the transport costs for one shipment because mostly contracts for a longer period or large flows are negotiated. Another point is the difference between transport costs, transport tariffs and the price. The tariffs are negotiated and fixed for a period of time and a number of shipments. What the actual cost for firms are depends on the way the firm utilises the capacity. If for instance return freight can be shipped in the wagons the tariffs for a large user remain the same, but the costs are lower.

In most markets the transport costs for rail transport are competitive. The only exception is the transport of combined transport. It is stated often that only combined transport to and from Italy can compete with road transport. In combined transport the very unpredictable pricing policy is often mentioned as a negative point.

Transport time should be viewed in relation with reliability. The schedules for rail transport are not bad. It is mostly possible to get a good schedule. To keep this schedule is another point. The average speed for rail transport is 15,7 km per hour (this value is exactly the same as mentioned in the white paper). Road transport is twice as fast, and combined transport is 50% faster than conventional rail transport.

By transport time we mean the total time needed for a shipment, including loading and unloading. Transport time is less important for the majority of companies. Mostly the goods were not very high valued. Transport time is, especially with bulky product, seen as kind of storage. With high value products like computers, parcels and pharmaceuticals, time plays a different role. Fast delivery is one of the main competing aspects in these markets. Closely related to transport time is reliability and time of delay. These factors are valuated as more important than transport time.

The closing time at the place of dispatch refers to the time the goods have to be delivered to the place of transport. In most cases this is not a very important criterion. However in some cases the production process and the departure times conflict. In one case (see Spain) the products can only be delivered late in the afternoon. This is too late for the train to take the products with them. The flexibility in schedules, or rather the absence of flexibility, is more important.

The closing time for dispatch is criticised in certain markets. For example in Spain, where the closing time is too early to use rail for fresh agricultural products. A number of companies stated that their production process determines the closing time. Compared to road transport the closing time is sometimes a problem. In other words, road transport is almost always available.

Suitability of transport capacity is defined as the availability of transport capacity when needed. This seems to be a very important criterion. When capacity is lacking, transport cannot be performed. The availability of suitable wagons seems to be a problem in France and Germany. Another point is the quality of the transport capacity. In a number of countries the quality of the wagons was criticised.

Reliability of transport is without a doubt the most important factor. The most important thing about reliability is the possibility to plan (production, inventory and transport). This is also the factor, together with information that is mostly criticised in international rail transport.

The reliability is related to a number of aspects. The most important aspect is the time of arrival. It is no exception that trains arrive several days after the expected time of arrival. Wagons or containers are lost for several days. The main problem seems to be that when a (small) delay is encountered, the rigid time schedule doesn't allow a new sloth. Mostly this means 24 hours delay. It happens also that the delay is more than 48 hours (see the large number of shipments where this is stated).

The reliability of road transport is on average 94%. Still a lot higher than rail transport (64%) and even combined transport (72%). Especially the last figure is remarkably low because combined transport has fixed schedules.

The extend of delay is less important. If delay occurs this means that production or other activities cannot be carried out as planned. The delay in rail transport turns out to be very high. Because of the strict schedules and the limited number of rail slots, a delay mostly means a delay of 24 hours. This is irrespective of the total time. Even delays of 48 hours are not an exception.

The extend of delay in rail transport, is due to the rigid schedules, almost always 24 or 48 hours. Whether this is important or not differs per sector. Companies, who are used to rail transport and the delays, take a certain amount of delay in account and have extra stock for a number of days. This means that delay is not very important to them. In other cases it can lead to a considerable loss. The mean in the interviews was 21 hours for rail transport and only 5 hours for road transport. In combined transport the delay was 12 hours.

Flexibility to individual requirements refers to the possibility to change e.g. the amount to be transported or a change in departure time, it becomes more and more important and is not one of the strong points of rail transport. In production processes the stock in the pipeline is diminished or even reduced to zero. This means that directly after the production is finished, transport has to take place. If something goes wrong in the production process, transport has to wait. Road transport and even inland shipping can wait, rail transport cannot wait, because of tight schedules. This means that trains leave empty.

It can be stated here that the lack of flexibility is the cause that rail transport is disqualified in a number of transport branches. This is especially true for combined transport. The flexibility of rail transport is rated 64%, while road transport has a flexibility of 93%. Even the flexibility of combined transport is rated higher than conventional rail transport at 72%.

Risk of damage is for most companies very important. This is directly related to the number of transhipments. The larger the number of transhipment the higher the risk of damage. In a number of industries, especially car producers, the damage in rail transport is substantially higher than with road transport. In other cases it is very hard to determine whether production or transport is responsible for (invisible) malfunctioning. Electrical apparatus are a good example of this.

The risk of damage is, according to the interviews, the lowest with road transport (6 ‰) and the highest with rail transport (10‰). Combined transport is almost as damage free as road transport with an average of 7‰.

A closely related aspect is the damage caused by strikes of the railways. In the first place it is not easy to get the damage repaid. In the second place there is also a lot of sequel damage because wagons are not returned and priority is given to domestic clients. A strike of a week disorders the rail transport for several weeks.

Information during transport: In most cases shippers want information if something goes wrong. Status information (e.g. to localise the goods al the way) is far less important. The main difference between road transport and rail transport is that with road transport the shipper gets almost always information and with rail transports almost never. The information comes from the receiver of the goods, who complains that the products didn’t arrive. Some interview partners assume that the actual situation is worse because some receivers already take a delay in account and don’t notify the sender of the goods. The railways never take an initiative to phone clients when a delay occurs. Sometimes the client even takes the initiative to monitor the shipments. This touches a more general point: the lack of initiative on the side of the railways. New developments almost always come from companies and if you are lucky the railways are prepared to participate.

Announcement of scheduling problems during the trip (status information) is very important. Especially in cases of delay the receivers of the goods should be informed. One of the main complaints is that the shipper has to act. The initiative will never come from the railways.

The announcement of scheduling problems is best with road transport (89%) and worst with rail transport (59%), Combined transport has a better score than conventional rail transport with 79%.

1.5 The future of FREIGHT rail transport

From the interviews a rather clear picture about the present situation and the future of rail transport emerges. The majority of the interviewed companies are satisfied with domestic rail transport, but not with international rail transport. The major complaints are:

- Lack of reliability
- Too little flexibility
- Little or no co-operation between railway companies

In the white paper ‘A strategy for revitalising the community’s railways’ the directions are clear. Separating infrastructure and services, transparent financial liabilities and more competition are key elements. The interviewed companies support this direction.

1.5.1 Separation of track and services

The separation of track and services in different business units is one of the key points of the European commission in its white paper (July 1996) to make competition possible. The company works for his rail transport with EWS, the only railway company in the South of the UK, both for contracted as for non-contracted rail freight transport. They hire wagons from EWSR and have wagons of their own. Although the quality of rail transport improved a lot since the privatization, there is still a lot to improve like reliability, flexibility and tracing and tracking. But the tariffs are relatively competitive to road transport.

1.5.2 Access to tracks and competition

The opinion of most companies is that competition is necessary to encourage the needed improvements in management, services and equipment. Liberalisation will lead to higher investments and more market oriented management and services.

It almost goes without saying that most national railway companies are not in favour of competition. The profits on freight transport are very low at the moment. They fear even lower revenue from freight transport and lower safety standards leading to unsafe transport.

Most users of rail transport see increased competition as a way to improve the services of the national railways and to force them to more international co-operation. Competition between railway companies is not the ultimate goal. Better service for an acceptable price is the ultimate goal. The experience of companies using ‘outsiders’ state that the service from the national railways has improved from that moment.

As has been stated Sweden and Great Britain are in front with regard to liberalisation. This doesn’t mean that competition exist. Some companies in England complain that, although the market is privatised, only one company offers rail services in the South West of England.

Between different countries, the opinion about the necessity of liberalisation is different. Most French companies are happy with rail transport as it is at the moment and do not see why it is necessary to privatise rail transport.

1.5.3 Trans European Rail Freight Freeways and Eufranet

Although the concept of TERFF’s is relatively new, the term has in a short time become very popular. This is surprising because to this moment no TERFF actually exist. The freight freeway concept consists of:

- One stop shopping (OSS): a key element.

- Open access for all freight services.
- Guaranteed slots.

In the interviews the some companies thought that freeways were a step in the right direction. It should be noted that till this moment none of the six selected freeways actually functions mainly because of the infrastructure costs in Germany. Other companies did not see any real difference with the actual situation. Especially in combined transport several intermediates offer services comparable with the freeway concept.

The opinion about the future of railway varies among the interview partners. The opinion about European railways at the moment is unanimous: international rail transport cannot compete with other modes of transport. The quality is too low. Especially reliability and flexibility are below the required standards. It seems very necessary that a kind of European Railway will emerge.

In future road transport will be confronted with higher costs and an increasing congestion. This gives rail transport in principle a good position to gain some ground. This will however only happen if railways change. They should act more like a private company.

Competition is seen as a good start, but some remarks have been made about competition. The most important is that competition should not lead to a more complicated transport planning. Nowadays it is already very hard to negotiate with the different national railways. An increase in number of companies to negotiate with would make it more difficult to get an offer. At this moment the time to get an offer is already very long compared with road transport.

New concepts have to be developed, with emphasis on reliable transport, smaller shipments on the one hand and optimisation of transport capacity on the other hand. This is where infrastructure comes in. More reliable transport can only be guaranteed if the infrastructure capacity is large enough

The final conclusion must be that the railways in Europe have a long way to go. The current speed of changes is too slow to keep up with the changes in logistics in Europe.

Chapter 2 Modelling of Transport Demand and Forecasting 2020

2.1 Introduction

One of the main tasks of the EUFRANET project was the provision of an appropriate freight transport demand model, which is able to calculate market response of rail freight as a function of the new quality levels defined in the different strategies on a European wide scale. The simulation results for the different scenarios build the basis for the evaluation and assignment process.

The following four main working steps had to be carried out:

- establishment of the base year origin-destination matrices of freight transport flows within the European Union and the neighbour countries,
- calibration of the freight transport demand model,
- calculation of the reference forecast for the target year 2020 and
- calculation of rail freight market response for the different strategies (scenarios).

2.2 Base year Origin-Destination Matrices

2.2.1 Matrix Structure

The freight matrices used in the EUFRANET project consist of cargo flows by commodity group and by mode between zones of the 15 member states of the European Union and the neighbour countries Switzerland, Norway, Poland and Tschech Republic. The matrices are complete only concerning EU-12, Austria and Switzerland. For the other countries only the flows in relation with these 14 countries are included.[1]

2.2.2 Base year 1992 Matrices

Basis of the base year origin-destination freight transport matrices was the data base of the year 1992 received by NEA. As mentioned in section 2.2.1 the data base was complete only concerning EU-12, Austria and Switzerland. For the other countries only the flows in relation with this 14 countries were available.

A lot of working steps had to be carried out to establish a complete and consistent data base of freight transport flows of the base year 1992 which could be used in the EUFRANET project. The main working steps include:

1. combination of the different data sets received by NEA,
2. distribution of the mode sea/rest to the other modes for origin-destination relations without short sea connections,
3. zonal adoptions, especially disaggregation of the German and Swedish regions,
4. sublementation of transports within Sweden and transports to and from United Kingdom,
5. splitting of the mode rail into conventional and combined rail transports,
6. calculation of transport performance using a distance matrix calculated from an appropriate European road network.

[1] This means, that there are no flows included for example within Poland or from Poland to Norway.

2.2.3 Results

According to figure 2.1 all freight transport flows sum up to 10185 million tonnes and 1286 billion tkms. Only 8.6 % of the transport volumes and 39.7 % of the transport performance are done by international transports.

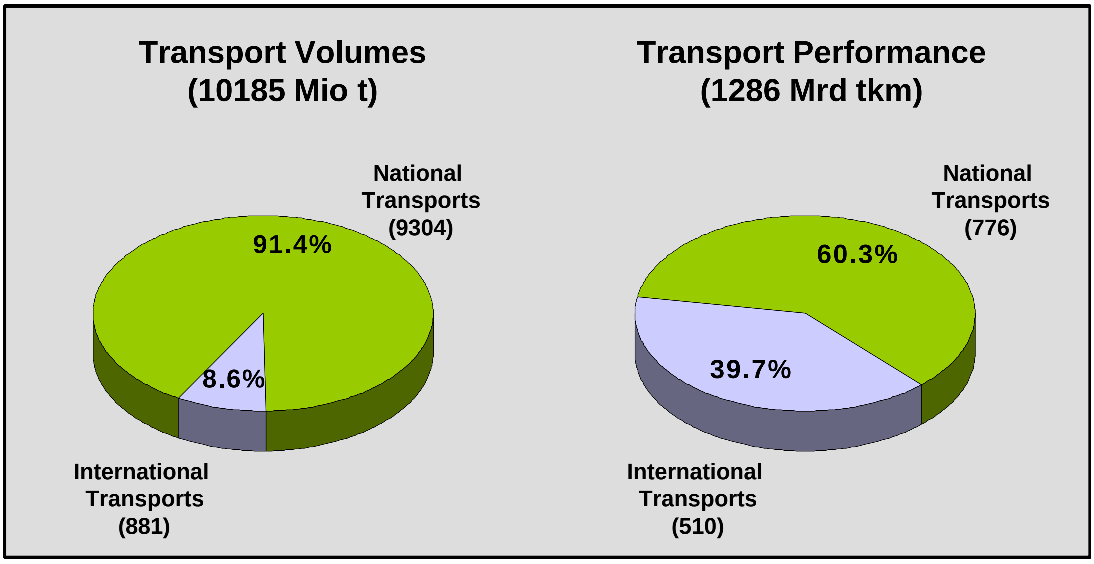


Figure 2.1: Key Figures 1992

An overview of the key figures for the different modes is shown in table 2.1. Concerning the transport volumes the modal shares are 0.3 % for combined transport, 4.1 % for inland navigation, 6.1 % for conventional rail transports and 89.4 % for road. For the transport performance the modal shares are 1.7 % for combined transports, 7.8 % for inland navigation, 13.1 % for conventional rail transports and 77.4 % for road.

Mode	National Transports	International Transports	Total	Percent
Transport Volumes [Mio t]				
Road	8577	536	9114	89.4
Rail conventional	522	100	622	6.1
Rail combined	18	18	36	0.3
Inland Navigation	187	227	415	4.2
Total	9304	881	10185	100.0
Transport Performance [Mrd tkm]				
Road	645	351	995	77.4
Rail conventional	101	67	168	13.1
Rail combined	7	15	22	1.7
Inland Navigation	23	76	100	7.8
Total	776	510	1286	100.0

Table 2.1: Key Figures 1992 by Mode

2.3 Freight Transport Demand Model

2.3.1 Model Components

The freight transport demand model which is used in the EUFRANET project for the forecasting of the Reference Forecast 2020 and the different scenarios 2020 consists of the following main model components:

- a demand model to forecast the total traffic in the year 2020 between zones as a function of the socio-economic assumptions,
- a disaggregated modal split-model to forecast the market response of the competitors as a function of the quality levels,
- a wagon model to convert the forecasted transport volumes of rail into loaded and empty wagons and
- a train simulation model developed by IVE to simulate the train building process and to assign the trains to the rail network.

Because the quality levels of rail are calculated as a result of the train simulation and therefore depend on the forecasted transport volumes and wagons an equilibrium process is applied. In this equilibrium process the demand model and simulation are executed until equilibrium between demand and quality is reached.

2.3.2 Demand Model

The task of the demand model is the prediction of the global freight transport flows between the zones (not splitted by mode) for the target year 2020 as a function of the assumed socio-economic developments. The demand forecast is done in a four step procedure. In a first step the demand by country and direction (national, export and import) is projected. In the following steps this demand is disaggregated by commodities and regions. Finally the regional distribution of the transport flows is done.

The projection of the demand by country is done independently for each direction and nation, exports and imports using regression functions calibrated on time series data 1970 to 1990 from EUROSTAT. Explaining socio-economic variables are gross value added and trade exports and imports.

Then the main demand by country and direction is disaggregated by commodities using commodity specific trends for each country derived from EUROSTAT data 1980 to 1992.

Task of the next working step is the disaggregation of the predicted demand for each country, direction and commodity group to zonal level using regression functions calibrated on the base year data. Explaining variables are employment and gross value added by market sectors.

In the last step the regional distribution of the transport flows is predicted using a double-constrained gravity model independently for national and international transports.

The mathematical formulation of the regression models and the gravity model is shown in table 2.2.

Main Demand

$$\ln t_c = \alpha_c + \beta \ln x_c$$

with

c	=	country,
t_c	=	tonnes for country c,
α_c, β	=	regression parameters;
x_c	=	socio-economic variable of country c (gross value added, trade exports and imports)

Disaggregation by commodities

$$\ln t_g = \; a_g + \left(b_g g \right) y$$

with

g	=	commodity group,
t_g	=	tonnes for commodity group g,
y	=	year,
α_g, β_g, γ	=	regression parameters.

Disaggregation by region

$$\ln t_{ig} = a_g + b_g \ln(d_i) + \sum_k g_{gk} \ln(x_{ik})$$

with

i	=	region,
g	=	commodity group,
t_{ig}	=	tonnes of region i in commodity group g,
d_i	=	density of region i (density = total transport volume of the country / GV
x_{ik}	=	explaining socio-economic variables of region i,
α_g, β_g, γ_{gk}	=	regression parameters.

Regional distribution

$$t_{od} = a_o b_d g_{od} \frac{t_o t_d}{\sum_{uv} t_{uv}} \exp(U_{od})$$

with

t_{od}	=	tonnes from zone o to zone d,
t_o	=	total tonnes dispatched from zone o,
t_d	=	total tonnes received in zone d,
U_{od}	=	utility from zone o to zone d calculated in the modal split-model,
α_o, β_d	=	parameters to adjust the predicted values to the former working steps,
γ_{od}	=	parameters to adjust the formula to the base year OD transport flows.

Table 2.2: Mathematical Description of the Demand Model

2.3.3 Modal Split-Model

2.3.3.1 Overview

The modal split-model used in the EUFRANET project for the calculation of market response is an aggregated state of the art multinomial nested logit model taking into account the specific needs of the EUFRANET project. BVU Beratergruppe Verkehr + Umwelt GmbH, Freiburg, has a long experience using such models and has applied them successfully in a large number of national and international studies.

The general approach for the modal split-model is based on the simple empirical experience that the decision-making behaviour of individuals does not present itself as a result of random coincidences but depends to a substantial degree on certain (behaviour)-determining framework conditions instead. This means for the specific case of mode choice decision in freight traffic that the mode choice decisions of the shippers are based on characteristics of the goods transported, characteristics of the dispatcher and receiver and characteristics of the available transport modes, and this decisions are largely depended on the intensity of this characteristics.

2.3.3.2 Survey

Starting point of the modal split-model was the existent disaggregate modal split-model for freight transport established by BVU on behalf of the German Ministry of Transport and the German Railway Company. This model is based on more than 700 computerised personal interviews carried out 1995 in producing companies and freight forwarders inside Germany and successfully applied in a large number of studies.

For the EUFRANET project an additional survey was done interviewing important European companies. In this survey especially international and long-distance transports are covered which are underrepresented in the German survey and which are important for the special needs of the EUFRANET project. Both the German and international surveys are then used together in the calibration of the European wide modal split-model.

Figure 2.2 shows the distribution of the achieved transports by mode, commodity group, consignment size and distance class the underlying screening and sampling plan of the survey was very successful. In addition also a wide range of different origin-destination relations were achieved.

2.3.3.3 Segmentation

Table 2.3 shows the segmentation of the data carried out. A total of four different segments were formed, each composed from one or more commodity groups. The fourth segment is for the very big shipment weights relevant to inland navigation. The table shows that the number of data records (mode choice decisions) in the four segments is between 606 and 6755.

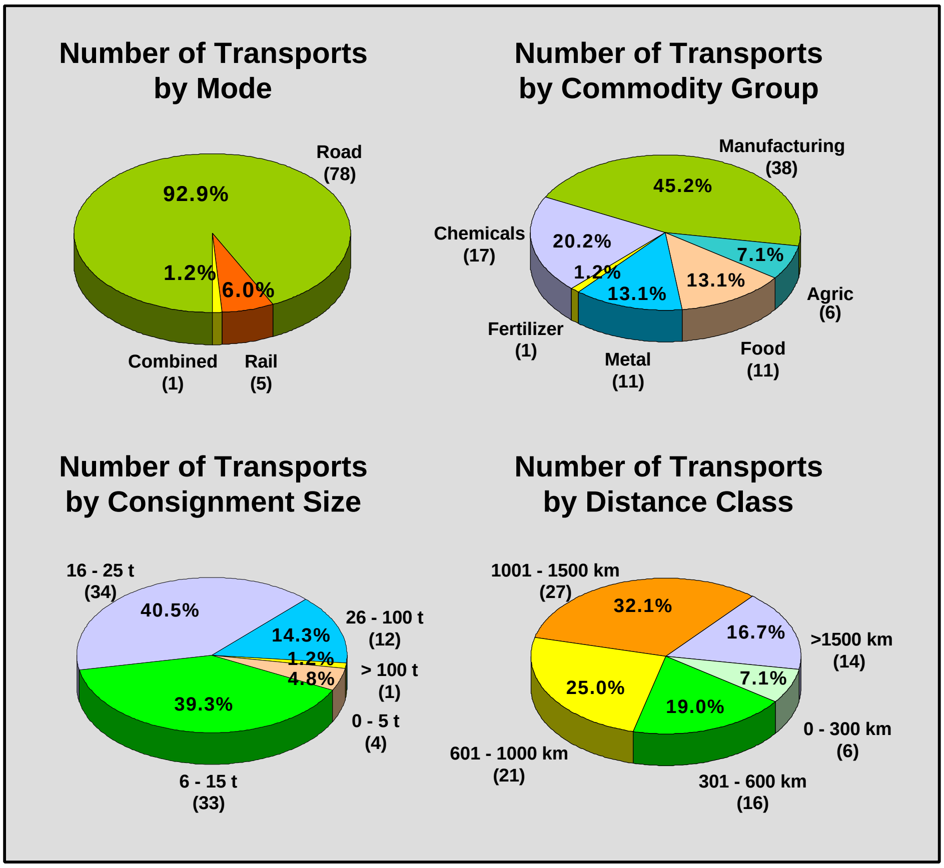


Figure 2.2: Number of Transports

	Number of Data Records			%
	RP	SP	Total	Total
1. Commodity Group 0 – 1: Agricultural, Food				
Road	180	1560	1740	81.0
Rail	6	131	137	6.4
Combined	10	260	270	12.6
Total	**196**	**1951**	**2147**	**100.0**
2. Commodity Group 5 – 8: Metal, Minerals, Chemicals				
Road	275	2292	2567	70.2
Rail	38	557	595	16.3
Combined	29	466	495	13.5
Total	**342**	**3315**	**3657**	**100.0**
3. Commodity Group: 9: Manufacturing				
Road	437	4243	4680	69.3
Rail	47	728	775	11.5
Combined	88	1212	1300	19.2
Total	**572**	**6183**	**6755**	**100.0**
4. All Commodities: Shipment Weight > 100 Tonnes				
Road	6	58	64	10.6
Rail	30	255	285	47.0
Combined	32	225	257	42.4
Total	**52**	**380**	**606**	**100.0**

Table 2.3: Segmentation of the Modal Split-Model

2.3.3.4 Model Estimation

The multinomial logit model assigns each possible alternative an utility which measures the attractiveness of this alternative. In the decision making process it is then assumed that the mode with highest utility is chosen.

Let

$$U_i = \alpha_0 + \sum_k \alpha_k x_{k,i} + \varepsilon_i$$

be the utility of mode i and

α_0	=	alternative specific constant,
α_k	=	parameter for characteristic k,
$x_{k,i}$	=	value of characteristic k for mode i,
ε_i	=	error term.

Then the probability p_i of choosing alternative i in the logit model is the well-known formula

$$p_i = \frac{\exp(U_i)}{\sum_j \exp(U_j)}.$$

Task of the model building process is to estimate the unknown parameters α_k for each model segment.

In the EUFRANET project a lot of extensions of the simple logit model were applied to improve the quality of the model. Main extensions are:

1. the scaling of the revealed and stated preference data sets to avoid biases in the estimation process,
2. taking into consideration inertia dummies, which measure, how far the choice in the stated preference experiments depends on the actual choice,
3. avoiding of constant cross elasticities by using hierarchical (nested) logit models,
4. using nonlinear transformations of the characteristics (box-cox-transformations)[2],
5. joint estimation of all model parameters and
6. extending the logit model by a so called “in-market”-value reflecting the fact that the time sensibility (value of time) depends also on the difference of the transport time of the available modes.[3]

The result of the model estimation is shown in table 2.4. For all four model segments a model could successfully be estimated. For segment 1 and 3 a hierarchical model was estimated.

[2] In the box-cox-transformations price and time are transformed by the functional specification

$$x \rightarrow (x^{\lambda}-1)/\lambda \quad (0 < \lambda \leq 1).$$

One advantage of this nonlinear models is the fact that the value of time (VOT) is not a constant as in the linear case but a function of price and time.

[3] When the transport times are comparable then reactions are much higher compared to the case that one mode is much faster than the other mode.

Segment		1,Comm. group 0-1	2,Comm. group 5-8	3,Comm. group 9	4, >100 t
Observations		2147	3657	6755	606
Final log(L)		-608.6	-1292.2	-2358.9	-176.0
D.O.F.		18	17	21	17
$Rho^2(0)$		0.6018	0.5004	0.5091	0.5830
$Rho^2(c)$		0.3401	0.3914	0.3918	0.5653
Variable	**Applies to alternative**	**Parameters (t-statistic)**			
pprice	all	-0.7313 (-4.4)	-1.187 (-7.5)	-0.9570 (-8.2)	-1.645e-4 (-4.1)
ptime*	all	-0.5688 (-2.7)	-1.208 (-5.0)	-1.056 (-6.5)	-6.679e-5 (-1.2)
pfitn	all	0.01474 (3.7)	0.02762 (6.6)	0.02416 (7.4)	0.01846 (3.2)
padds	all	0.002902 (0.7)		0.004566 (1.9)	
preli	all	0.02133 (3.7)	0.01713 (4.2)	0.009368 (4.2)	0.007155 (1.4)
pdelay	all		-1.903e-4 (-2.1)	-1.682e-4 (-2.5)	
pflex	all				
prisk	all	-0.003143 (-1.1)		-0.006374 (-3.2)	
pprob	all			0.001855 (1.7)	0.01645 (3.2)
proadrp	road				0.7339 (0.8)
prailrp	rail	-2.828 (-4.0)	-1.372 (-5.6)	-2.037 (-7.3)	
pcombrp	combined	-1.664 (-4.5)	-1.007 (-3.7)	-0.5865 (-3.7)	
pshiprp	ship				-0.1010 (-0.2)
proadsp	road				0.8794 (2.2)
prailsp	rail	-1.075 (-3.0)	-0.9587 (-5.1)	-0.6320 (-4.7)	
pcombsp	combined	-0.3862 (-2.6)	-0.1037 (-0.8)	-0.2523 (-3.2)	
pshipsp	ship				-0.3058 (-0.7)
pinert	all	0.2053 (2.0)	0.7436 (5.9)	0.5722 (7.0)	0.3572 (2.2)
ptrack2	rail	0.7695 (2.6)	0.7943 (4.2)	0.6935 (5.0)	
pton4	ship				0.00102 (2.4)
pkm2	rail				0.002766 (3.8)
pfragile1	road	0.4095 (2.5)		0.07475 (0.8)	5.926 (3.5)
pbigvolum1	road				-2.416 (-2.8)
pjit1	road		0.3917 (2.5)	0.02308 (0.3)	3.535 (3.3)
pgrenz2	rail		0.5722 (3.4)		
pgrenz3	combined	0.5267 (3.0)	0.3043 (1.6)	0.3796 (4.1)	
pgrenz4	ship				1.618 (3.1)
scaleSP1	all	1.473 (4.5)	0.8462 (7.2)	1.235 (8.1)	1.397 (3.7)
scaleRP	all	2.220 (1.5)	0.9880 (2.6)	3.175 (2.2)	
scaleSP2	all	1.481 (3.4)	0.6790 (5.3)	1.362 (6.0)	
tree 13	all	0.8357 (8.4)		0.7403 (18.1)	
boxcox	all	0.2	0.2	0.2	

* Total transport time scaled by "in-market"

Table 2.4: Description of the Mode Choice Models

Figure 2.3 shows the resulting value of time in ECU per ton and minute for the different model segments.[4] Highest value of time is in segment 3, followed by segment 1 and segment 2. Only a low value of time is shown in segment 4 (very large transports relevant to inland navigation).

4 Only for the linear models.

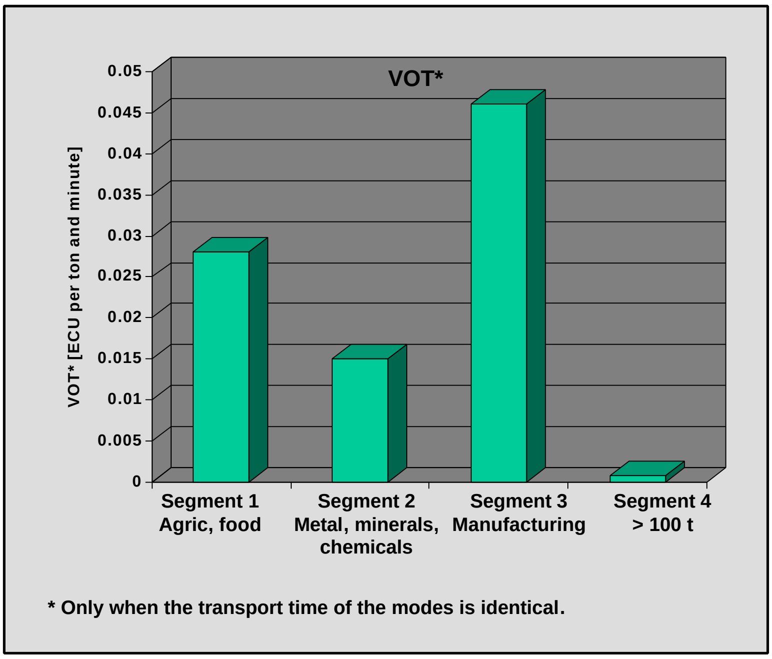


Figure 2.3: Value of Time (VOT) by Segment

An additional validation of the model was done comparing the observed and simulated mode choice decisions with the predicted choices from the model. As a result the model is able to correctly predict 83 % and more of the mode choice decisions in all segments which means a high quality.

2.3.4 Wagon Model

The wagon model is used to convert the forecasted traffic volumes of rail freight into wagons.

The structure of the wagon model is shown in figure 2.4. In a first step the origin-destination transport volumes are converted into loaded wagons by applying average loading weights per mode and commodity group. In a second step empty wagons are added so that the number of wagons in both directions are balanced. The final wagon matrices are then transformed to IVE to run the train simulation model.

2.3.5 Market Response

Figure 2.5 shows the procedure which is used to calculate the market response. In the simulation process the transport demand 2020 is splitted to the different modes by applying the modal split-model independently for each OD pair and commodity group.[5]

The quality levels for road and inland navigation are calculated directly within BVU by using appropriate networks and searching best routes in the networks.

For rail (both conventional and combined transports) the situation is more complex. In this case an equilibrium process is simulated taking into account that the outcome of the modal split-model depends on the quality levels and the quality levels themselves as a result of the train simulation depend on the traffic volumes.

5 Calculation of market response is done only for interzonal transports.

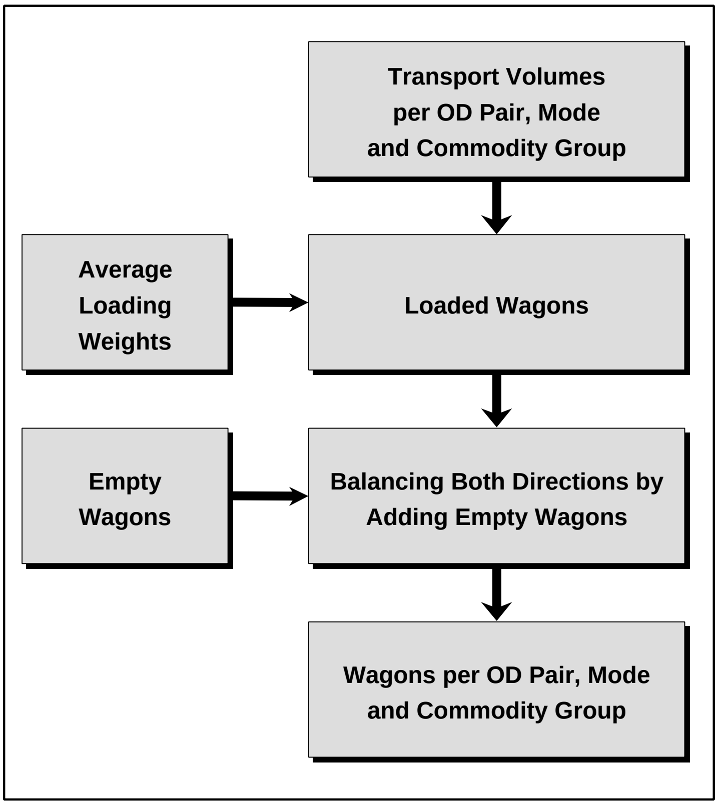


Figure 2.4: Structure of the Wagon Model

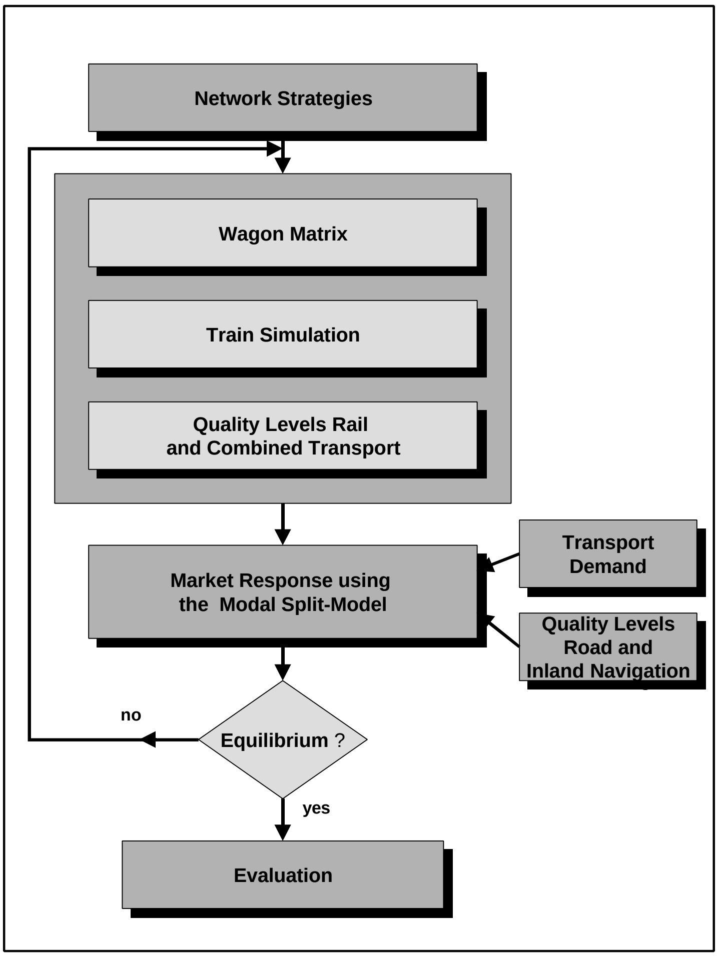


Figure 2.5: Market Response

2.3.6 Application System SIMU-GV

All components of the freight transport model[6] together with analysis tools are integrated into BVU's existing simulation system and equipped with a uniform, user-friendly surface. All components are multilingual.

Main components of the application system are:

SIMU-GV: This is the main co-ordinator of all components of the application system including the administration of the scenarios and interfaces for export and import.

Simulation: In this component all simulation steps (demand forecast, modal split, wagons etc.) are executed.

ROMP: Analysing tool for the database of origin-destination transport flows.

MapEdit: Graphical information system for
- generation of thematic maps,
- presentation of origin-destination transport flows,
- presentation and maintenance of networks,
- presentation of network loads.

2.4 Reference Forecast 2020

The so called Reference Forecast 2020 is based on the current quality levels in rail freight transportation and serves as a basis for the development and evaluation of new network strategies.

2.4.1 Scenarios of Macro-Economic Environment

The macro-economic scenarios underlying the EUFRANET project are based on the two publications European Regional Prospects[7] and SCENARIOS[8]. The European Regional Prospects contain regionally and sectorially differentiated data for the base year 1995 and the forecast year 2001, while SCENARIOS provides data for the base years 1993 to 1995 and the forecast years 2000 to 2040 in a sectorially and regionally more aggregated form.

For the special purpose of the EUFRANET project the two data sources were combined to get consistent and complete macro-economic scenarios for the base year and the target year 2020. The final socio-economic scenarios include the following variables:

- population by region,
- employment by region and sector

[6] Excluding the train simulation model which is run by IVE, Hanover.

[7] European Economic Research and Advisory Consortium (ERREO), European Regional Prospects, Analysis and Forecasts to the Year 2001 for European Cities and Regions, Volume 2: Detailed Historical Data and Projections by Region and Sector, May 1997.

[8] SCENARIOS, Deliverable no. D2, External Developments and Relationship to the Transport Sphere, October 1997.

  - agriculture,
  - energy and manufacturing,
  - construction,
  - market service,
  - non market service,
- gross value added (GVA) by region and sector
  - agriculture,
  - energy and manufacturing,
  - construction,
  - market service,
  - non market service,
- trade by region and direction
  - import,
  - export.

Figure 2.6 shows the annual growth rates of the individual variables until 2020 in the sum of all countries. Accordingly, the population growth with 0.1 % per year and the number of persons employed with 0.3% per year is relatively moderate, whereas the gross value added with 2.6 % growth per year shows a substantially higher growth rate. In all, this means a growth in productivity of 2.2% per annum. By far the highest growth rates are shown in foreign trade. Figure 2.7 show the distribution of population in 1995 by NUTS2 region, Figure 2.8 and 2.9 present the regional distribution of GVA in 1995 par habitant and increasing rate of GVA between 1995 and 2020.

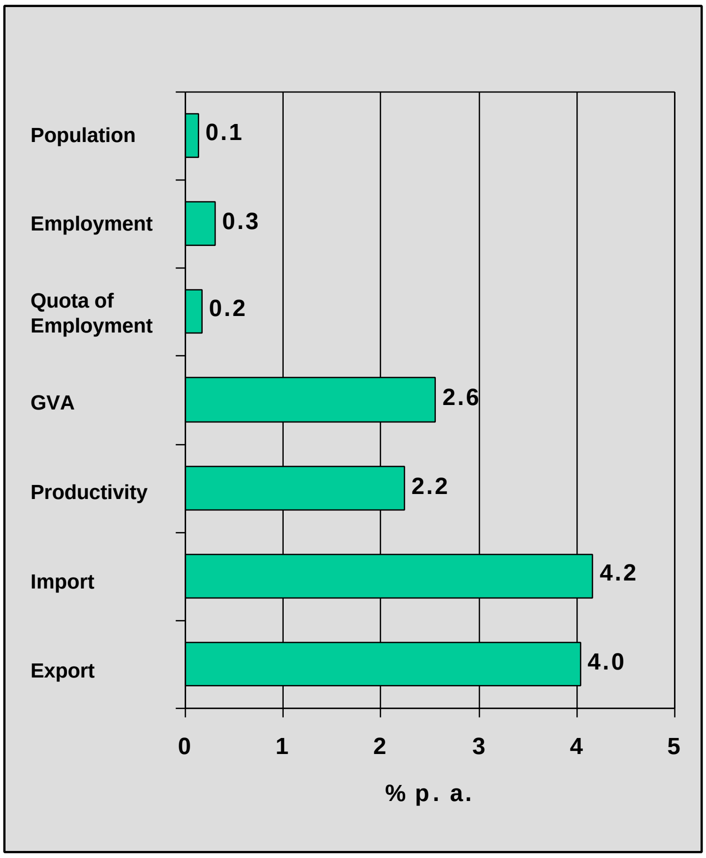


Figure 2.6: Annual Growth Rates

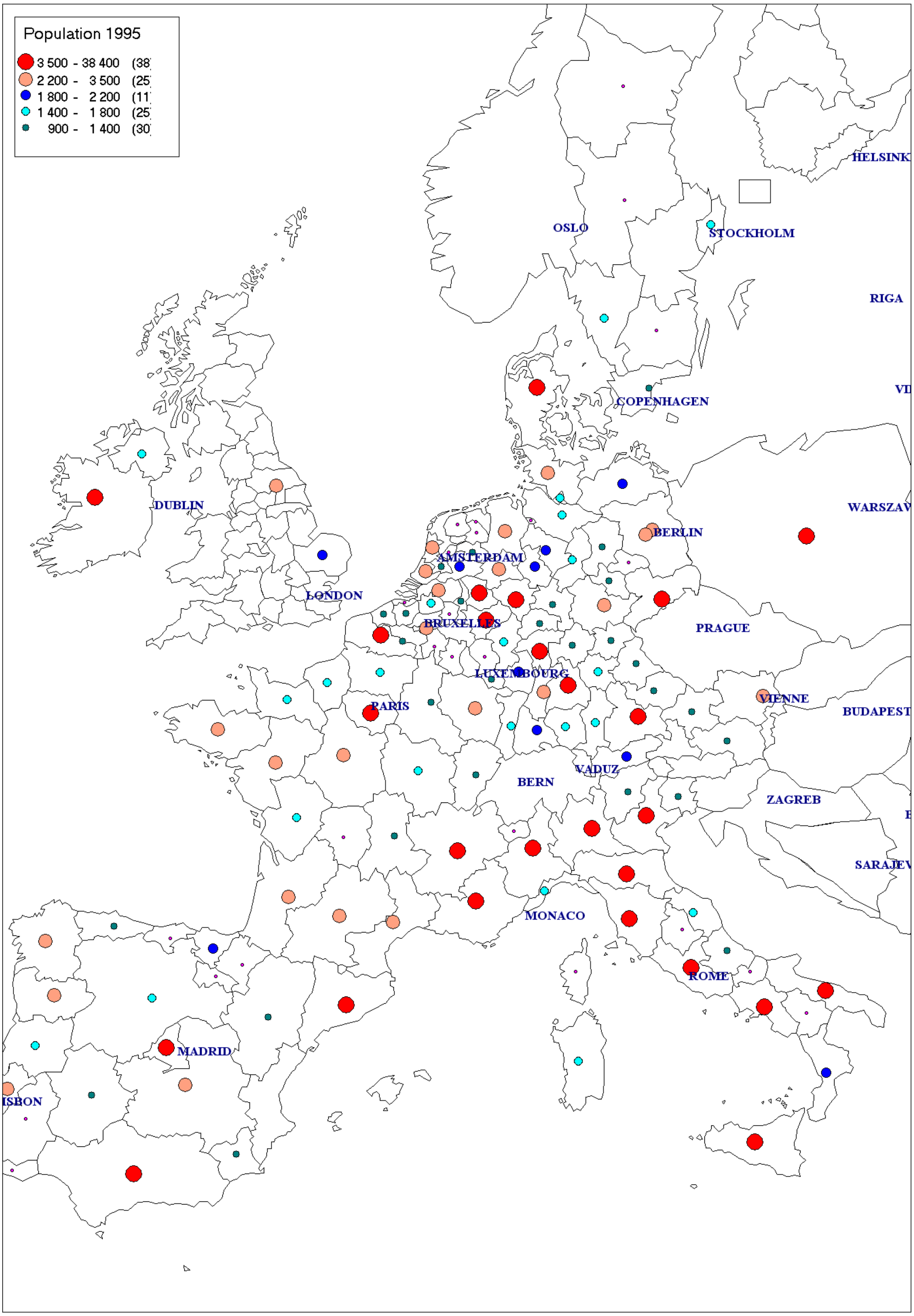


Figure 2.7 : the distribution of population in 1995 by NUTS2 region

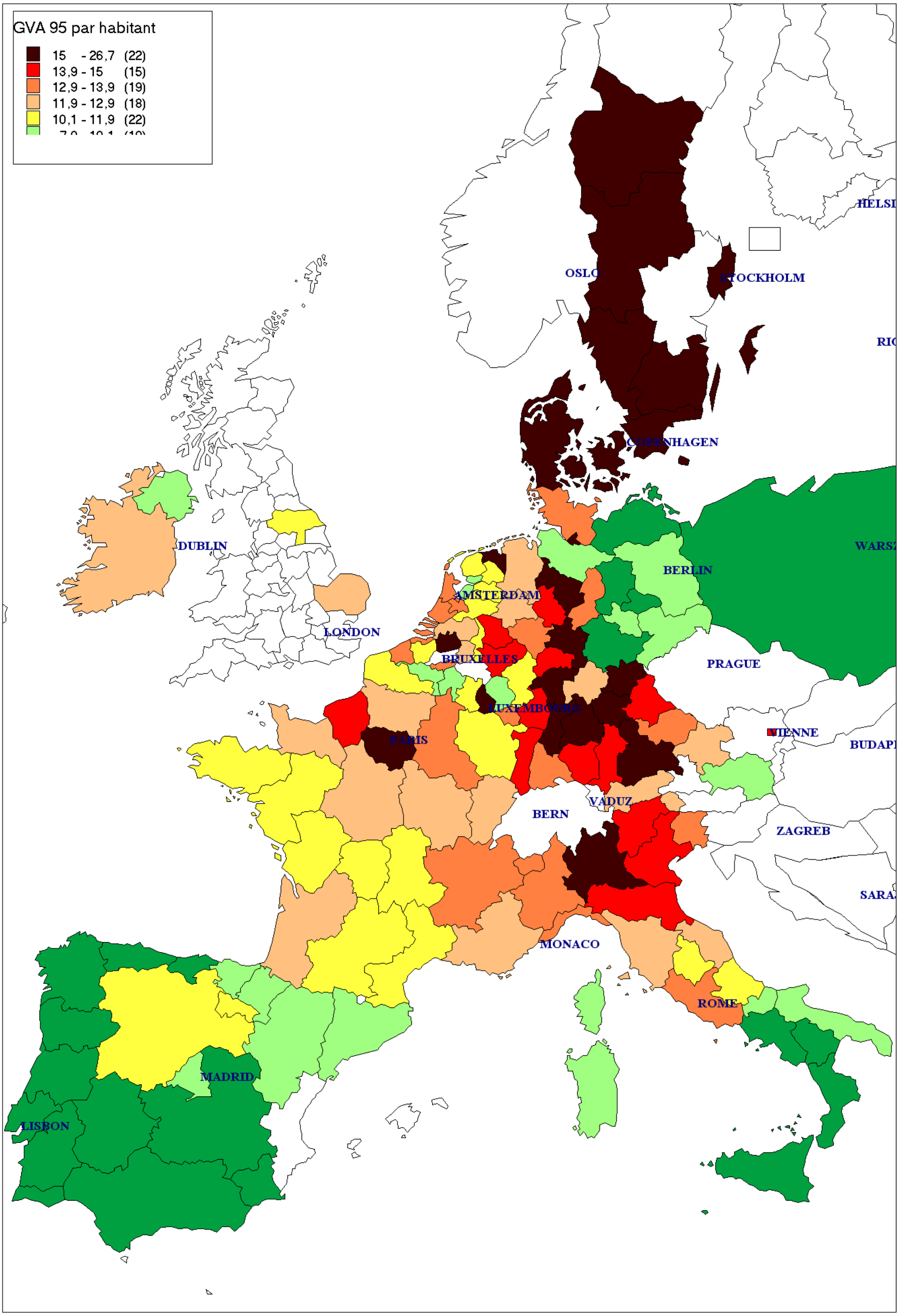


Figure 2.8 : distribution of GVA per habitant in 1995 and in NUTS2 region

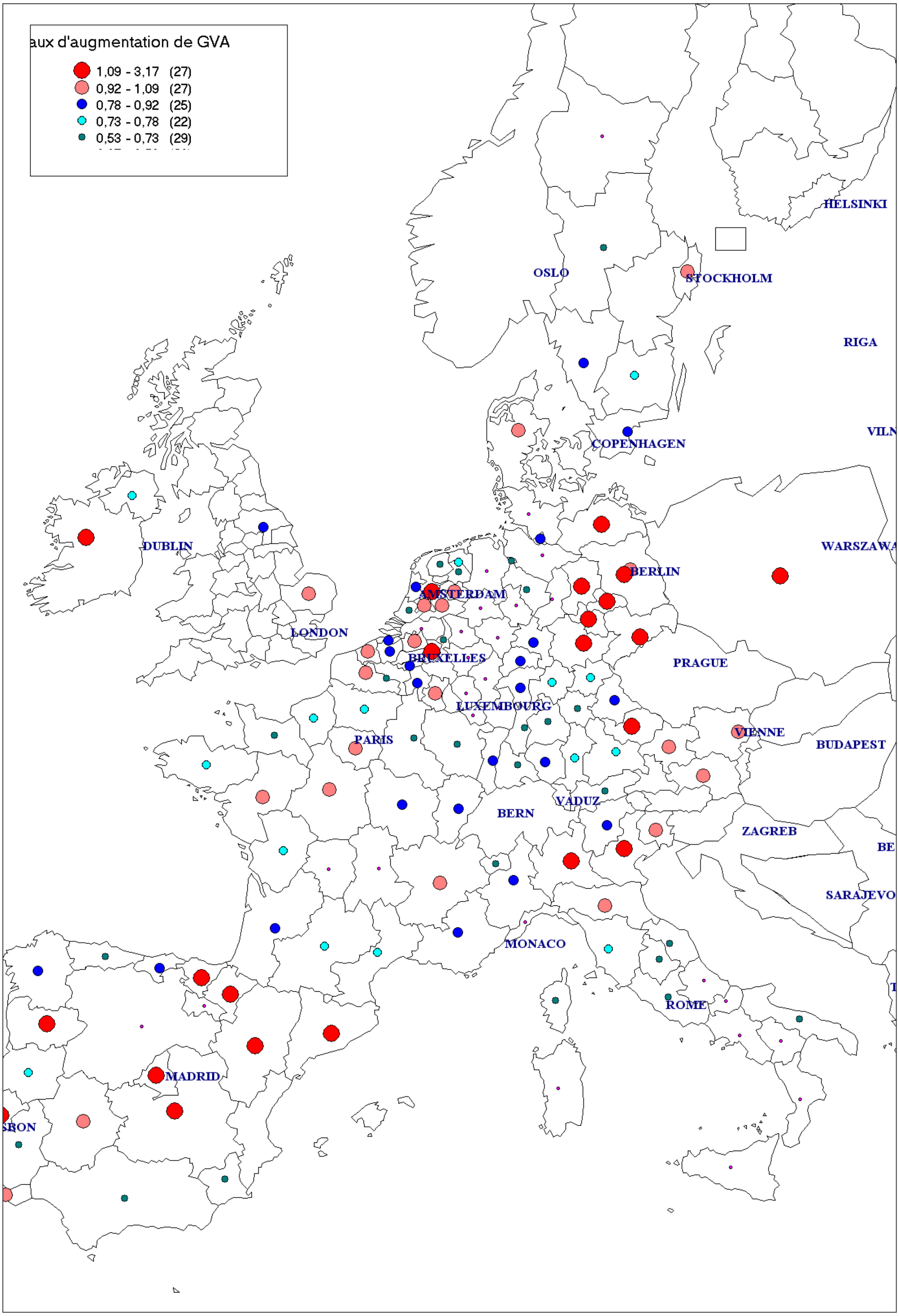


Figure 2.9 : increasing rate of GVA per habitant in NUT2 region between 1995 and 2020

2.4.2 Quality Levels

The quality levels of road are calculated by using a huge European road network that consists of more than 7500 modes and nearly 12000 links. For each link the following information are coded:

- Distance,
- Link type including Motorway, Major road, Ordinary road, Ferry,
- Number of lines,
- Maut.

The transport time of road between two zones is calculated by searching the fastest route in the network and adding resting time for the drivers and loading/unloading time. For the transport price average price functions are used which depend on the shipment weight, transport distance and commodity group. On the average the price functions result in 0.080 ECU per ton and kilometre.

The quality levels of inland navigation are calculated in analogy to road by using an appropriate network consisting of 376 nodes and 437 links. Each link contains the following information:

- Distance,
- Gradient (up, down or even),
- Number of locks,
- River.

The transport time of inland navigation consists of access/egress on road and the shipping time on the network including waiting time for the locks and resting time. The transport price is calculated from costs for loading and unloading, access/ egress on road and price functions for the shipping price on the network. On the average the transport price results in 0.028 ECU per ton and kilometre on the network and 0.042 ECU per ton and kilometre including loading/unloading and access/egress on road.

As mentioned in the previous sections quality levels of conventional and combined rail transports are provided by IVE, Hannover as a result of the train simulation. For each OD pair and mode the following information is transferred to BVU:

- transport time on the network,
- distance on the network,
- transport time for access/egress on road,
- distance for access/egress on road,
- number of rearrangements.

The transport price is calculated within BVU using price functions on the network and adding costs for loading/unloading and access/egress on road. On the average the price functions result in 0.040 ECU per ton and kilometre on the network and 0.065 ECU/tkm for conventional transports and 0.054 ECU/tkm for combined transports including loading/unloading and eccess/egress on road.

For the Reference Forecast the following assumptions are made:

- **Road:** Reduction of transport price –1 % per year (-24.5 % from 1992 to 2020).
- **Inland navigation:** No changes to the base year.
- **Rail conventional and combined transport:** Changes to the base year only as a result of changed wagon matrices.

2.4.3 Results

The main results of the Reference Forecast 2020 are listed in table 2.5. Accordingly, the total freight volumes increase by 27.8 % and the freight performance by 70,5 % from 1992 to 2020.

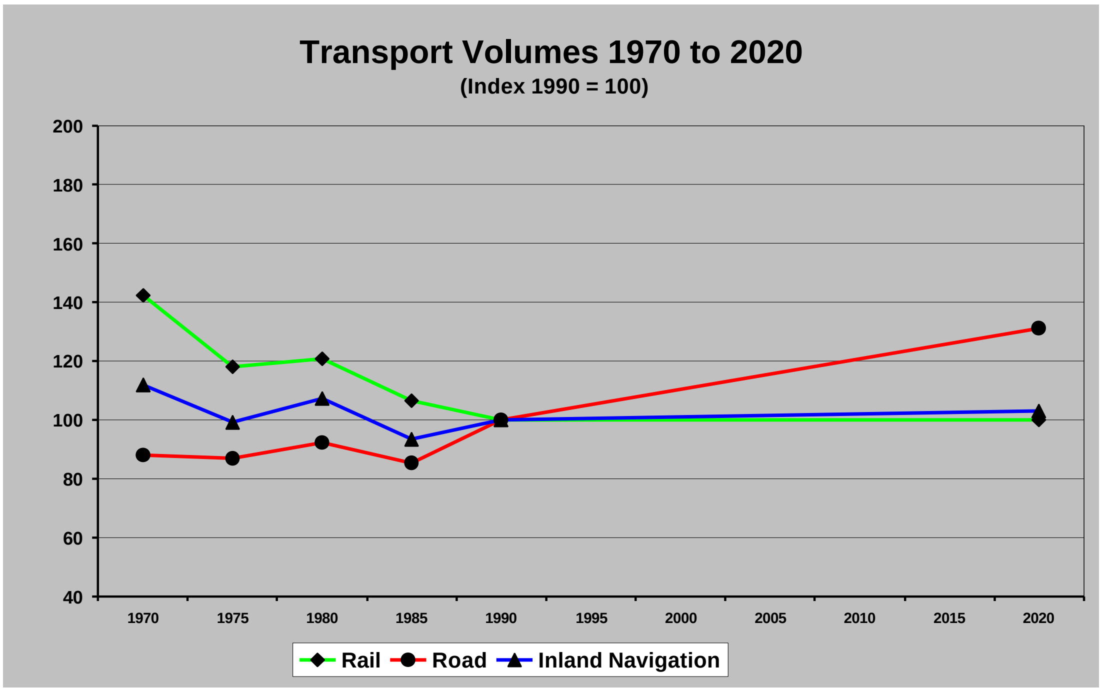
The highest growth rates are expected for road and combined transports. For conventional rail transports and inland navigation the volumes change only a little and the performance is increasing by 13 % and 19 %.

Mode	**Volumes**				**Modal Split**	
	1992 [Mio t]	**2020 [Mio t]**	**Difference [Mio t]**	**[%]**	**1992 [%]**	**2020 [%]**
Road	9113.7	11934.6	2820.9	30.95	89.48	91.70
Rail conventional	621.7	604.9	-16.8	-2.70	6.10	4.65
Rail combined	35.5	48.3	12.7	35.87	0.35	0.37
Inland navigation	414.5	426.4	11.9	2.86	4.07	3.28
Total	**10185.4**	**13014.1**	**2828.7**	**27.77**	**100.00**	**100.00**

Mode	**Performance**				**Modal Split**	
	1992 [Mrd tkm]	**2020 [Mrd tkm]**	**Difference [Mrd tkm]**	**[%]**	**1992 [%]**	**2020 [%]**
Road	995.5	1849.2	853.7	85.76	77.39	84.33
Rail conventional	168.5	190.4	21.9	13.03	13.10	8.68
Rail combined	22.4	34.2	11.8	52.53	1.74	1.56
Inland navigation	99.9	119.1	19.2	19.19	7.77	5.43
Total	**1286.3**	**2192.9**	**906.6**	**70.49**	**100.00**	**100.00**

Table 2.5: Key Figures of the Reference Forecast 2020

The comparison of the expected growth rates of the transport volumes and performance with the development of European freight transport from 1970 to 1990 is shown in figure 2.7. The figure shows that the growth in freight transport mainly goes back to high growth rates of road whereas rail and inland navigation is decreasing or increasing with only low growth rates.



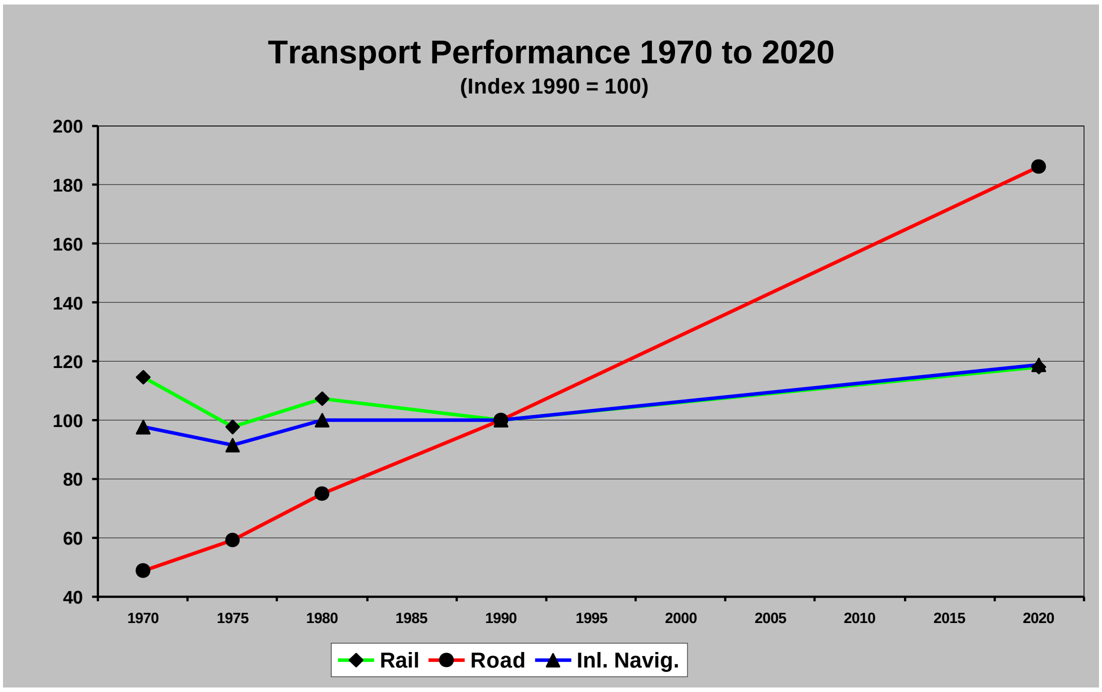


Figure 2.7:Transport Volumes and Performance 1970 to 2020 (Reference Forecast)

Chapter 3 Operation Alternatives and Simulation of Transport Supply

3.1 Alternative of Rail Operation

The aim of this section is to create a list of technical and operative solutions for a future railway network, which describe the alternative solutions in terms of techniques, operation and infrastructure. It should collect and process available data from European railways, railway associations and research institutes, for example UIC, ERRI etc. Finally the correlation of these alternative solutions with the quality of service will be made.

3.1.1 Alternative Solutions

Monitoring systems: Monitoring systems include systems for the supervision of rail operations (signal monitor, train supervision, etc.) as well as systems which monitor the route, the transport time and other characteristics of the transport goods.

Early Error Detection: If a fault occurs during transport it must be recognised and analysed as quickly as possible. The results of the analysis should automatically define the necessary measures. For example: an overheated wheel must be identified as quickly as possible in order to avoid further damage to vehicles and tracks. Since overheated wheels generally result in delays to the train, the consignee should be promptly informed of the incident. It is also desirable to be able to issue the customer with a handling plan, giving details of the expected arrival of the train and whether, and to what extent, the goods are damaged.

Standardisation of Electronic Data Exchange: The process of transportation inevitably requires various administrative tasks to be carried out. It is desirable to have a standard procedure throughout Europe which could electronically process the necessary paperwork, e.g. way-bills, duty forms, delivery contracts, etc. Each interface between customers, suppliers, operators and the rail companies would then be identical, making the process simpler for the customer. It would also intensify the competition between suppliers, since the customer would not need to change computer systems when changing transport company but could continue to work with the same system. Systems such as HERMES, DIBMOF, ERTMS etc. have established a basis for exchange of standardised electronic information.

Localisation Tools: Localisation tools enable the positioning of individual carriages within a train. This information can be used to help supervise an operation of the train or to aid the planning of a rearrangement of the train at the next station. It can also be passed on to the customer to give them an indication of the progress of their goods. Global Positioning System (GPS) is an example of a localisation tool in use.

Automatic Coupling/Decoupling: The manual coupling and decoupling of wagons at marshalling stations currently makes up a high proportion of the duration of stay of a wagon. With the help of automatic coupling systems, for example the innovative Z-AK (jointly developed by Knorr-Bremse and the DB AG), the coupling process can be carried out more quickly. Experiments are currently being run by the DB AG, SBB and FS with some success.

Since vehicles with Z-AK can be coupled to vehicles with conventional coupling there is no need to simultaneously convert all European wagons. The wagons can be converted step by step, which makes the investment necessary for the conversion easier for the rail companies to plan and finance.

Standardisation of Train Assembling/Dissembling Processes: The goal is to reduce the number of processes in the transport chain: Each step within a transport chain carries the risk of an incident or delay and the possibility of damage to goods. A reduction in the number of separate steps in the chain reduces this risk. Added to this the costs for the shipment are optimised, resulting in a reduced transport price.

Obligate Schedules: The departure times of freight trains do not currently adhere to a schedule. A delayed departure from the station generally results in route conflicts with other trains. If the conflicting train has a higher priority, the delayed goods train must divert onto a relief track to allow the priority train to pass. Once this manoeuvre is completed the freight train may resume its route. Since diverting onto another line greatly reduces the speed of the train, every overtaking manoeuvre results in an additional delay. The result is a late arrival. If the departure times were more strictly observed, such delays could be avoided.

Dedicated/Priority Networks: The latest network strategies of large railway companies involve the integration of passenger and goods traffic. The aim is to allow goods traffic to use high quality stretches of track during the day. This will make harmonising speeds easier to achieve.

In a dedicated network certain routes would be reserved exclusively for goods traffic. There would also be guaranteed minimum values for certain parameters, for example axle loading, loading gauge, signalling systems, etc. In a Priority Network passenger trains would also be permitted but with a lower priority for route allocation purposes.

New Locomotive Generation: Current vehicles are planned with an expected operating lifetime of 15 to 20 years. Most locomotives will only be replaced with new, technologically up to date models after their lifetime has expired.

This results in several disadvantages in comparison to transportation using heavy goods vehicles, which have a life-cycle of 3 to 7 years. In the construction and fabrication of locomotives, adequately constructed (and therefore very costly) parts and materials must be used. A further problem is that due to the long life span of a locomotive, technological developments, for example the cleaning of exhaust fumes, struggle to make an impact on rail technology. Arguments such as the environmental advantages of rail over road transport are hard to justify when comparing a 10 year old diesel locomotive to the new generation of HGV engines.

The construction of locomotives with a shorter life span reduces costs in development and construction. New technology can enter the rail industry more easily. This not only has positive effects on the image of rail but also has environmental advantages. The automation of operations also offers advantages and helps to save costs. The savings can then be passed on to the customer, making rail transport a more competitive option in comparison to road transport.

Unit Construction System: Locomotives built according to building block principles are more economical than those formed individually. Building block principles used by other industries, e.g. HGV or aeroplane construction, are particularly suited to adaptation for the rail industry. This reduces development costs and indirectly helps to lower transport prices in the rail sector. The CargoSprinter produced by DB AG is an example.

Standardisation of Equipment, Signalling, Wagon Techniques: Varying, and often incompatible technology is currently used by the rail companies in Europe. For example; incompatible signal technology, different wagon construction techniques, various types of wagon coupling and braking systems. This leads to increases in costs as well as self-erected barriers and this means HGV transport gains competitive advantage. Some examples of problems are:

- Because of a slightly differently constructed overhead cable the DB AG electric locomotive can only be driven from Germany to Switzerland when the current collector is changed.
- Different signal systems mean that multi-system locomotives are necessary for traffic crossing borders. Because of the technology needed to recognise the different systems, this is considerably more expensive than a conventional locomotive. ECTS offers the first solutions to this problem.
- The different braking systems necessitate maximum speeds for different types of carriage. If a wagon with conventional braking technology is attached to an international train where all other carriages have modern brake technology, the maximum speed would be that of the wagon with the old style brakes.
- The variation in loading gauges means that it is impossible to use some wagons in international transport. It is therefore necessary for the rail company to maintain at least two types of wagon: one for national and one for international traffic. This enormously increases the cost of investment in rolling stock.

The use of uniform technology in these areas would mean simplification of operation and also construction. Standardisation of technology would also drastically reduce planning costs. This would have great advantages in terms of costly individual and special solutions and also in development costs. The cost of manufacture of the equipment would decrease because more construction could be done using already prepared units. This leads indirectly to a drop in transport costs and also to a reduction in the price of rail transport.

Standardisation of Train parameters: Varying standards in the rail infrastructure throughout the EU-States make the operation of international transport difficult. The standardisation of train parameters within Europe should be carried out to improve the situation. Examples of parameters are maximum speed, load (tons) per metre, train length, loading gauge, maximum train weight, axle load, minimum performance standards for locomotives, etc.

New Technologies: To achieve quicker and cheaper handling of goods using combined traffic countless new technology has been developed. It is important that these techniques only cause low adaptation costs to the HGV side. Technologies such as Road Railer, Kombitrailer or the Automatic Loading System (ALS) are techniques which have already proved their day to day worth, or are about to do so.

In conventional wagonload traffic a high degree of automation is required to quickly and efficiently carry out a carriage change over. Moreover the present day weight and length limits for trains should be exceeded. The automatic coupling and decoupling of wagons (developed by Knorr-Bremse and the DB AG) is helpful in this respect (see Automatic Coupling and Decoupling).

Using the mechanical connection of the automatic coupling, the brake and electrical cables can also be automatically connected. By means of electric steering cables (ESL) information about the state of the wagons, the contents of the wagons, the transport destination, the customer infrastructure and the further relevant information can be transmitted. Tedious manual brake tests, written records of the wagon order, etc. would be discarded. Moreover the information could be linked with a Monitoring System (see above).

Using the ESL system time consuming brake tests could be automated. Fast and effective electronic brakes could be used in place of the convention air pipe line braking systems. This electronic braking system permits higher loading and a higher maximum speed.

The SJ LightContainer is another idea which could help to optimise transport times, transshipment and environmental pollution. An extremely light container (max. 15t) is used which can be carried on a light wagon with only two axles. This reduces the total weight of the train, with the consequence that the train can travel faster than a conventional train, cutting down the transport times. A further advantage is that the lighter train uses less energy, which is environmentally advantageous. Because the container is so light it can be lifted with simple shipment equipment, for example a fork-lifter, which is cheap and convenient for customer delivery.

New Operation Techniques, New Production Systems: To remain in competition with HGV's in conventional wagonload traffic, a new, more efficient method is necessary. A decisive factor in cost increase is the reorganisation of the carriages in marshalling yards. The expenditure on personnel, infrastructure of modern marshalling yards and shunting methods necessary for the operation results in high costs in the total transport chain. To make the process more economical it is necessary to minimise the number of times the carriages have to be shunted (within a single transport chain). This can be achieved using new production systems, for example Train-Coupling and Sharing.

This process builds small Block Trains which have the advantages of low transport times and high flexibility. Block Trains which partially travel the same route are coupled together, making long trains (Train-Coupling), and subsequently travel along the same route as one train unit (Train-Sharing). This reduces the cost whilst at the same time helping to ease the problem of bottlenecks. Train-Coupling can be carried out on empty stretches of track which renders shunting unnecessary. Modern technology enables the coupling of train units to take place whilst trains are moving so there is no time loss at this stage. Extensive research into the TCS System is carried out at IVE.

Automatic trains without drivers (Signalgesteuerte Transporteinheiten SST) are a further increase in the level of automation. This system is currently being developed for works traffic by the DB AG together with VW. Using this system the train would be led exclusively by the signalsystem. Another example of driverless trains is currently in operation on Line 14 of the Paris Metro. Trains are sent without drivers through the Paris Underground system.

Another method is the Mega-Hub-System. Carriages are collected at one or more points (Mega-Hubs), processed and and then driven to their destination. All trains arrive from all directions simultaneously. The trains then travel on as a transport unit, according to their destination station. This technique is used by the postal service in America with great success.

Offer orientated Production Systems are another type of production process. Whilst most systems operate according to demand; i.e. a particular departure time, length or route of the train, the offer orientated systems have previously determined carriage configuration, route and departure time (like passenger trains). Liner-Trains are an example of an offer-orientated system used with combined traffic.

Liner-Trains are trains with a fixed number of wagons. The configuration of the train does not change during the journey. In a similar way to a passenger train, Liner-Trains travel a fixed route at a fixed time. Liner-Trains were thoroughly investigated at IVE.

Homogeneous Traffic Flow: To increase the flow of trains through a network, it is worthwhile adjusting the speeds of the trains to suit one another, i.e. harmonising. This process is significant at points where operational bottlenecks exist. Speed harmonisation can be used for both goods trains and passenger trains. It is an effective instrument in a priority oriented network.

International Disposition System, International Rostering Planning: For an effective and economic operation it is important to establish the international positioning and allocation of rolling stock and locomotives. This helps to avoid the necessity of empty running, the result of international trains having to change locomotives at borders.
It also reduces waiting times at borders, which leads to a shorter journey time. The risk of delay is also reduced, since there is no need for the rolling stock to wait at the border for a locomotive.

Transport Stock system, Reservation Systems: It is currently difficult for customers to find transport connections quickly (i.e. within a few minutes) when a border crossing is involved. A booking exchange service using a method similar to reserving a flight over the internet could remedy this. In this exchange service unused space on combined traffic (CT) could be offered and the customer could book space on an existing service. Using this process special offers, for example, last-minute offers could be made available.

Freight Traffic during the day: Goods traffic transported by road is proof that a considerable quantity of goods must be transported during the day. By shifting some goods transport to daytime, peak loads during the night could be avoided. This would also result in an even work load for the stations. Since the capacity and the infrastructure of the treatment yard is geared towards the successful management of peakloads during the night, the reduction of load peaks during the night coupled with an even workload throughout the day would enable restructuring to take place. This would help to save infrastructure costs, which would have a direct effect on the transport costs.

Centralised Traffic Control (CTC): When a local failure happens in the railway system, the problem is served by the local employees. That implies, that the solution to serve this problem is only a local solution. These solutions depend on the kwowlegde of the duty employee, because the solution has to be found manually.

In many cases, it is very important to manage a local problem in a national or even in an international scale with a standardised high operational quality. For example, if there is an accident on a route, some planning tools could reroute the ongoing trains and calculate some new routes for new trains. In order to realize this, a remotely controlled block signal system could be used: train movements are controled by block signals whose indicators supersede the superiority of trains.

This signal system could be connected to operating watch tools and simulation tools. If the operating watch tool registers an abnormality, the simulation tools have to start automatically. Some standard variants could be simulated. After that simulation process, the simulation tools have to find an adequate solution with a global character. This strategy will serve the high quality of the solution.

3.1.2 Linking quality of service and Alternative Solutions

To recognise which quality of transport service could be handled by the simulation model and which alternative solutions could be integrated in the calculation, a link between the quality of service, alternative solution and the simulation parameters has to be made.

The following tables show this combination. The alternative solutions are additionally classified by the criteria of techniques, operation and infrastructure.

Assignment of Reliability and Simulation Parameters

Decision Criteria (WP 1)	Alternative Solution (WP 5.1)	Simulation Parameter
Reliability	**Techniques**	
	standardisation of electronic data exchange	
	early error dedection in a transport chain	
	monitoring systems	
	automation of coupling/ transporting process	waiting time, assembling time, marshallling time
	Operation	
	standardisation of train buildings processes	assembling time, waiting time, marshalling time
	reduce processes in transport chain	route matrix
	obligate schedules	starting time, used schedule
	CTC	
	Infrastructure	
	dedicated networks/ priority networks	networkparameter, attributes of nodes and edges

Assignment of Information and Simulation Parameters

Decision Criteria (WP 1)	Alternative Solution (WP 5.1)	Simulation Parameter
Information	**Techniques**	
	GPS	
	EDIFACT	
	electronic transport data registration	
	Operation	
	transport stock system	
	electronic transport unit watching	
	reservation systems	
	disposition systems	
	one-stop-shop	
	TERFF	border crossing time
	CTC	
	Infrastructure	
	-	

Assignment of Increase Flexibility and Simulation Parameters

Decision Criteria (WP 1)	Alternative Solution (WP 5.1)	Simulation Parameter
Increase Flexibility	**Techniques**	
	-	
	Operation	
	Freight traffic during the day	used schedule for different train types
	TCS	assembling constraints, weight, length, assembling time, min/ max number of wagon
	transport stock system	
	liner trains	assembling constraints, weight, length, assembling time, delivery time, velocity
	offer oriented production systems	Train building constraints
	Infrastructure	
	dedicated network/ priority network	network parameters

Assignment of Reduced Transport Cost and Simulation Parameters

Decision Criteria (WP 1)	Alternative Solution (WP 5.1)	Simulation Parameter
Reduce Transport Cost	**Techniques**	
	reduce capital investment rolling stock	
	new locomotive generation (wegwerf lok)	
	standardisation of equipment	border crossing time, assembling time
	standardisation of signalling	
	standardisation of wagon technology	shunting time, assembling time, velocity
	standardisation of train parameters	train length, max. number of wagon, velocity, weight, performance
	new train generation (CargoSprinter)	train speed, train length, train weight, number of wagon
	unit construction system	
	Roadrailer, trailerzug, Kombirailer	train speed, assembling time
	Operation	
	rent a wagon/ locomotive	
	avoiding shunting movements	route matrix
	homogeneous traffic flow	
	new operation systems (TCS)	criteria for train types
	international rostering planning	
	increase train length	train length
	salary	
	Infrastructure	
	reduce capital investment of new tracks	reduce network
	reduce capital investment marshalling yards	reduce nodes
	reduce track prices	
	maintenance cost	
	larger loading gauge	loading gauge
	higher axle load	axle load

Assignment of Frequency and Simulation Results

Decision Criteria (WP 1)	Alternative Solution (WP 5.1)	Simulation Parameter
Frequency	**Techniques**	
	Freight traffic during the day	used delivery schedule
	Operation	
	shuttle trains	assembling constraints, weight, length, assembling time, min/ max number of wagon, delivery time
	Infrastructure	
	difference between following trains	number of tracks per line

Assignment of Reduced Transport Time and Simulation Parameters

Decision Criteria (WP 1)	Alternative Solution (WP 5.1)	Simulation Parameter
Reduce Transport Time (door-door)	**Techniques**	
	automatic coupler	assembling time, shunting time
	electronic duty forms/ electronic way bill	border crossing time
	multi-system locomotives (no locomotive change at border)	border crossing time, velocity
	electronic transport data registration	assembling time, shunting time, waiting time
	Operation	
	reduce shunting movement (better route matrix)	route matrix, max. number of Wagon
	more blocktrains (shorter Trains)	min. number of wagon, train building constraints
	faster train	max Train Speed
	no border stops	border crossing time
	speed harmonisation	min/ max train speed
	dedicated network/ priority network	network parameter
	Megahub	route matrix, train buildings constraints
	TCS	route matrix, train buildings constraints
	efficient collecting/ delivery strategies	route matrix, train buildings constraints
	Infrastructure	
	-	

3.2 The Simulation Process

In order to observe the effects of the various possible solutions on the existing network, the available simulation parameters are applied to each alternative. The simulation parameters enable the creation of an image of each solution using the chosen simulation model. The simulation of traffics on network was carried out using an iterative process with BVU. The methods used is described below (Figure 3.1).

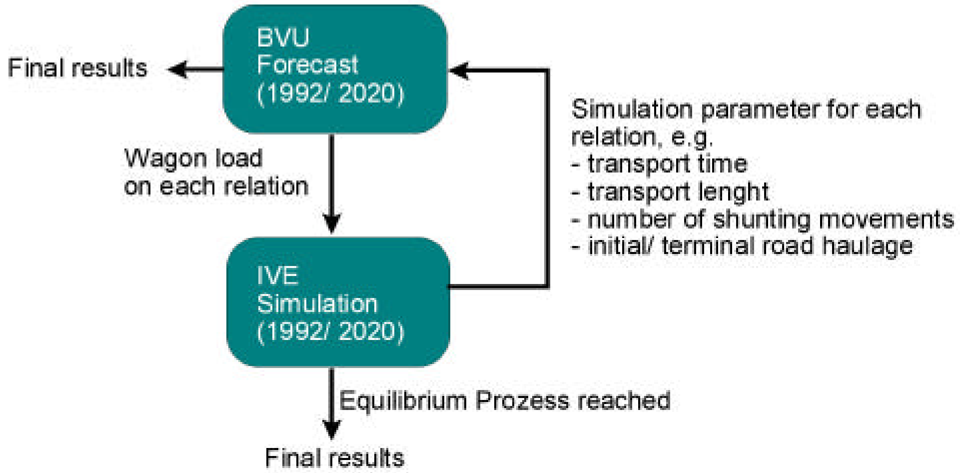


Figure 3.1: Principle of the Equilibrium Process

The entry wagon flow between the NUTS-Areas is determined from the BVU with the help of the modal split model (s. EUFRANET, D3, Study of long term Flow Scenarios). Afterwards the wagon flows were consigned to the IVE. At the IVE the wagon flows between the NUTS-Areas have been projected onto the links between the entry points.

The data gained by this process was entered into the simulator. Then the simulator computed the railway traffic on the basis of input and on the restrictions of the input parameters. As a result, different resulting parameters were received. Some parameters, e.g. the transport time of main rail haulage, the transport time of initial and terminal road haulage, the length of path taken between the entry points etc. were transmitted back to BVU.

According to possible changes in the transport quality a new modal split was calculated afterwards. Furthermore, new wagon flows were generated, too. These new wagon flows were sent back to the IVE. At the IVE the simulation of traffic flows between entry points was started once more.

The number of cycles for that iteration process was not limited. Merely the divergence of the data from the iteration process no. n and no. n+1 had been defined as a criterion to stop the simulation process for each relation.

During the simulation it could be observed that after a maximum of four iteration cycles no significant difference between the generated modal-split volume of this loop and the loop before existed. The equilibrium was reached.

Because of the structure of the simulation process bad loops were avoided. For example, it cannot be possible that a steady increase in transport quality generates an ongoing increase in wagon volume. By the limitation in capacity of treatment yards and of tracks the transport quality was limited to a certain upper level. Therefore the number of wagons gained in the modal-split model was limited to a certain number. The reverse bad loop in which a steady decrease in quality would result in a loss of relations will be avoided in an analogous way.

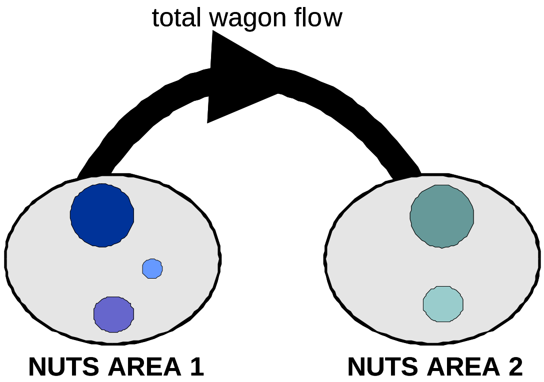
3.2.1 Projection of NUTS-Area Flow

The wagon flows required for the simulation process had to be gained from the data given by a program module especially designed for this purpose. The functionality of this module is described in the following paragraphs.

The data received from the BVU describes the different wagon flows of the conventional wagon load traffic WLT and the combined traffic CT from a start to a destination area.

The unit of the wagon flows is the number of wagons per day. As a classification of area the NUTS-classification has been chosen. To start a simulation, this data has to be projected onto the daily wagon flows. Furthermore, it is neccessary to deliver the wagon flows on each entry point of a NUTS-Area. The methods used are described in the following paragraphs.

3.2.2 Division of Wagon flow at Entry Points within a Zone



Before the distribution of traffic flow can be established, entry points within a NUTS-Area must be defined. Together with the Railway Companies the railway stations which represent today‘s important entry-points in each NUTS-Area were chosen from a list of available stations. Marshalling stations with their own revenue are also considered. A NUTS-Area has a minimum of three and a maximum of seven entry points. As previously mentioned, an entry point can be the crossover point to another network (e.g. road or inland navigation), and can therefore also be considered to be a destination point.

In order to enable the proportional distribution of the traffic amongst the stations, the entry points are ranked according to their significance in terms of traffic levels (ranking). All stations within a NUTS-Area receive a weighting factor, dependent on the ranking. This weighting factor enables a quantity-oriented distribution of goods. It is worth noting that the sum of all weighting factors within a NUTS-Area is one.

$$g_{total} = \sum_j g(j) = 1, \quad 0 \leq g(j) \leq 1$$

Where g(j) represents the weighting factors of station j within a NUTS-Area.

The distribution of traffic between stations within a NUTS-Area is carried out using the previously defined factors according to the function:

$$m(i,j) = g(i,j) M_{total}(i)$$

Where m(i,,j) represents the amount of traffic and g(i,,j) the weighting factor ofstation j within NUTS-Area i.

To show the working principle, a simple example is created: Within a NUTS-Area there are 3 stations: B1, B2 and B3, having 40%, 35% and 25% of the traffic within the NUTS-Area respectively. Following the formulae, a NUTS-Area volume of traffic of 200 wagons would be distributed as follows: B1 would receive 80 carriages, B2 would receive 70 and B3 would be allocated 50.

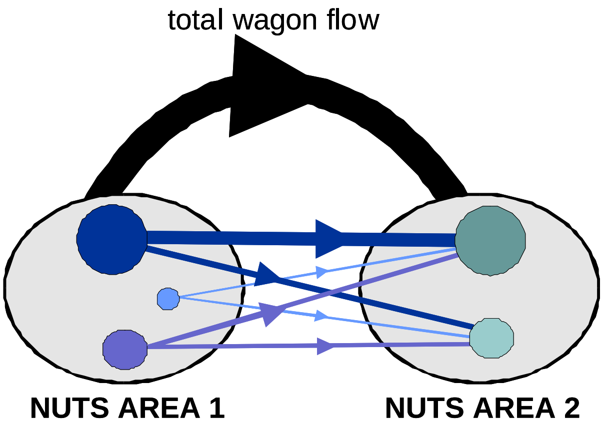
3.2.3 Division of Wagon flow on relation

The next step is to establish the relationships between stations using the same process. Again, two-party NUTS-Area weighting factors are determined. The station-relationship factor is partially dependent on the entry point weighting factor.

$$r(i,j,k,l) = g(i,j)g(k,l)$$

The station-relationship weighting factor r(i,j,k,l) is the weighting factor of the relation between station j in NUTS-Area i and station l in NUTS-Area k. The traffic flow from one station in NUTS-Area i to another in the same NUTS-Area is calculated using the following formula:

$$m(i,j,k,l) = r(i,j,k,l)\,M_{total}(i,k)$$



Where m(i, j, k, l) represents the flow of traffic from station j in NUTS-Area i to station l in NUTS-Area k. M_{total} describes the total traffic flow between NUTS-Areas i and k.

Following the establishment of the station classification and the relationship between stations, the model can make a preliminary distribution of the traffic, taking into account the weighting factors. Since the main focus of the investigation is traffic with a minimum travelling distance of 200 km, travel within a NUTS-Area is not taken into consideration.

3.3 Description of Supply Model

3.3.1 EuroPlan model

The simulation model used in this study is called EuroPlan. In the following the model, its components and the principle of the functions will be briefly explained.

The program system EuroPlan allows the investigation of different scenarios and the use of variants within the scenarios. A scenario describes fixed situations and configurations; for example, a network with planned or notional dedicated or prioritised lines is a possible scenario definition. Within the scenario, variants are defined. This includes the influential simulations and control parameters which are necessary for the investigation. Two variants differ from one another by the alteration of a disjunctive group of parameters.

The figure 3.2 below shows the principle setup of EuroPlan. The first stage describes the basis data to be inputted. This basis data defines the scenario, including the traffic network and the routing matrix. The build up of the routing matrix is described in more detail later in the text. The traffic network is described below.

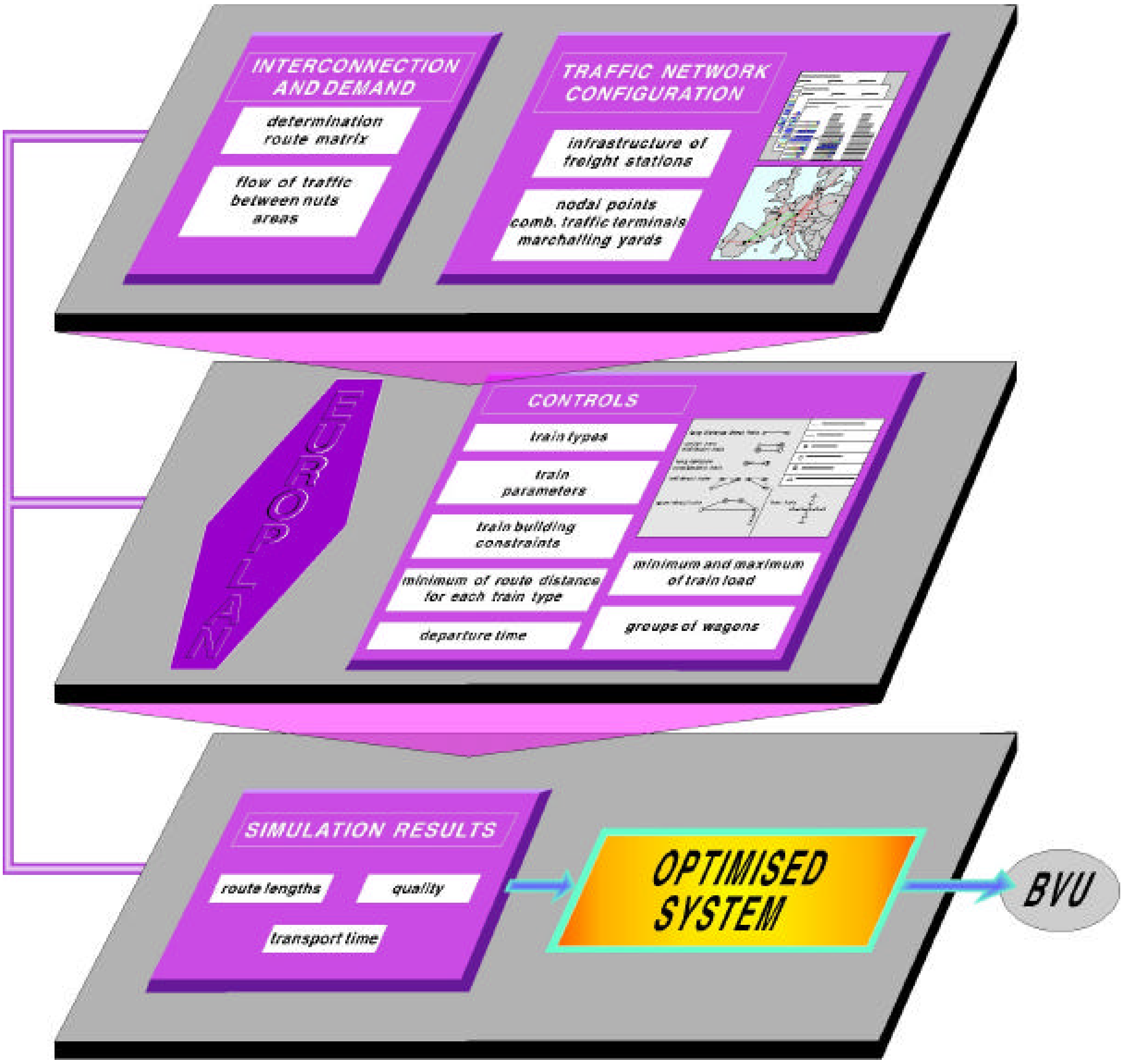


Figure 3.2 : The Principle of the EuroPlan Model

3.3.2 Simulation Parameters

To enable the modelling of rail goods traffic using EuroPlan, the input parameters must first be defined. These parameters are deduced from the technical and operational alternatives which are assumed in the simulation. Examples are the maximum train length and the maximum allowable speed. An overview of the parameter groups is given below.

3.3.2.1 Time Parameters

Standing Time describes the maximum waiting and standing time of a wagon grouping in a shunting yard. The standing time includes the waiting time both in the arrival sidings and the departure sidings. The standing time can be used to control the maximum length of stay for a train in a station. A train which is not loaded to full capacity can wait in the station for wagons which enter the yard later. The train waits until the maximum standing time has been reached or it travels without having reached maximum transport capacity. This aids in the investigation of the degree of grouping of wagon flow.

Marshalling Time describes the time from the start of wagon shunting (i.e. when the wagons are separated) until the entry of the train into the departure sidings.

Building Time is the maximum train formation time in a shunting yard. This includes the time taken for the mechanical coupling of the wagons, the wagon control and the testing of brakes.

Border Crossing Time is the average time spent while waiting at the border by a train. This might include the time spent waiting to change locomotives or to carry out customs formalities.

Departure Time is the time at which the train leaves the entry point.

3.3.2.2 Train Parameters

1) General train parameters

Train length describes the maximum permitted length of a type of train. For each type of train different permitted lengths can be given.

Train velocity describes the possible maximum speed a certain type of train can reach. The actual maximum travelling speed of a train on a track is the speed at the lower end of the permitted top speed range and the possible top speed of the type of train.

Max. number of wagons describes the maximum possible number of wagons per train type. For different types of trains different numbers can be given.

Min. number of wagons describes the lowest number of carriages per train, which is necessary to drive a block train.

Train weight describes the maximum permittable overall weight of a train type. For different train types different weights can be given.

Train performance describes the performance of a locomotive.

2) Train types

The simulation model permits a choice of different types of trains. These will be defined over the different parameter values. The wagon matrix is divided in the simulation process according to type of train: Bulk Trains, Block Trains and Single-Wagon Trains. These are described below.

Block Trains

If the amount of goods needing to be transported between an entry point and a destination point is large enough to make up a whole train, a block train will be formed. This train then travels directly between the designated points and the wagons are not rearranged on route.

The number of wagons which are necessary for the formation of a Block Train can be varied in the simulation. The choice of a low wagon limit has the consequence that more wagons are transported as Block Trains than when a higher limit is chosen. Block Trains can occur in conventional wagon load traffic as well as in combined traffic (CT).

Bulk Trains: Block Trains with Bulk

Coal, ore and other bulky goods are referred to as Bulk. Oil and oil products can also be included in this category. Bulk Trains are a form of Block Trains with some special characteristics. One special feature being the amount of goods carried and the other is the type of goods.

The above named goods generally occur in very large amounts and are usually transported according to a fixed timetable. As a rule, homogeneous product carrying trains are driven directly between the entry and destination points. The direct transportation of these trains without reconfiguration of the train leads to high productivity and attractive transport times. If the amount of goods is not sufficient for the operation of a daily Bulk Train then they may also be transported on a 2 or 3 day basis or even a weekly basis.

Single-Wagon Trains

All wagons which are not part of the Bulk Trains or Block Trains are transported as Single-Wagon Trains. Transport of these wagons is based on fixed routes which pass through one or more marshalling stations. In the marshalling station the wagons are grouped with other wagons with the same final destination or a common point on route so that they can travel together. Single-Wagon Trains can be divided into Conventional Trains and Multiple-Section Trains.

Conventional Trains All direct connections given in the route matrix between junction stations, reference stations and marshalling yards are used by Conventional Trains. These trains travel even when the number of wagons travelling between the stations is low. Wagons travelling as a part of Conventional Trains pass through every designated station on their journey.

Multiple-Section Trains Multiple-Section Trains miss out one or more stations on route. Unlike Conventional Trains, Multiple-Section Trains are only formed when a certain number of wagons must be transported between two places. This often occurs when the number of wagons between two NUTS-Areas is great enough to allow a train to travel directly between the reference stations of the two NUTS-Areas. The marshalling stations designated along the route for this link would not be used in this case. If there are not enough wagons to warrant the formation of a Multiple-Section Train the wagons are transported as part of a Conventional Train.

3.3.2.3 Network Parameters

The traffic network is constructed using the usual graph model. It consists of edges and nodes. An edge represents the connection between two nodes. The edges as well as the nodes possess attributes, which describe each point. The model uses a vectored graphic system, so that the edges have directions in addition to start and end nodes. In reality the edges correspond to tracks. The nodes describe the entry points, junction stations, shunting yards, harbours, combined traffic terminals, border stations and even switching points. The edges and nodes possess an extensive number of descriptive attributes.

As an example an edge has the following attributes: identification number, start node, end node, length, maximum allowable speed, electrification status, axle loading, etc. A node might have the attributes of identification number, shortcut name, x-,y-coordinates, type, NUTS-Area, Country etc. The individual attributes of the nodes and edges used in this study could not all be integrated into the model, since the values were not available for the whole network. When this occurred with important attributes standard values were used.

3.3.3 Simulation Method

The simulation parameters of the first and second levels are entered into the simulation model together with the wagon flow data. In the third level, results received from the simulation will be processed graphically. The quality of the simulation can be judged by means of the received result parameter. And the parameters can be varied and changed in order to generate new solutions in several iteration steps.

Links between entry points, which determine a satisfactory volume of traffic, will be run directly without intermediate stops in the simulation model. The bulk traffic will depart in block trains in just the same way. The remaining relations, in which the volume of traffic is not sufficient for a block train, will be covered in a sub-system.

The organisation of the sub-system used in the simulation has been drawn up following the German junction system. The carrier compartments will first of all be assembled in a larger station. Afterwards the assembled trains will be transported to the nearest treatment yard.

In this treatment yard, mainly a marshalling or shunting yard, the trains will be dismantled into groups of carriages. Once dismantled the wagons will be sorted according to their destination and the main-line trains will be put together. The formed trains then travel on to a distant treatment yard. On arrival the trains will be dismantled again, formed into new trains and afterwards in reverse order of transportation the wagons will be sent to the destination entry-points.

3.3.3.1 Routing Matrix

The route which the carriages take during the transportation from any starting point to any destination entry point, will be defined over the given routings. Each route, as seen by the transport route, consequently appears as a chain of several stations, which appear one after another for the purpose of grouping with other carriages (carriage groups).

The individual stations within a route are structured in different hierarchical layers. To build up a real meaningful view of the routing matrix, the method used first of all locates areas of economic significance. After this a ranking will be carried out with the help of the volume of traffic and economic development etc. This ranking will sort the identified areas according to their significance in terms of traffic.

Afterwards, the treatment yard areas will be located with consideration to the importance of traffic, its volume, its connection to the network and its capacity. This method does not have the above mentioned disadvantage of establishing important stations at the first stage. For this reason it was chosen for the simulation.

3.3.3.2 Level of Treatment Yards

For the simulation route matrix four hierarchical layers were built(Figure 3.3). Each of these layers contains stations which on a different level have the task of train formation and grouping. Below the types of stations at the different layers are described.

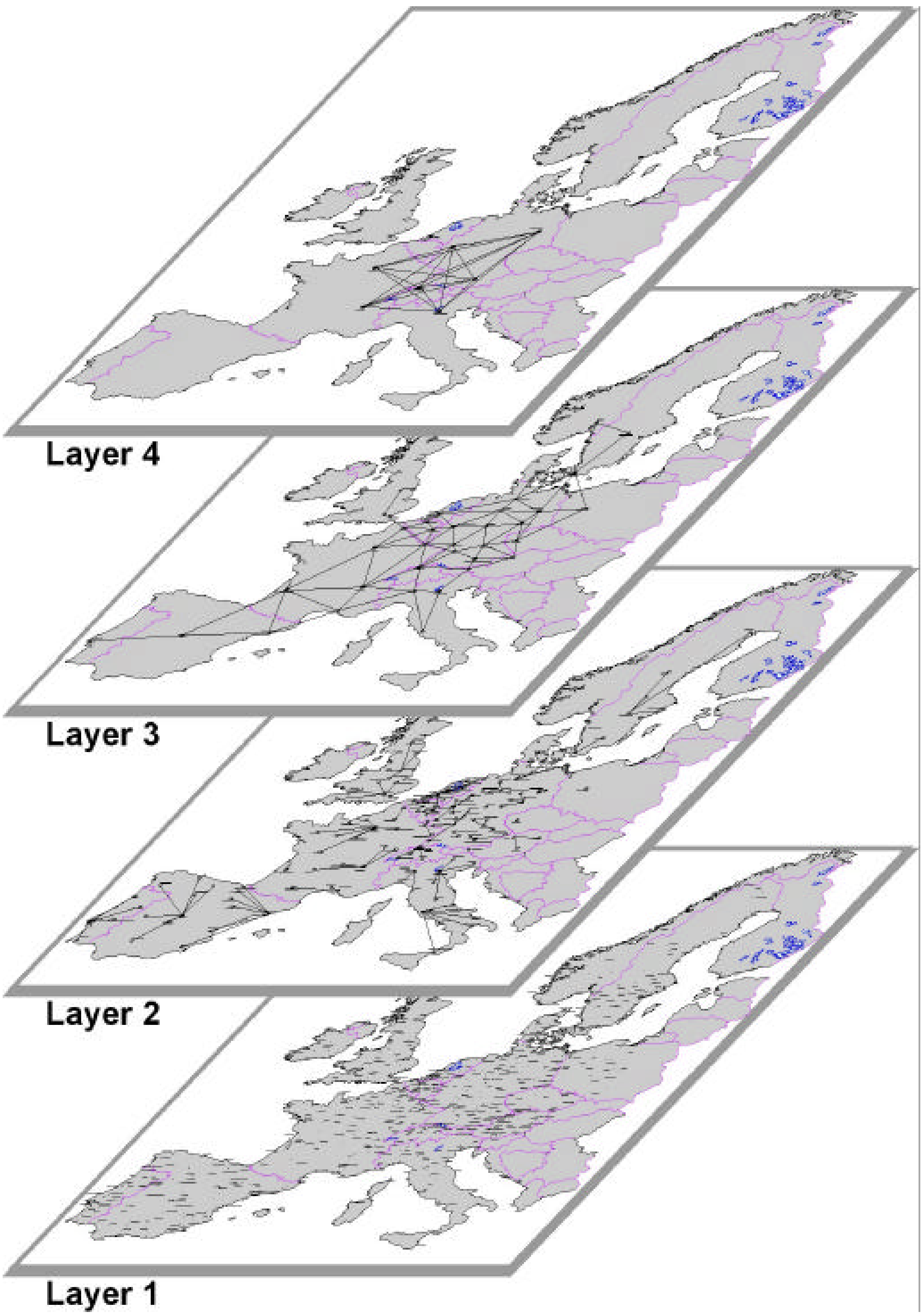


Figure 1.3: Layers of Different treatment Yard Levels

Layer 1: Entry points

Layer 1 is composed of all the nodes within the entire network. They have the function of an entry point. These nodes illustrate the interfaces of the railroad network to the outside world i.e. the starting and end points for the transport of carriages on the rail network. It considers such issues, which determine a real typical volume of carriages. For this, the information from the railways involved in the project EUFRANET was fallen back upon.

Layer 2: Third level treatment yards (junction stations)

In each NUTS-Area, a reference station is defined. For this, it is a question of the station with the greatest importance in terms of traffic for the considered region. These are usually stations with the task of train formation or with a particularly high volume of traffic. The selection of the relevant stations was carried out in co-operation with the railways involved on project EUFRANET. The stations of layer 2 undertake the grouping of the region‘s volume of wagons.

Layer 3: Second level treatment yards (shunting yards, marshalling yards)

In every European country various stations are defined, which have the main task of train formation for the national transport. For this reason we are concerned with stations which in reality have the status of a shunting yard and the relevant capacity for train formation.

The selection of the relevant stations for the countries France, Germany and Sweden was carried out in co-operation with the railway companies involved in the project EUFRANET. The remaining countries were dealt with the help of available literature and data.

Layer 4: First level treatment yards

The first level treatment yards form the most important stratum for the completion of railway transport in Europe. Long distance international transport is set up within these yards as a matter of priority. Consequently, the stations have the main task of grouping wagons for long distance, cross-border transport. Naturally, national trains are also grouped in these stations.

Just like second level treatment yards these have the relevant capacity for train formation.

3.3.3.3 The Linking of Stations

In order to deal with traffic between stations, the stations must be linked to one another in an organised fashion. To prevent misunderstandings at this point, it is to be mentioned that the linking is important only for the planning of a carriage‘s route. During the simulation the actual route of a carriage is based upon the simulation network with the described nodes and edges.

Each group of carriages starts at an entry point (layer 1), then travels to a defined reference station (layer 2) and thereafter goes on to the marshalling yard to which it belongs. The way from one marshalling yard to another makes up the biggest part of the distance, which the groups of carriages have to travel. The route often comprises several marshalling yards, which are passed through one after another. Some marshalling yards are linked to one another with more direct connections than others. This depends upon their significance in terms of traffic. If there is a direct connection as well as a connection crossing another marshalling yard, the direct connection will be chosen.

When the group of carriages gets to the last marshalling yard (layer 3 or 4) of the route, it continues on to the reference station of the target region (layer 2) and finally to the destination entry point.

By connecting nodes from the first layer to those of the second layer, goods from the regional level can be assembled. Afterwards, in the second step, stations of the second layer are connected to those of the third and fourth. In the third step, treatment yards from the third and fourth layer are connected to each other. Finally, national and international traffic can be dealt with. By these means, the basic network for a European route matrix is created.

3.3.3.4 Process of Wagon Assembling

The model simulates the real operation procedures of freight traffic. This includes on the one hand the necessity to form trains which should be as long as possible. On the other hand transport time should not exceed a certain level, depending on the kind of goods. Therefore EuroPlan avoids operating very short trains over large distances as well as frequent changing of wagon groups in the marshalling yards.

At each station of each level it is checked whether wagon groups of different traffic relations can be bundled to a train. The wagon groups bundled to a train have to be at the same place at the same time. Using the previously defined routes the remaining paths of the individual wagon groups up to the destination points are compared with each other.

The final destination points (layer 1) of the different wagon groups are compared first in the process of searching the routes. In the next step, corresponding reference stations (layer 2) are checked. Finally the model searches common marshalling yards (layer 3 and 4). Due to the allocation of all reference stations to one marshalling yard the search will supply only one result.

As soon as a fixed number of wagons for a corresponding station in the routes is present, the appropriate wagons are assembled to a train which runs to the determined point directly. The number of wagons depends on the variant that is simulated. If the number of wagons with a corresponding station is too small, all wagon groups drive to the next point, which is given to them by the route. In this case no points of the route are skipped, so that the number of rearrangements increases. As a result the transport time becomes larger.

3.4 Simulation Output

The simulation of rail goods traffic with the model EuroPlan yields results about the different rail transportation parameters. The results can be divided into information about the wagons and information about the rail network on which they are travelling.

3.4.1 Information about Wagons and Trains

Total Travel Time: The total travel time of a wagon is the time spent on the track by the wagon during transportation between an entry point and a destination point. This includes time for intended rearrangements in marshalling stations. The given value for the total travel time is an average of the results for individual wagons.

Sum of Wagon Hours: The sum of the wagon hours is the product of the number of wagons and the time required for the transportation of these wagons.

Distances: The distance travelled by a wagon on the tracks is given by this parameter. Results vary for two wagons travelling between the same places depending on whether the wagon has travelled directly (Block Train) or been diverted to one or more marshalling stations (Single-Wagon Train).The given value for the parameter is an average of the results obtained for the individual wagons.

Sum of Wagon Kilometres: The sum of wagon kilometres is given by the product of the number of wagons and the distance travelled by these wagons.

Rearrangement Procedures/Wagon: The number of rearrangement procedures per wagon shows how many times the wagon has passed through a marshalling station during the transportation. The given values for the rearrangement procedure/wagon are the average of the results for individual wagons.

Sum of Rearrangement Procedure: The sum of the rearrangement procedure is the product of the number of wagons and the number of intended rearrangements in the marshalling stations during transportation.

3.4.2 Information about the Infrastructure

Load in the Marshalling yards: The load in the marshalling yards can be expressed by the number of wagons which are shunted in the station each day. All stations on levels 3 and 4 of the route matrix are classed as marshalling yards.

Loads on the Network Tracks: The loads on the tracks in the network can be expressed by the number of trains travelling on the stretch each day. The direction of the train is significant here.
Sum of Train Kilometres: The sum of train kilometres is the multiplication of the number of the trains and the lengths of the routes covered by the trains. This parameter can be separately determined according to country; i.e. train kilometres for France, Germany etc. The given value for train kilometres is the average value for one day, unless stated otherwise.

All the above named parameters can be separately determined for each type of train. The load on the marshalling stations is not applicable for Bulk Trains and Block Trains because they do not use these stations.

Chapter 4 Definition of Dedicated Network for Freight

4.1 The Basic EUFRANET Network

The transport infrastructure description includes all the physical elements upon which transport operations take place. It provides information about the constraints resulting from limitations in availability and capacity and lack of compatibility. The description of the basic EUFRANET network must be very precise because it will be referred to by all the interested parties, the European Commission, national, regional and local governments, railway companies, infrastructure management organisations, end users and the community at large.

The infrastructure consists of links and nodes. A link represents the connection between two nodes. In reality the links correspond to tracks (with tunnels and bridges) and the nodes are the entry points, junction stations, shunting yards, harbours, combined transport terminals, border stations and even transfer points. The links and nodes possess an extensive number of descriptive attributes. A link has attributes such as start node, end node, length, maximum permitted speed, electrification status, axle loading, etc. A node may have the attributes of Cartesian co-ordinates, type, Area, Country etc.

To begin the process of specifying the basic network, all known data sources for railways were reviewed (INRETS, IVE, UIC, railway companies and other research projects). The key elements considered for the dedicated network were as follows:

- the location of nodes, the functions performed at each node (marshalling, transhipment, etc.) and the main parameters characterising each function: maximum capacity assigned to European traffic, minimum acceptable performance (in terms such as maximum time per operation) minimum acceptable efficiency (for instance, maximum cost per operation);
- identification of links and the main parameters characterising each link: number and direction of tracks and, for each track, maximum capacity (trains/hour), time and priority given to European traffic, maximum gradient, minimum radius of curvature, maximum permitted speed;
- for links and nodes: gauge, height of catenary, electric power, maximum train length, maximum axle load, maximum load per metre;

Figure 4.1 and Figure 4.2 show the links and nodes on the basic EUFRANET network. This network consists, in total, of about 2,300 links and 1,700 nodes. The total length of the basic network is approximately 140,000 km. In Figure 4.2, the European entry points are defined as the three entry points with the highest traffic in each NUTS2 region. This results in fairly uniform coverage of Europe and means that regions with low rail traffic are well represented. This was necessary in order to achieve a good level of accessibility and be able to differentiate between different types of traffic (bulk, conventional, intermodal). A consequence is that many European entry points are not part of the core "dedicated" network, where the major traffic flows are supposed to concentrated.

It is important to stress that this network is compatible with that commonly used in Germany for the DB strategy , with that used in France for the "schema de service" and also with the UIC network. Precise geographical co-ordinates are available for both links and nodes. A road network is associated with it so that competition between road and rail can be analysed from the perspective of route choice and quality of service.

4.2 Network Traffic Analysis

Identification of the dedicated network is based on traffic analysis and the experience of railway companies who belong to the EUFRANET consortium. It began with a market analysis using the transport demand matrix and relevant detailed information on the capacity of the network. The market analysis identified links and nodes which are potential candidates for such a network because they are important for satisfying freight transport demand. Although there are no formal rules for such a selection, it should always be based on the greatest attraction for freight transport, which will be measured afterwards for validation.

The O-D matrix for 1992 was used for this, so it was possible to compare the results from the assignment to actual values. In a similar manner, comparisons were conducted with the predicted values for the year 2020 to provide a picture of the future situation of goods traffic. Figures 4.3 and 4.4 reproduce the traffic assignment for 1992 and 2020 for single wagon trains (number of trains per day), transferred to the WISDEM tool so that it can be used for further evaluation of EUFRANET. These Figures show the relative stability of traffic patterns - there is increased traffic on only few links towards outer areas.

Single Wagon Trains account for most of the load on the European rail network. This is the result of a number of different patterns of flows, but it is clear that some links on the basic network are more important for European freight traffic than others.

There also appears to be heavy traffic on the Alpine crossings (Basel-Milano, Lyon-Torino) as shown on the map below (Figure 4.5). Although the simulation appears quite satisfactory, particularly in the centre of Europe, traffic on some Alpine crossings (Lyon-Turin) and a few links in northern France might appear underestimated compared to observed traffic.

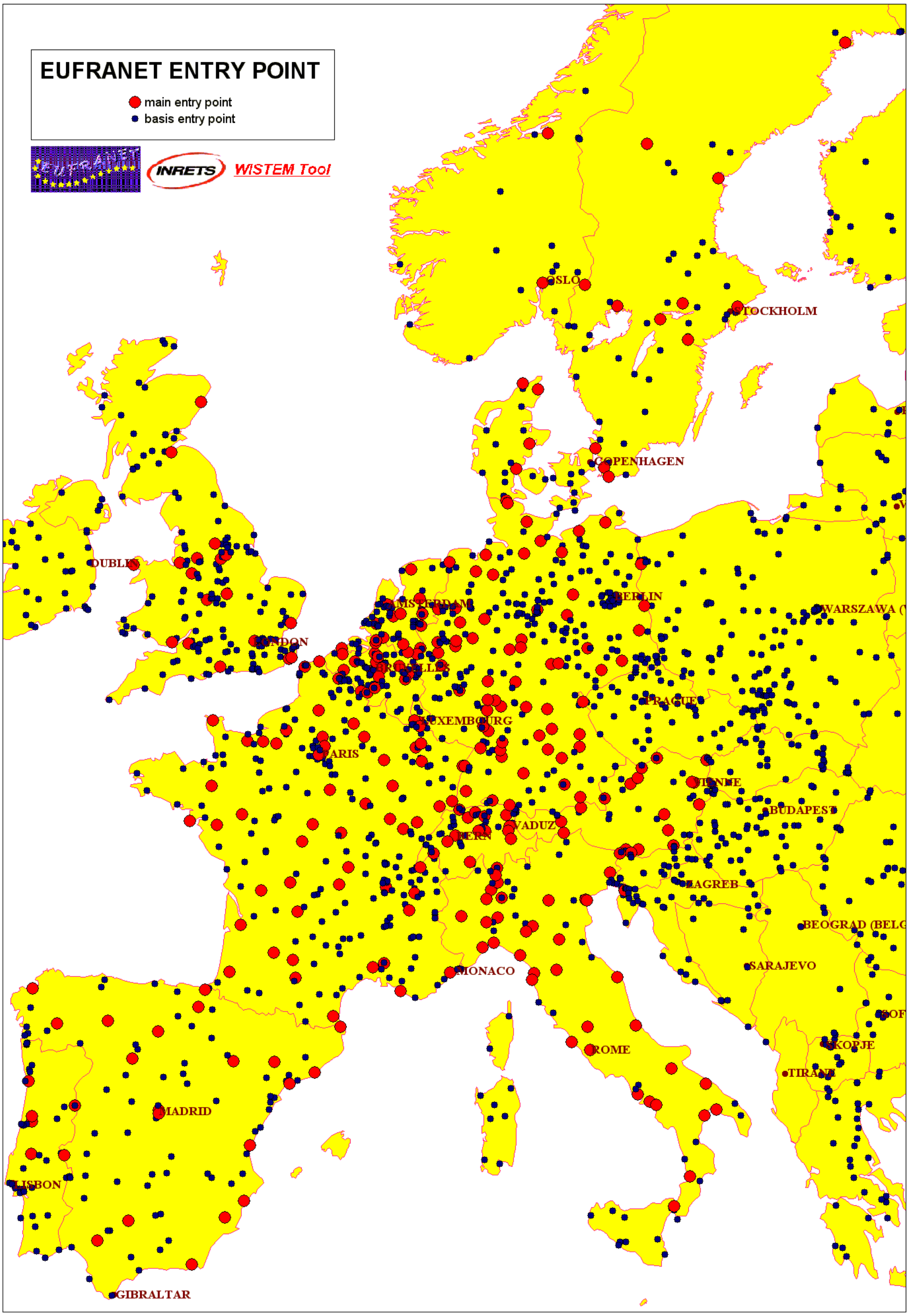


Figure 4.1. Basic EUFRANET entry points

Figure 4.2. The basic EUFRANET network on a relief map

Figure 4.3. Simulated load on network in 1992 - single wagon trains (source of assignment data : IVE)

Figure 4.4. Simulated load on network in 2020 - single wagon trains (source of assignment data : IVE)

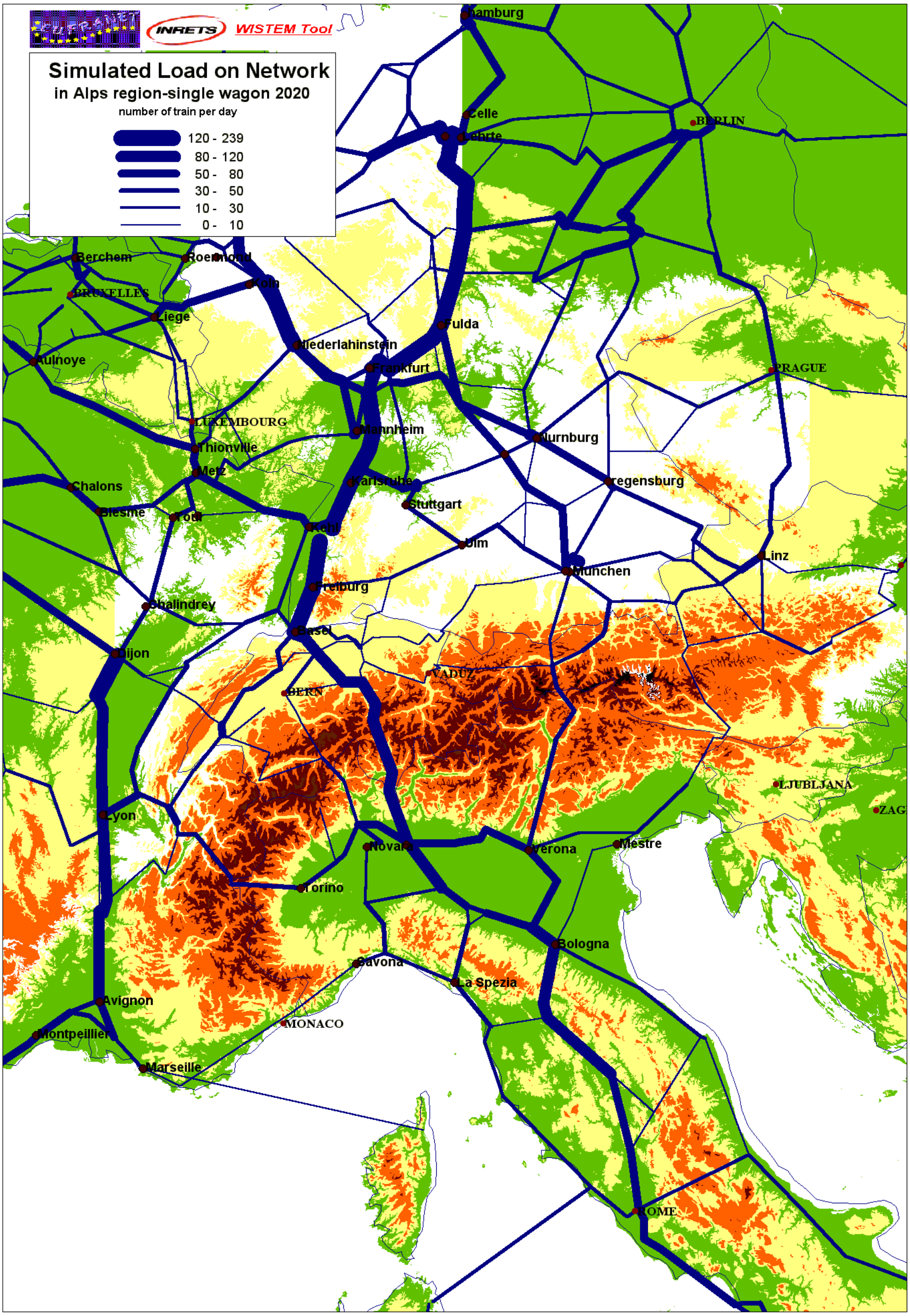


Figure 4.5 Simulated load on network in the Alpine area - single wagon 2020 (source of data : IVE)

4.3 Dedicated Network for frieght, a European Strategic Network

4.3.1 What is the dedicated network for freight?

The dedicated freight network could be the cornerstone of the TRANS-EUROPEAN NETWORK FOR FREIGHT TRANSPORT. The goals of the Dedicated Freight Network are to move goods safely and efficiently, to provide improved access, to promote a stronger economy and to protect the natural environment. Geographically, it can be identified by the main corridors with special recognition of points of connection between modes; these corridors can be characterised with reference to economic and social centres including the locations of business activities, residential zones, potential resources, or places of cultural interest.

While a dedicated network can be represented spatially, we must clearly understand that it will be far more than a 'map' of transportation facilities. Demand maps and access maps will tell us much more about underlying needs than would a simple inventory of existing facilities. A description of a dedicated network not only includes descriptions of the infrastructure components but also of transport operating systems, in order to emphasise the importance of optimal utilisation of transportation resources. This means more efficient use of the European transportation infrastructure, better service, more convenience, and more choices for users. It is thus a strategic network and not just a patchwork of individual facilities. With a dedicated network, we can project the impact of changes in transportation policies and investments, in order to assess how changes in the quality and quantity of transportation services will affect the economy and the environment.

4.3.2 Identification of the Dedicated Network

If the dedicated freight network is to become a key element in the development of European freight transport it cannot be derived only from a top-down approach starting from European policy. Its identification and development must also result from a "bottom-up" approach, consistent with an emphasis on the local and European transportation decision making processes.

Therefore in order to identify the dedicated network the results of assignment and market analysis were used to answer the following questions:

Is the freight part of the network coherent from a physical point of view, as regards interconnectivity, interoperability and intermodality?
How many lines have to be integrated within this part of the network?
Is it possible to reduce the number of links without losing too much traffic ?

To answer these questions, the IVE performed an ABC Analysis (ABC Analysis provides a means of establishing what proportion of the total volume of freight can be assigned to a specific network, or what size of network is needed to transport a given proportion of the freight volume). Table 4.1 shows the most important links on this network. The *Origin* and *Destination* column lists important links in the order of their volume of traffic. The *Country* column indicates whether the link remains in one country or passes through several. The *Length* column gives the length of the link as a percentage of the total length of network. The other four columns give the percentage of the total traffic on the network which is carried by the links.

origin	destination	country	length	single92	single 20	block92	block20
BASEL	MILANO	CH-I	0,70%	4,16%	4,21%	2,17%	1,98%
HANOVER	FRANKFURT	D	0,70%	6,45%	6,33%	5,58%	5,73%
HANOVER	DUISBURG	D	0,54%	3,48%	3,11%	4,32%	3,04%
HAMBURG	HANOVER	D	0,36%	2,80%	2,59%	3,71%	2,98%
FRANKFURT	BASEL	D	0,83%	5,38%	5,13%	1,63%	1,44%
DUISBURG	FRANKFURT	D	0,54%	3,33%	2,88%	2,70%	2,32%
KARLSRUHE	BOLOGNA	D-CH-I	1,49%	7,98%	7,94%	3,95%	3,81%
DIJON	LYON	F	0,40%	1,51%	1,61%	1,28%	1,54%
CALAIS	METZ	F	1,03%	1,26%	1,36%	0,03%	0,46%
LYON	MIRAMAS	F	0,55%	1,73%	1,90%	1,93%	2,83%
PARIS	ROTTERDAM	F-B-NL	0,99%	3,23%	3,07%	2,12%	3,49%
MILANO	ROMA	I	1,25%	2,49%	2,74%	1,63%	1,54%
HAESSLEHOLM	FROEVI	S	0,81%	0,36%	0,43%	0,57%	0,42%
LYON	BASEL	F	0,84%	1,07%	1,10%	0,00%	0,54%
LINZ	ANSBACH	D-A	0,74%	0,99%	1,07%	1,39%	1,99%
MUENCHEN	FULDA	D-A	0,74%	0,97%	0,96%	0,35%	0,63%
PARIS	DIJON	F	0,66%	1,02%	1,05%	1,68%	1,72%
PARIS	POITIERS	F	0,70%	1,54%	1,66%	2,33%	3,01%
PARIS	METZ	F	0,70%	1,25%	1,35%	0,37%	0,67%
VERSAILLES	RENNES	F	0,73%	0,15%	0,13%	0,35%	0,50%
BERLIN	WIEN	D-CZ-A	1,67%	1,57%	1,49%	1,86%	1,68%
MADRID	AVIGNON	F-E	2,41%	2,32%	2,59%	2,80%	3,52%
MADRID	POITIERS	F-E	2,41%	2,32%	2,59%	2,80%	3,52%
Total			**21,81%**	**57,37%**	**57,31%**	**45,57%**	**49,36%**

Table 4.1. The most important freight links on the network. Source: IVE

The table above shows that less than 22 % of the network length carries about 60 % of the volume of traffic. Therefore, it would be appropriate to envisage a two-level network, the first carrying large volumes of freight, and the second being more oriented towards geographic coverage than traffic density.

By applying these principles, candidate links and networks can be selected. These are those that are considered to provide the most viable solutions on the basis of traffic analysis and physical "consistency". Starting from this preliminary working hypothesis, trade-offs are done between links in order to determine the most advantageous and reasonable solution for a European freight transport network. Finally three types of network for a dedicated network for freight were defined as follows:

Core network

The core network is mainly dedicated to freight. In principle, no passenger train will be allowed to run on this network. In practice there might be some passenger trains, and in this case "freight priority" might be a more appropriate specification. For many links, "full" priority would be an excessively stringent condition if we want the core network to provide "uniform" physical coverage. Also we can propose that on specific links, special slots will be given to freight trains. A consequence of dedication is higher capacity for freight trains. The quality of transport in terms of reliability and time will also increase, because there will be fewer conflicts with other trains than on the basic network.

Intermediate Network

The intermediate network is mainly dedicated to freight, but some local passenger trains will also be allowed to run on it. Freight trains will have more priority than in the present situation, but this will not be absolute. The quality of the services will be improved, too, but not as much as on the core network. This condition will then be stated in term of expected performance on such a network as regards speed, waiting times and reliability.

Diffuse network

The diffuse network can be used by freight trains, but passenger trains will usually have priority. The quality of transport is therefore not as high as on the dedicated networks and the quality of supply will be quite similar to that which exists at present. However access conditions to the intermediate network and core network from the diffuse network can be specified.

Figure 4.6 shows the final version of the dedicated network for freight. and Figure 4.7 shows the dedicated lines crossing the Alpine region.

Figure 4.6 The EUFRANET dedicated network for freight: core network and intermediate network

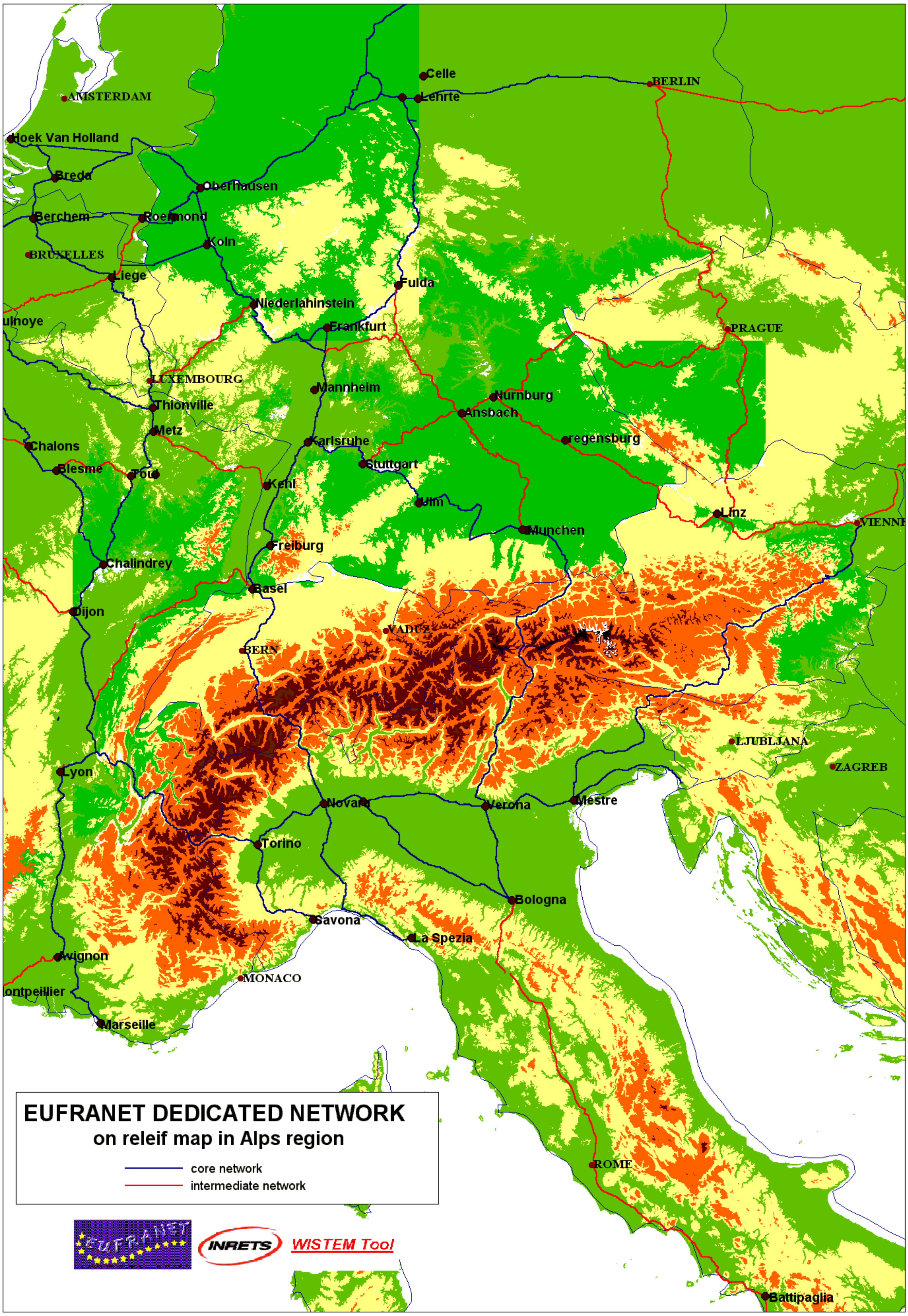


Figure 4.7. The dedicated lines crossing the Alpine region

4.4 Validation of The Dedicated Network

This section will begin by analysing how much of current European rail traffic would use the core network (or intermediate network) as defined above, and how the improvement of the quality of service on the core network will attract traffic from other lines. To this end, we have defined a basic scenario and a core network scenario. It is important to start with a basic scenario because strategies have to be considered with reference to a uniform base. The improvement with the core network scenario can be taken as a kind of reference point for further analysis. At this stage, it just provides additional validation of the dedicated network which proves how sensitive it is to these improvement.

Table 4.2 gives the traffic assignment results for the "basic" assignment scenario. The *core network* and *intermediate network* columns indicate the percentage of trains on the core network and the intermediate network, and the *total* column shows the total percentage of trains on the core and the intermediate networks in relation to the total number of trains on the basic network. The results show quite a high percentage - about 35% of the traffic on less than 20% of the length of the basic Europe rail network; with the intermediate network the figures are respectively 60% and 20%. These figures show that the core network (and intermediate network) correspond to the location of most of the traffic; it also provides quite good validation of the proposed dedicated network as a whole, even if some local adjustment may be required at a later stage.

country	Core network	Intermediate network	Total
A	25,67%	47,57%	73,25%
B	27,39%	8,91%	36,30%
CH	5,73%	0,00%	5,73%
CZ	0,00%	100,00%	100,00%
D	54,19%	6,03%	60,22%
DK	84,78%	0,00%	84,78%
E	0,00%	47,02%	47,02%
F	30,90%	41,92%	72,83%
GB	0,00%	10,44%	10,44%
I	0,98%	75,77%	76,75%
L	35,21%	5,63%	40,85%
N	0,00%	100,00%	100,00%
NL	37,52%	2,08%	39,60%
P	0,00%	89,64%	89,64%
PL	67,38%	0,00%	67,38%
S	35,39%	41,41%	76,80%
Total	34,75%	23,97%	58,72%

Table 4.2. Percentage of traffic on the dedicated network : basic scenario 2020 (data source : IVE)

Then with the improvement of the quality of service on the dedicated network, the ability of the dedicated network to attract traffic from the other lines was analysed. The basic scenario differs from the “core network” scenario as regards train lengths, train speeds and transport times. It has been shown that the core network (with the intermediate network) results in an additional increase in overall traffic. Table 4.3 shows these traffic assignment results by country.

country	Core network	Intermediate network	Total
A	34.3%	48.9%	83.2%
B	86.5%	5.1%	91.5%
CH	31.7%	0.0%	31.7%
CZ	0.0%	98.9%	98.9%
D	82.0%	8.2%	90.2%
DK	84.5%	0.0%	84.5%
E	0.0%	62.9%	62.9%
F	52.9%	42.4%	95.3%
GB	0.0%	27.7%	27.7%
I	1.3%	82.4%	83.8%
L	96.2%	3.8%	100.0%
N	0.0%	100.0%	100.0%
NL	44.1%	3.5%	47.6%
P	0.0%	87.8%	87.8%
PL	78.8%	10.6%	89.4%
S	39.9%	48.1%	88.0%
Total	65.5%	18.9%	84.4%

Table 4.3 Percentages of traffic on the dedicated network : core network scenario 2020 (data source : IVE)

An improvement in the quality of service on the core (and intermediate) network, will make this dedicated network significantly more attractive in the countries of the centre of Europe, with the dedicated network attracting a very high percentage of traffic. But attraction will also be very high in other countries such as Sweden, France, Italy, Spain and UK, which shows that these countries are very sensitive to improvements in the intermediate network. The Netherlands is a special case because only few lines are involved (although these are well located on the core network) and the final results will very much depend upon the problem of the Betuwe line.

The third stage was to conduct geographic analysis. This involved an examination of whether the lines in the dedicated network actually provide the best route for traffic. The 1992 and 2020 projection were therefore assigned to the dedicated network. Figure 4.8 shows a comparison between the core network and the assigned traffic. This confirms that most of the dedicated lines correspond to the major traffic corridors. In addition, it confirms the high stability of the pattern of flow in the centre of Europe where the "core" is located, and that "intermediate" links are able to attract increased traffic in peripheral regions. This combination of the core network with the intermediate network therefore appears appropriate in the context of long-term change.

The impact of dedicated network on traffic assignment could also be analysed. Figure 4.8 shows the comparison of traffic assignment on the basic network and on the dedicated network. Red traffic represents the traffic assignment on a dedicated network after the improvement in quality of service, green traffic represents the traffic assignment on the basic network without the dedicated network.

Figure 4.9 confirms that most of the traffic volume is on the core (and intermediate) network. With the dedicated network, traffic on the dedicated lines will increase. Examples are Hanover-Berlin, Luxembourg - Antwerp and Paris - Antwerp.

It is also clear that some change in the description of the quality of service on specific routes might be necessary. We have already mentioned that for the Netherlands the Betuwe line requires more specific analysis. In Germany, the dedicated route between Hanover and Berlin could be changed: the simulation shows that such a change would not significantly reduce the overall attraction of the network.

Some problems do arise in France where the choices for dedicated network are still under discussion. With regard to assigning routes to existing flows, we have to keep in mind some modifications made by INRETS; the Vantimille route between France and Italy is not a good route for freight and most of traffic crossing into Italy from South East Europe will pass through Modane. In northern France some traffic between Lille, St Quentin and Paris towards the South will indeed be assigned to the so-called "North East artery" along the Belgium border; this artery is already almost fully dedicated to freight. In the same way the traffic coming from Doubs valley might go through Dijon when entering the Saône valley rather than going directly to Bourg. Finally, there are two freight lines in the Rhone valley, west and east of the river. This was not easy to show on an A4 map. The eastern line is almost fully dedicated to freight.

But it is also interesting to see that most of adjustments of the present traffic assignment are occur when a dedicated network with improved quality is introduced: this is partly due to the fact that some lines are already better operated for freight train and this can also be taken as an additional argument in favour of the EUFRANET approach.

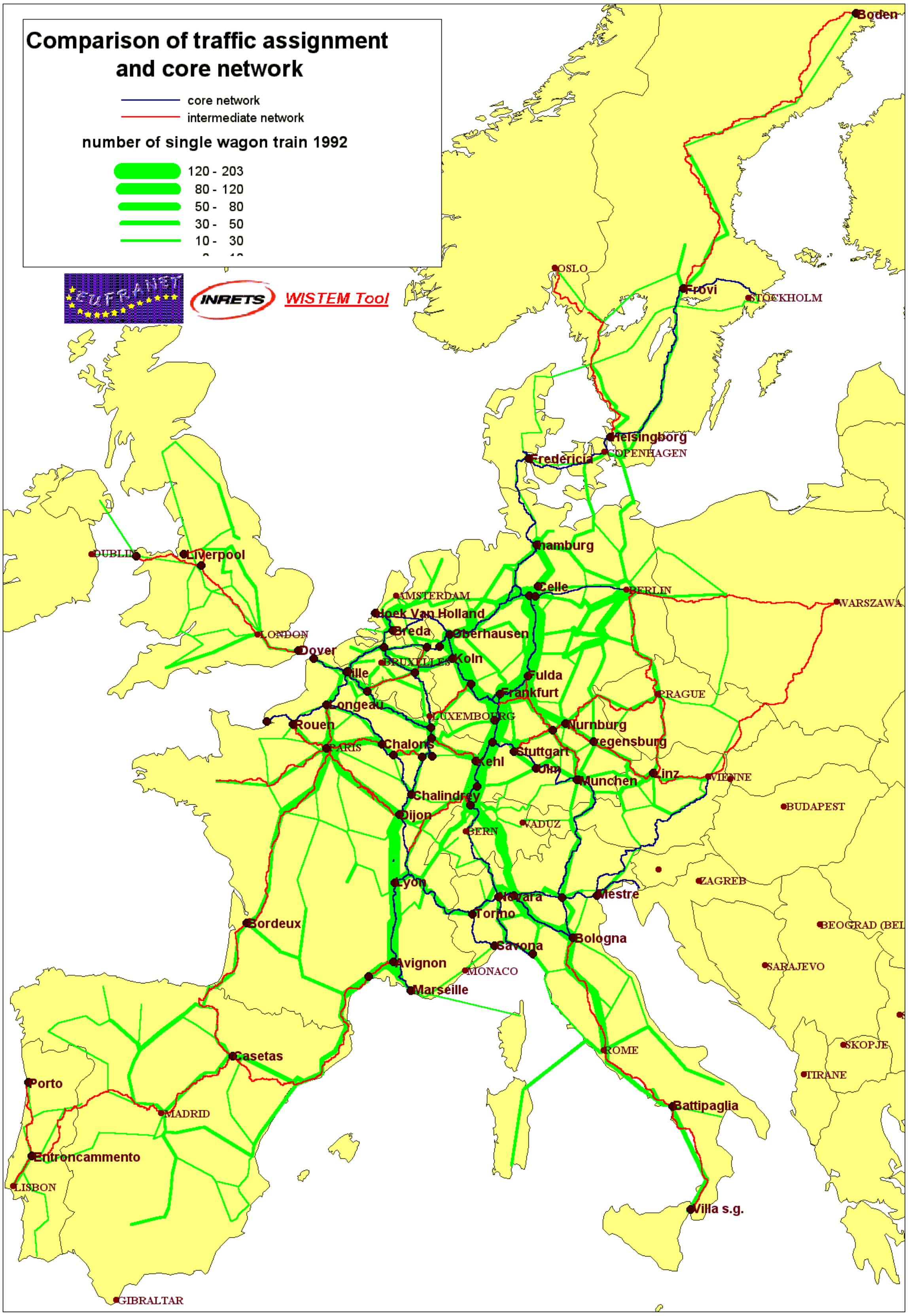


Figure 4.8. Comparison of dedicated network with traffic assignment 1992

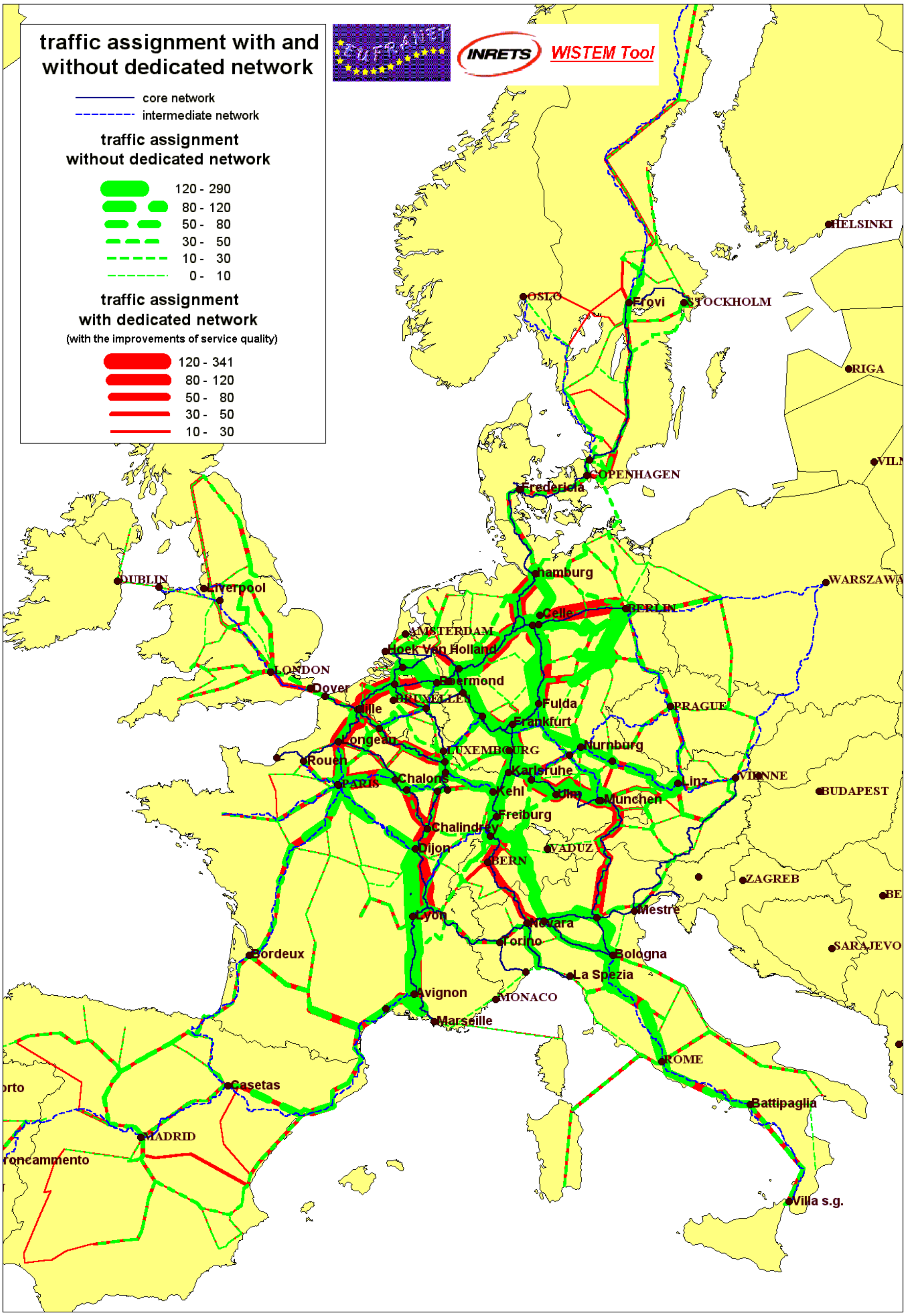


Figure 4.9. Comparison of traffic with and without the core network

Chapter 5 Analyse of Strategic Scenarios of Rail Operation

5.1 Definition of scenarios

Once a coherent dedicated network with three different levels (core, intermediate, diffuse) has been identified, the next step is to test its utility. For this purpose, a number of scenarios have been defined and assessed. These combine alternative operating systems and network strategies for developing European freight rail transport. Each scenario makes different hypotheses about the characteristics of the network and operating system. This chapter describes the scenarios which have been selected.

5.1.1 The scenarios as alternatives to present development trends

The scenarios were intended to consist of relevant and realistic hypotheses and defining them was a collaborative process involving partners in the consortium and representatives from railway companies. However, the scenarios had to be sufficiently contrasted in terms of levels of service and operating system performance for the differences between alternatives to be clear. Each scenario differs as regards the characteristics of the operating systems, the lengths of the trains and the speeds on the three network levels.

The variables used for defining the scenarios were as follows:

Train type, including bulk train, block train, wagon load traffic (WLT) traffic, combined transport (CT) and shuttle train.

Length of train: this is expressed in terms of a permitted maximum and minimum number of wagons. The hypotheses range from 60 wagons (about 1050 metres) to 10 wagons.

Maximum Train velocity: this is the maximum speed the different types of train are able to reach. It has been assumed to be as follows:

Bulk train:	60
Wagon load traffic (WLT) train:	120
Conventional WLT train:	80
Combined transport (CT) block train:	120
Conventional CT train:	100

However, the profile of a given track (gradient, bends) may mean that this speed cannot be reached.

Marshalling Time: this is the time from the start of wagon shunting (i.e. when the wagons are separated) until the train enters the departure sidings We have assumed a value of between 1 and 6 hours.

Border Crossing Time: this is the average time a train waits at the border. This includes any time spent waiting to change locomotives or attending to customs formalities. The actual time will depend on the situation, and we have assumed a maximum value of 3 hours.

Transport price: implementation of an efficient operating system on the core network results in a 30% reduction in transport costs. This is the scale of reduction which can be expected when running, for example, a shuttle train in a dense corridor. At this stage, it has been assumed that the entire cost reduction will be passed on to the customer because of the strength of competition from the road.

Reliability: The reliability of WLT and CT trains has been calculated for each OD pair using an indicator calibrated on the basis of the survey results. We have assumed that reliability can increase to a level which is comparable with road transport.

Network type: speeds differ on the core, intermediate and diffuse components of the network. The use of passenger rail lines for freight services (diffuse and intermediate networks) is a critical aspect of network operation. This must be carefully analysed in order to mitigate potential conflicts between freight and passenger trains.

5.1.2. Defining scenarios:

The next step in the definition of scenarios is to combine the above characteristics. The objective is to present a range of alternative situations.

A basic scenario reproduces the current situation regarding rail operating systems. This scenario will provide the reference for comparison and assessment. When constructing this scenario, the year 2020 was used as the reference year for demand prediction.

Alternative scenarios were then created with different train lengths, a different spatial extension of the "dedicated network" and a different quality of service.

Six alternative scenarios were selected in which these hypotheses were nested, so that the impact of train length, extension of the dedicated network and quality of service can be assessed not only by making comparisons with the results from the basic scenarios but also by making comparisons with the results of the other alternative scenarios.

Scenarios C1 and C2 and the "core” network scenario

These scenarios test the utility of improved rail service on the core network and the effect of train length (long train (C1) and short train (C2)) in comparison with the basic scenario. The main hypothesis is that transport speed will increase and marshalling time and border crossing time will decrease on the core network in comparison to the basic scenario.

Scenarios CI1 and CI2 and the European network scenario (core + intermediate)

These two scenarios assume that in addition to the improvement of rail service on the core network (scenarios C1 and C2), the quality of service on the intermediate network will be improved for both long trains (CI1) and short trains (CI2). However, it is assumed that marshalling times and border crossing times will be longer and that speeds will be slower on the “intermediate” network than on the “core” network.

Scenarios CIQ1 and CIQ2 and quality of service scenario

These two scenarios basically involve hypotheses concerning improved quality of service on the core and intermediate networks, but also take into account the impact of transport price and reliability. The price decreases considered on the core and intermediate networks are 30% and 10% respectively, and reliability has been raised to a level that is comparable with road transport.

5.2 The general impacts of the scenarios on rail transport demand

The impacts of the scenarios have been measured by comparing them with the results of the basic scenario at the horizon 2020. The EUFRANET traffic generation model considers modal transfers does not take account of the overall increase in traffic volume which is due to an improvement in the quality of service.

5.2.1 The basic scenario

The basic scenario is a “trend” scenario. The hypotheses concerning the socio-economic environment have been made after a detailed analysis of the trends that affect economic activities for each industrial sector and each region.

With regard to the transport cost hypothesis, it is important to note that it has been assumed that road costs will decrease by 1% per year, which is in line with the past trend. It has been assumed that rail costs will remain unchanged. In other words, the competitiveness of road transport will improve in comparison to rail, so that the basic EUFRANET scenario is not based on an assumption that rail renewal can come from higher charges for road transport, which would not be realistic in the light of past trends.

As a consequence, rail traffic increases slowly in the basic scenario, by 12% in tonne-kilometres, and rail's modal share is reduced by almost one third over the period, falling from 14.8% to 10.3%. This fall applies to both national and international traffic. The drop in bulk traffic is less due to a loss of competitiveness than to the contraction of the bulk market.

5.2.2 General results of the impact on rail demand

The general impacts are analysed in tonnes and tonne-kilometres for national and international transport, with a disaggregation between bulk, wagon load, and combined transport volumes. Road and inland navigation volumes are given for the purposes of comparison. The two tables below (Table 5.1 and 5.2) give the general results of the impacts of the scenarios that have been output by the BVU demand model after iterations of the IVE operation model.

Bulk traffic often requires specific analysis with regard to changes in volumes and competitiveness with other modes. Major flows, involving very specific situations, with a precise origin and destination may significantly influence overall change at both national and European levels: links to major ports carry large volumes of bulk traffic as well as large volumes of combined transport traffic; this will be confirmed by the detailed geographical analysis.

The relative changes in wagon load and combined transport traffic are particularly interesting, because separate rail operating systems, or even separate terminals, are often required (although this is not always true as mixed trains are also operated).

BVU Beratergruppe Verkehr + Umwelt GmbH

Key Figures Volumes [10^6 t]

	Reference Case	(C,1)	(C+I,1)	(C+I+Q,1)	(C,2)	(C+I,2)	(C+I+Q,2)
National Transports							
Road	10759	10717	10688	10550	10656	10637	10495
Rail WLT bulk	314	330	341	400	352	359	420
Rail WLT non-bulk	169	189	203	274	220	229	304
Rail CT	19	27	32	43	36	39	49
Rail total	502	546	575	717	608	627	773
Inland Navigation	147	145	145	140	144	143	139
Total	11408	11408	11408	11408	11408	11408	11408
International Transports							
Road	1176	1152	1140	1085	1129	1120	1060
Rail WLT bulk	73	78	82	103	86	89	112
Rail WLT non-bulk	49	57	61	89	69	73	103
Rail CT	29	41	47	63	51	54	68
Rail total	151	176	189	255	206	216	283
Inland Navigation	279	278	277	267	271	271	263
Total	1606	1606	1606	1606	1606	1606	1606
All Transports							
Road	11935	11869	11828	11635	11785	11757	11555
Rail WLT bulk	387	408	422	503	439	447	532
Rail WLT non-bulk	218	246	264	363	289	302	407
Rail CT	48	68	78	105	87	93	118
Rail total	653	722	764	972	815	843	1057
Inland Navigation	426	424	422	407	415	414	402
Total	13014	13014	13014	13014	13014	13014	13014

Table 5.1 Traffic in tonnes for each mode and scenario

BVU Beratergruppe Verkehr + Umwelt GmbH

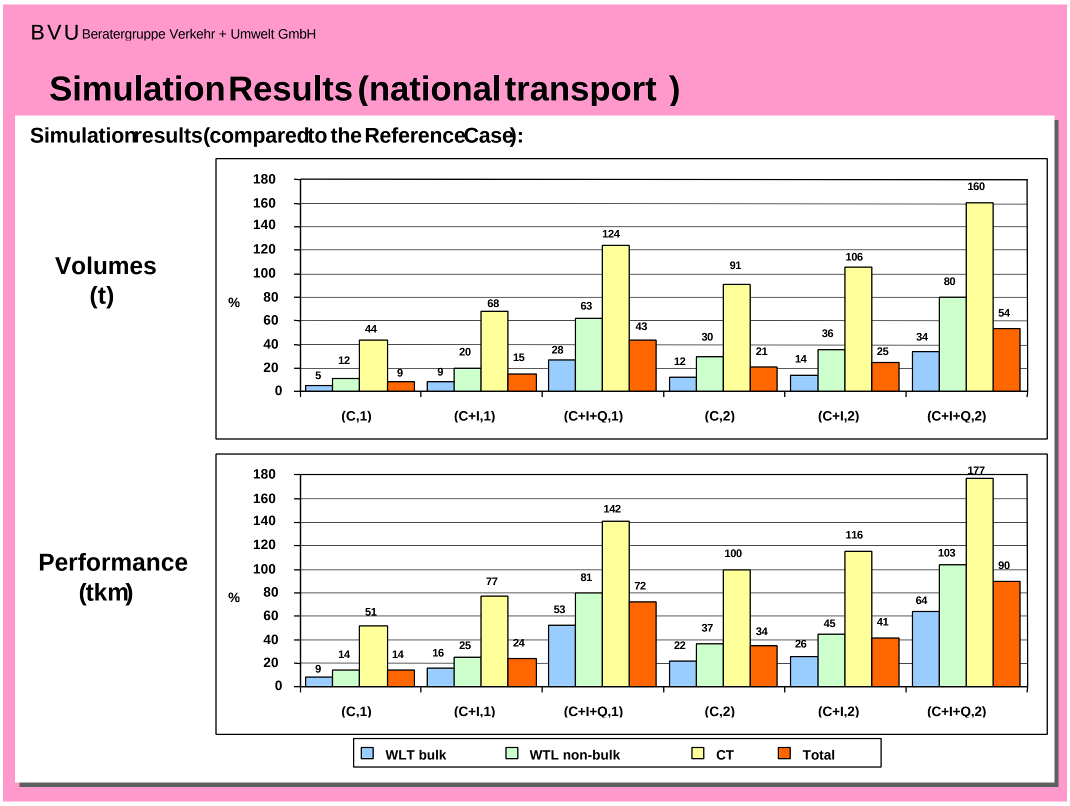
Key Figures Performance [10^9 tkm]

	Reference Case	(C,1)	(C+I,1)	(C+I+Q,1)	(C,2)	(C+I,2)	(C+I+Q,2)
National Transport							
Road	1048	1033	1022	971	1011	1004	951
Rail WLT bulk	52	56	60	79	63	65	85
Rail WLT non-bulk	50	57	63	91	69	73	102
Rail CT	8	12	14	19	16	17	22
Rail total	110[2]	125	136	189	147	155	209
Inland Navigation	18	17	17	16	17	17	16
Total	1175	1175	1175	1175	1175	1175	1175
International Transport							
Road	801	784	775	738	768	762	722
Rail WLT bulk	45	47	49	61	52	53	65
Rail WLT non-bulk	44	50	53	71	57	60	79
Rail CT	26	36	40	52	43	45	56
Rail total	115	133	142	184	151	158	201
Inland Navigation	101	101	101	96	98	98	95
Total	1017	1017	1017	1017	1017	1017	1017
All Transport							
Road	1849	1817	1797	1708	1779	1766	1673
Rail WLT bulk	96	103	109	140	114	118	150
Rail WLT non-bulk	94	107	115	162	126	132	181
Rail CT	34	48	54	71	58	62	78
Rail total	225	258	278	373	299	312	409
Inland Navigation	119	119	118	112	115	115	111
Total	2193	2193	2193	2193	2193	2193	2193

Table 5.2 Traffic in tonne-kilometres for each mode and scenario

Figure 5.1 present the simulation results for the different scenarios and compare them with the basic scenario. The impact on rail demand, for different types of traffic and different scenarios is shown. There is a fairly slight impact on bulk traffic demand on rail and the other modes (roads and inland waterways).

This is not surprising because bulk traffic is less sensitive to time variables. This does not in any way mean that rail should cease to be interested in this market - it can be a profitable one where major economies of scale and improvements in logistical organisation are still possible.



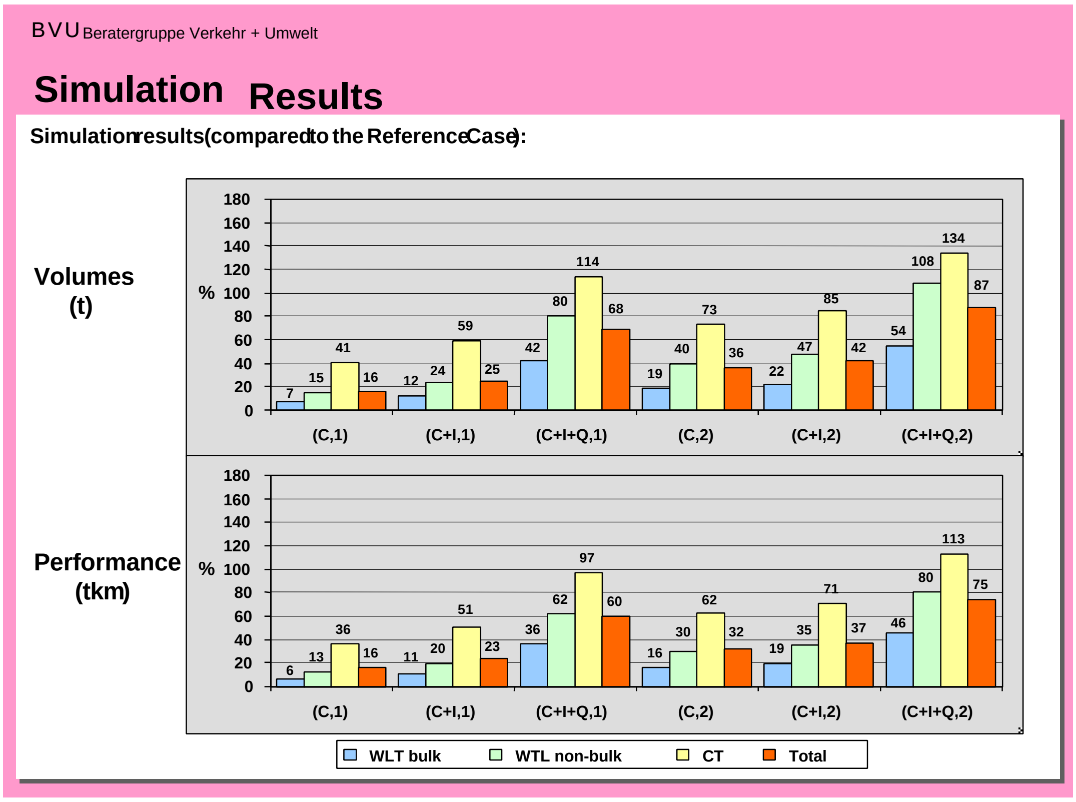


Figure 5.1 Comparison between the scenarios (national and international transport)

There is a fairly major increase in wagon load train and combined transport traffic. This impact is gradual as rail services improve, reflecting the sensitivity of these markets to time and quality considerations. The effects on the total volume of rail demand range from 6 or 7% to almost 150% and even more for combined transport traffic: this large range of results shows clearly that rail traffic is very sensitive to changes in supply conditions.

Although the sensitivity of combined train traffic appears to be somewhat higher than for wagon load traffic, the differences are not large and more detailed analysis is necessary taking account of flow patterns and distances.If we ignore the bulk market, it can be seen that: with the basic scenario, wagon load train and combined transport traffic increased between 92 and 2020, albeit more slowly than road transport.

with the alternative scenarios, wagon load and combined transport trains carry a significant volume of traffic in comparison with road transport. This can result in a doubling of the volume of rail traffic and even an increase in rail's modal share over the 1992 situation: this would constitute a major reversal of past trends.

The impacts of these factors on rail volume are quite clear, and are additive when simulation is performed using the “nested” construction of the scenarios. Figure 5.2 shows the comparison between the long train hypothesis and the short train hypothesis with the basic scenario.

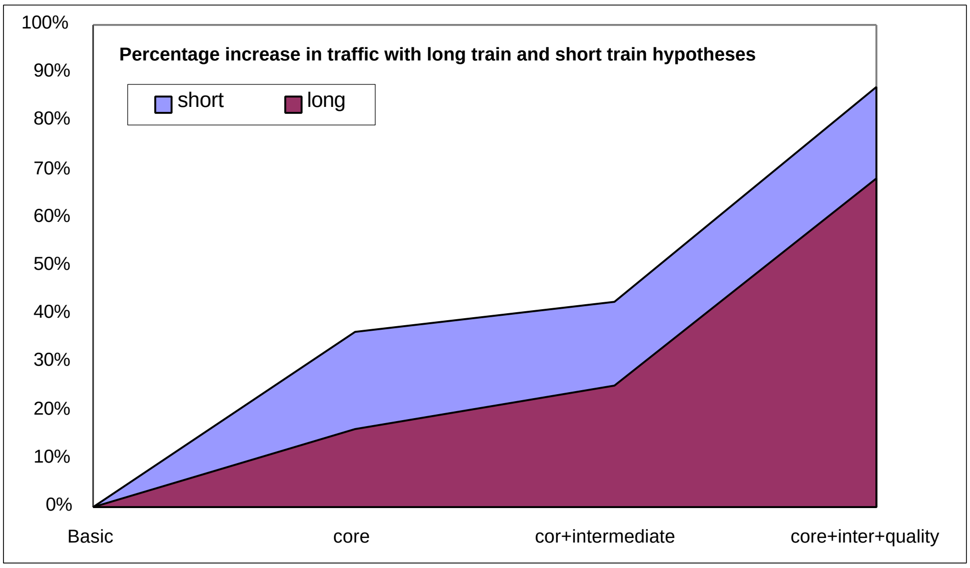


Figure 5.2 Percentage increase in traffic with long and short train hypotheses compared with basic scenario

However, some additional comments can be made concerning interpretation of the results: relatively slight impact of the “core + intermodal” network scenario as compared to the “core” scenario hypothesis must not be misinterpreted.

This small scale of this impact is mainly due to the fact that the “core” network has already attracted most European rail traffic. The impact of the addition of an intermediate network should be analysed on sub-networks independently of the “core network”. This can be done when focusing on more peripheral regions where there is no “core” network, like Spain, the UK, southern Italy or even the west of France.

However, peripheral regions also benefit from improvements on the core network, Table 5.3 shows the difference in traffic between the core network scenario and the basic scenario. The increased traffic in Spain, Italy and the UK should be noted. That is due to:

- the amount of import/export transport: these regions import and export over long distances and their transport performance is therefore influenced by the efficiency of the European network as a whole.

- a phenomenon of "synergy" between short and long-distance transport: local traffic moving between two consolidation points on the rail network benefit from the increased volumes on longer distances[9].

O	B	DK	D	E	F	I	L	NL	A	P	Fin	S	GB	CH	N	PL-CZ	Total
B		151	161	119	127	128	106	124	115	100	100	109	100	121	120	107	131
DK	125		142	137	123	140	100	192	131	100	109	107	119	139	112	100	130
D	146	134		136	116	120	122	174	117	108	106	111	123	127	142	108	123
E	117	108	109		107	104	153	123	102	113	100	107	122	105	100	110	110
F	120	121	123	109		110	113	118	118	100	115	104	116	119	113	127	116
I	147	156	143	107	135		119	144	115	100	149	117	243	131	127	122	142
L	107	100	120	107	123	108		137				100	141	100		100	112
NL	153	127	142	198	124	136	108		111	100	100	100	116	127	100	114	133
A	143	112	120	115	107	120	100	118		100	122	108	118	121	101	104	118
P	100		105	104	100	100			100					100			104
Fin	100	126	120	100	130	133		100						107			119
S	110	131	117	104	110	104	100	104	101	100			100	103			107
GB	100	100	125	125	114	192	135	120	100		100	100		100		100	132
CH	164	143	153	104	114	115	101	139	111	100	134	101	100		161	111	129
N	120	114	170	100	109	123		100	104	100				128			139
PL-CZ	109	100	118	102	114	118	100	117	107	100			100	114			115
Total	129	130	128	120	120	118	109	137	113	111	118	109	126	122	126	108	122

Table 5.3. Index of traffic (tonnes) with C1 compared to basic scenario (without bulk)

Furthermore, national and international results must be placed in a long term perspective. Figures 5.3 and 5.4 compare national and international traffic in tonnes and tonne-kilometres.

When comparing national and international volumes for the year 2020, it is important to stress that while international volumes are lower than national volumes in terms of tonnage, they become larger when measured in tonne-kilometres, even when rail transport to ports is counted as national transport. This development is particularly clear for combined transport.

This is essential for rail strategy analysis and results from the fact that international transport is growing at a much faster rate than national traffic: most of the expected increase in rail traffic will be due to international transport.

To put it even more clearly, if wagon load and combined transport train traffic doubles by 2020, most of the growth will come from international traffic and therefore from a dynamic supply strategy at European level.

[9] The SIMIQ model is very clear as regards this phenomenon (IQ project D6).

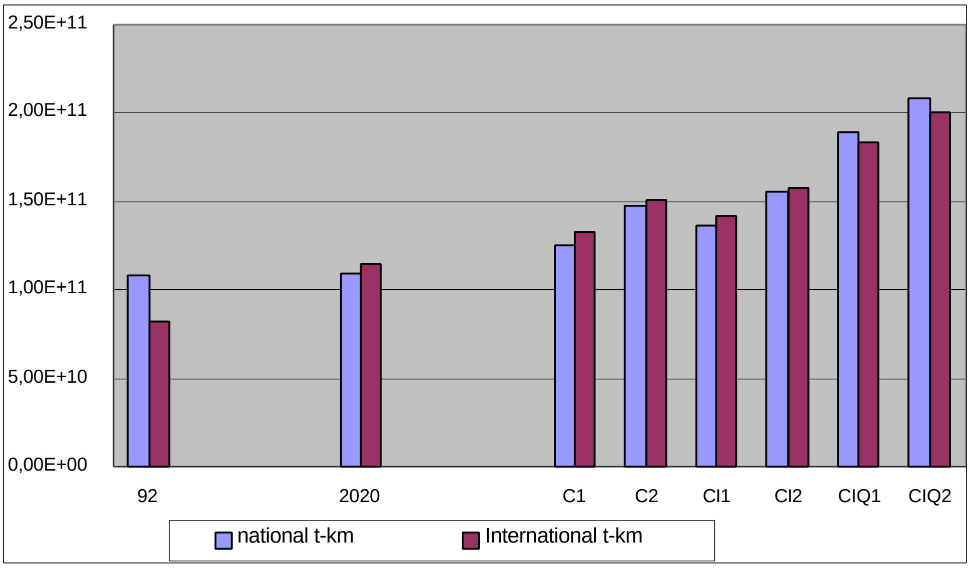


Figure 5.3 Comparison of national and international traffic (tonne-kilometres)

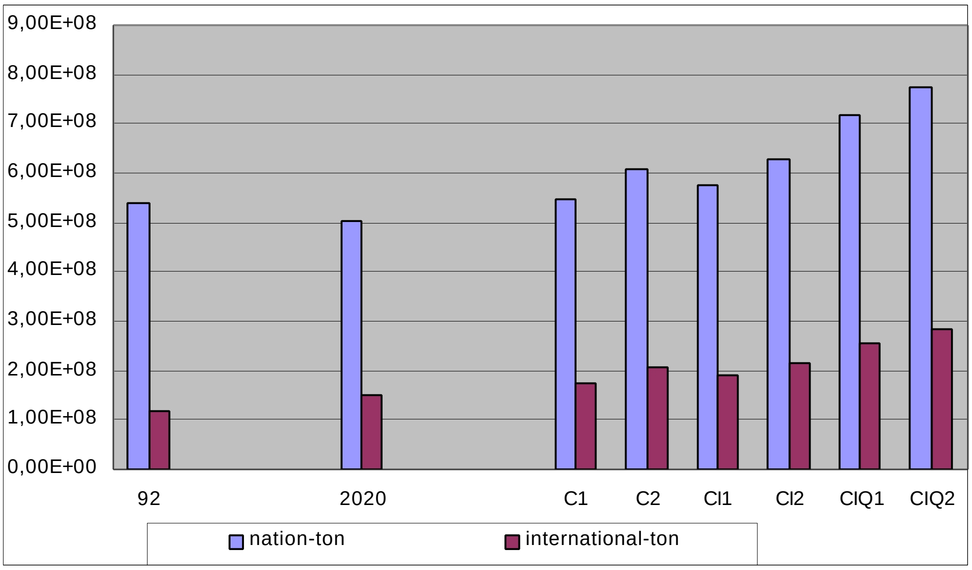


Figure 5.4 National and international traffic (tonnes)

Concerning the increase in national and international rail traffic as compared to the basic scenario at year 2020,the increases range from 7.4% to 50% for national traffic, and from 10.2% to 76% for international traffic. These figures include bulk traffic, which to some extent limits the impact of the improvement in supply. The increase in national traffic takes into account the aforementioned “synergy” effect whereby one country benefits at national and international level from improvements in the rail network in its neighbours.

International traffic is more sensitive to the supply scenario with a significant difference between countries, in particular for Italy, the Netherlands, the UK and Switzerland. The lesser impact on Scandinavian countries is partly due to the importance of bulk traffic there.

However the impacts on national traffic are also significant, and this includes countries without a core network such as Spain: the core network has an indirect impact and the international network plays a relatively important role. If we compare scenarios C1 and C2, the latter has almost three times more impact that the former for Spain and twice more for Italy. This can be explained by their more peripheral situation and the fact that they are served by the intermediate network. But it must be kept in mind that the improvement in national traffic in comparison to the basic scenario merely corresponds, in most cases, to traffic that was lost between 92 and 2020 as a result of competition from roads.

To summarise briefly, it could be said that the problem is to maintain traffic volume at national level and increase traffic volume at international level, and also, if possible, improve rail's modal share.

5.3 Detailed analysis of the impact on modal share

5.3.1 The impacts of the alternative scenarios on modal share

The change of modal share reflects a shift of traffic away from roads or waterways to rail in 2020 as compared with the basic scenario. The improvement in rail quality of service is responsible for most of the traffic that is transferred from the roads.

National traffic

For national traffic, since Denmark, Ireland, Luxembourg, Finland and Norway are represented by a single NUTS area in the simulation, regional changes within these countries could not be taken into account. In addition, Greece has not been not considered because it has no important rail links with the rest of Europe and would require a specific study.

It is clear that the initial situation of the countries is quite contrasting and that for traffic measured in tonnes, rail plays an important role in Germany, Sweden and Switzerland (27%, 12% and 23% respectively). Rail's modal share in tonne-kilometres is twice that in tonnes (8.7% versus 4.2%). This is explained by the fact that the average transport distance for rail is longer than for road (Figure 5.5).

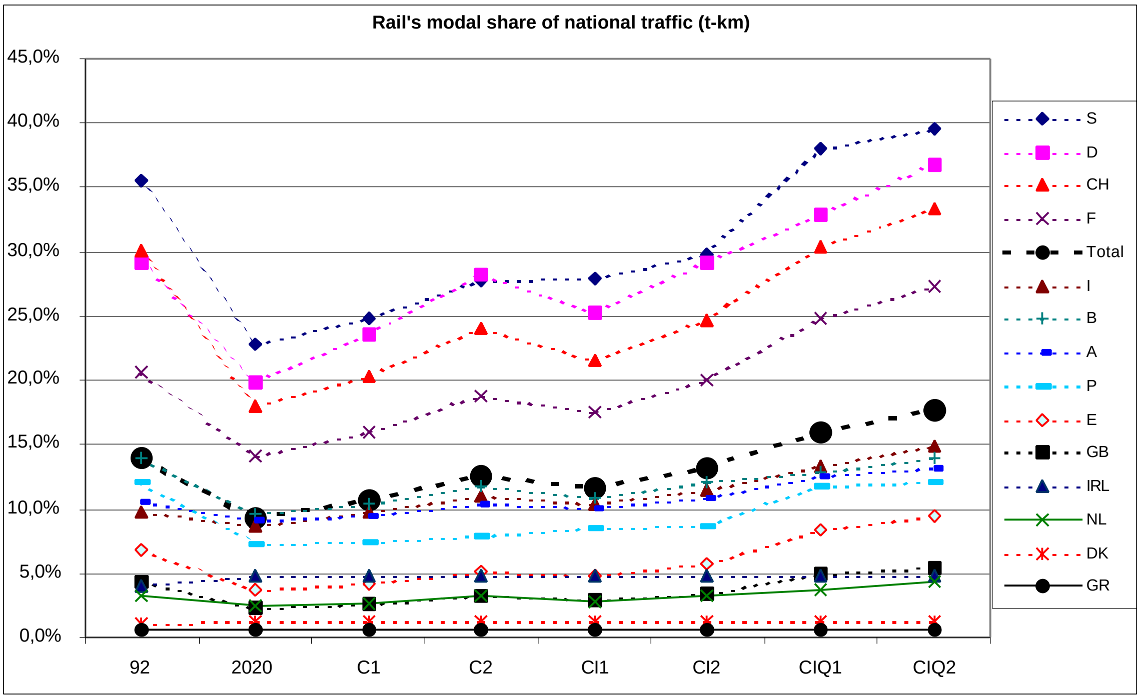


Figure 5.5. Impact on rail's modal share of national traffic (tonne-kilometres)

However, this general remark need not be true for all countries; the presence of short-distance large-scale bulk transport can affect the overall national results. In Germany, for example, modal share in tonnes is higher than modal share in tonne-kilometres because of the large amount of short distance national transport of raw materials. In tonne-kilometres, rail transport also plays a relatively important role in France; this initial situation has to be kept in mind when interpreting the results.

These first results for national traffic show that the increase in rail's modal share is quite significant in all the scenarios: rail's modal share increases from 8.7% in the basic scenario to 9.6% in scenario C1 and 15.9% in scenario CIQ2.

On the other hand, if the speed is sufficient, long train operating systems can be less demanding in terms of slot allocations and operating costs can probably be reduced. These reductions have not been taken into account at this stage so that the increase in rail's modal share to 9.6% with the long train operating hypothesis can be considered as a minimum.

In conclusion, as an initial approximation, implementation of a core “dedicated” network (scenarios C1 and C2) could result in an increase in rail's modal share at national level of between 10% and 30%

Combined transport accounts for only a small proportion of national traffic and most combined transport flows are international. The O/D data collected achieved statistical significance only in the case of Germany and France. This table is of most use as a means of analysing relative changes in modal share rather than absolute values. It confirms the sensitivity of combined transport to quality variables; quality improvements can increase modal share by a factor of 2.5 in these two countries, from 0.7% to 1.9 ,

International traffic

As mentioned above, Greece was not considered for international transport because it has no links with the rest of Europe; however Poland and the Czech Republic have been added to show that links with central Europe have a significant influence on European rail freight patterns. Tables 5.4 show the rail's modal share of international traffic in tonne-kilometres for each country and for each scenario.

For international transport, rail is important for some countries such as Luxembourg, Austria, Switzerland and some northern European countries such as Finland and Norway. In some countries, for which national rail transport was marginal in tonnes, rail achieves a better position at international level (i.e. Belgium, the Netherlands and Austria). In eastern European countries, rail remains an important transport mode for international transport.

It is thus important to notice that rail's modal share of international transport is higher than for national transport when measured in tonnes, but not when measured in tonne-kilometres.

on the other hand, rail's share of the international market is not very large on the longest international links because of interoperability problems due to border crossings, gauge differences and unattractive prices. This means that most international rail transport is conducted over average international distances, for example between the industrial regions of northern Europe (Benelux, northern France, the UK, the Ruhr and Rhine regions), or between northern Italy, southern Germany and the Rhone-Alps and Provence regions of France. International rail traffic frequently involves short or average distances: it spite of what one might think long distances are rarely involved.

Country	B	C1	C2	CI1	CI2	CIQ1	CIQ2	distance
B	9.2%	10.2%	11.8%	10.9%	12.4%	14.5%	16.6%	1186
DK	5.7%	6.3%	6.9%	6.6%	7.1%	8.1%	8.6%	1449
D	9.7%	10.4%	11.6%	10.9%	11.9%	13.4%	14.7%	1138
E	4.0%	4.3%	5.0%	4.6%	5.2%	6.1%	6.6%	2072
F	9.2%	10.2%	11.4%	10.9%	12.1%	14.7%	16.2%	1314
IRL	7.7%	7.7%	7.7%	7.7%	7.7%	8.0%	8.0%	1903
I	3.5%	4.1%	4.8%	4.5%	5.1%	6.4%	7.2%	1660
L	16.3%	17.9%	20.3%	19.0%	21.1%	23.1%	25.0%	851
NL	4.3%	4.7%	5.5%	4.8%	5.6%	7.3%	8.1%	1222
A	19.6%	22.4%	27.4%	24.3%	28.6%	34.1%	38.2%	1404
P	1.2%	1.2%	1.3%	1.3%	1.4%	1.6%	1.6%	2084
Fin	16.8%	19.9%	20.6%	20.3%	20.8%	25.6%	26.1%	2993
S	26.8%	27.9%	29.0%	28.5%	29.3%	30.8%	31.1%	2137
GB	1.6%	1.8%	2.2%	1.9%	2.3%	2.7%	3.3%	1500
CH	12.1%	14.0%	16.6%	14.7%	17.3%	20.8%	23.6%	1233
N	14.5%	15.3%	15.6%	15.6%	15.9%	17.5%	17.7%	2457
PL-CZ	26.4%	28.0%	30.2%	29.4%	31.3%	35.8%	37.7%	1456
total	8.7%	9.5%	10.7%	10.0%	11.1%	13.0%	14.2%	1639

Table 5.4 Impact on rail's modal share of international traffic (tonne-kilometres)

Therefore there is a large potential market for long-distance international transport in Europe and this is growing much faster than the national transport market. This potential for the long-distance international market is not fully reflected in the scenario impact analysis; with implementation of the “dedicated” network with quality improvements the forecast modal shift only increases from 8.8% to 13.4% in tonnes, and 8.7 to 14.2% in tonne-kilometres while for national transport this last figure was 15.9%.

In Austria, Sweden, Norway and Germany, combined transport accounts for a larger share of the market than in the other countries. But these tables also show that combined transport's share of the international market can more than double compared to the basic scenario and account for a significant part of the total international rail market in tonne-kilometres, i.e. 5.5% of the total transport market as compared to conventional rail's 14.2%.

Figure 5.6 shows the most important international rail links with the basic scenario. There are two zones where rail where rail has a large share of the market in comparison with road transport: within central Europe (including movements between Belgium and Switzerland, Luxembourg and Austria); and movements between the European continent and northern Europe (for example, from Luxembourg and Italy to Sweden).

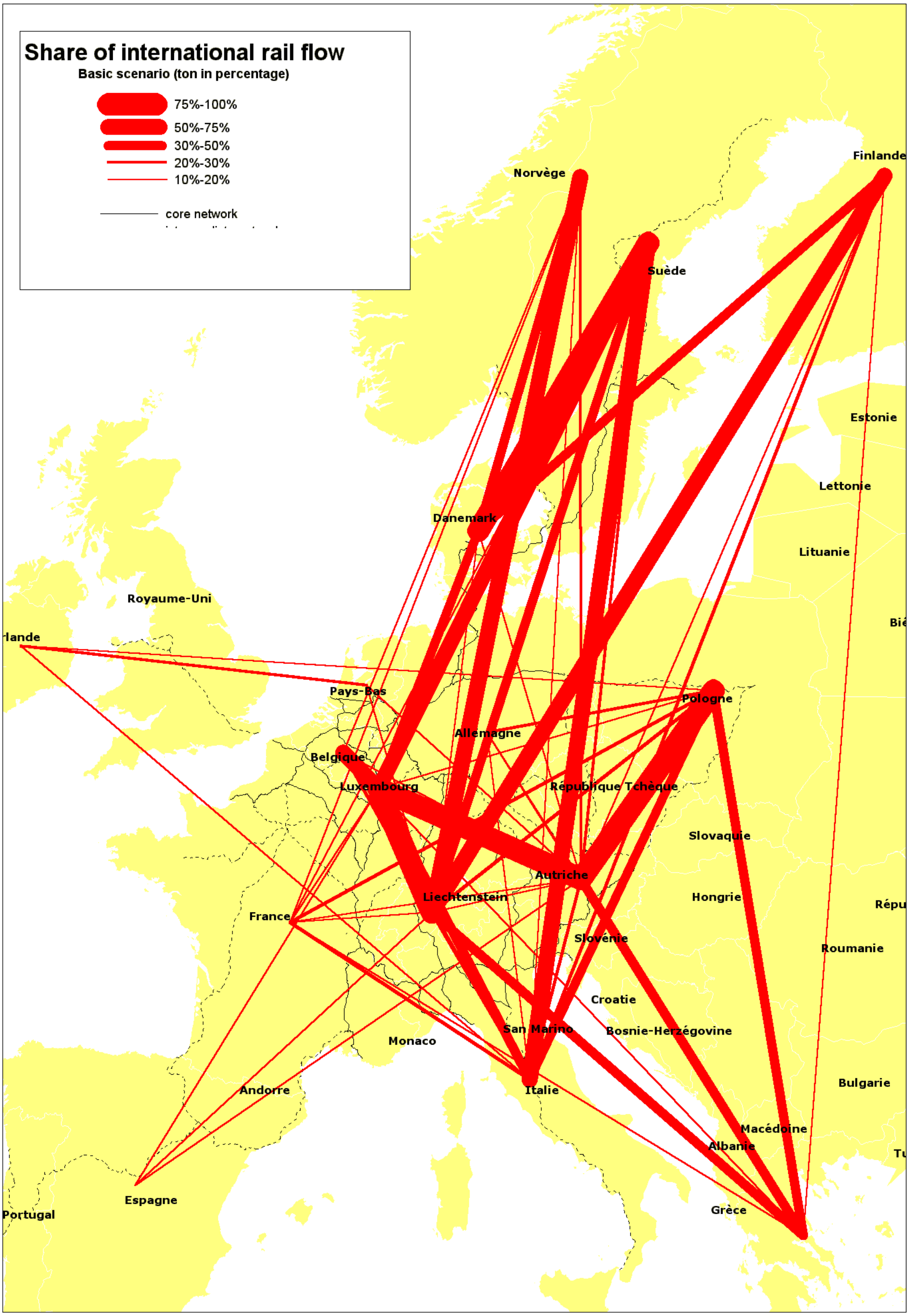


Figure 5.6. Rail's modal share of international traffic in the basic scenario

Analysis of total traffic (national and international)

The expected impact of the EUFRANET scenarios show that rail could reverse this trend and attain a modal share of up to 18% depending on the extent to which rail services are improved. Gains in national markets are of the same order of magnitude as gains in international markets although important differences exist between countries and the potential increase in volume differs considerably between different types of traffic.

Figure 5.7 below shows the orders of magnitude of the impact of EUFRANET policies and shows the scenarios which, in the year 2020, will enable rail to maintain its present situation or even improve on it to regain the position it lost twenty years ago.

The scenarios leave a wide range of options open to rail policy. But the upper limit is very constraining.

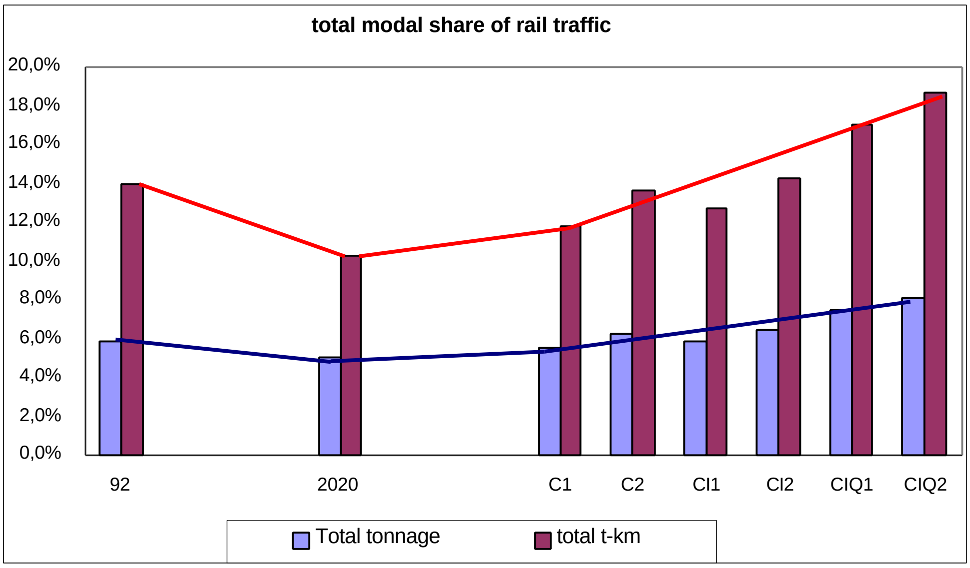


Figure 5.7 The total modal share of rail traffic in the alternative scenarios

These results mean that rail could not only maintain its modal share but even improve on the position in the year 2000 and regain the modal share it possessed at the beginning of the nineties or, with the most favourable hypothesis, return to the modal share it possessed in the eighties.

Without EUFRANET policies there would be a continuing decrease in rail's modal share, which would fall to below 9 or 8%. In practice this would mean that rail would remain in a strong position in only a few traditional markets with little hope of an increase in the volume it transports. Rail would cease to be a potential alternative to the roads.

5.3.2 Modal share according to type of product

For national transport, the main products transported are metals, manufactured products, ores, minerals and fuel. In some countries such as Greece, Austria, Portugal, France and Spain, foods and agricultural products are important markets for rail transport. Chemical products are important in the UK and Switzerland.

International rail transport flows are less concentrated national flows: agricultural and chemical products represent a bigger share of the market. In Norway rail traffic mainly involves crude oil, in the Netherlands petrol products account for a considerable amount of traffic, as does solid fuel in Poland and Czech Republic.

Products transported in bulk are less sensitive to improvements in rail services. This sector includes markets for which rail is often adapted, with specific rolling stock and industrial logistics. For industrial bulk traffic, competition from inland waterways can be strong on major waterway corridors, in particular the Rhine Valley serving Rotterdam and Antwerp, Belgian canals, or, to a lesser extent, the Seine and Rhone valleys.

However the increase might be significant for metal products and minerals which are used in the engineering and construction industries. These are transported between one industry and another, with large shipment sizes which one would expect to favour rail, but this is also a market where rail's share has decreased because of poor transport times and lack of reliability.

There are grounds for hoping that rail transport of fertilisers will increase, but distribution of these products is more diffuse as they are inputs for agricultural production. Chemical products also appear to be a promising market with rail's market share almost tripling. As has been mentioned above, these products are often considered as being hazardous goods.

The potential gain for manufactured goods might not be very large in terms of modal share, but, unlike bulk products, this type of transport is developing very fast. As economies become more specialised the potential for transport is becoming very great.

To summarise, rail is faced with quite different markets with differing logistical requirements, and cannot afford to neglect any of them:

- bulk products, for which rail's initial position is strong but which require specific logistics and a modification of bulk rolling stock and services,
- very rapidly growing inter-industrial markets, for which wagon load transport can be more appropriate,
- manufactured products, for which profound changes in distribution patterns are taking place; wagon load and combined transport can provide appropriate solutions for these.

5.4 Spatial Distribution of Flows

An understanding of the spatial distribution of flows is essential for network analysis, in order to identify the most important trade links and interconnections and assess accessibility within Europe.

Although the main opportunities for rail are located where European trade is increasing, rail geography has some specific features, as an analysis of modal shares on the major European links will demonstrate. Intuitively, one would expect rail to develop where economies of scale are possible, which means where flows are concentrated. However, although rail should be more competitive for longer distances, higher volumes are observed on shorter distances. Geography and the crossing of natural barriers also have an impact: the increase in international traffic leads to the construction of new tunnels on longer routes and for safety reasons these are usually rail tunnels.

In the previous chapter we have shown that the increase in traffic volume varies depending on the type of product: transport of bulk products, which represents around 45% of rail volume, is not expected to increase very much, especially at national level. Bulk products, which still represent a high proportion of the volumes on specific links, must again be considered separately if we want to achieve a better understanding of where the future opportunities for rail lie with regard to competition with roads. On the other hand, the distinction between wagon load traffic (general cargo) and combined transport might not always be necessary because the requirements of the markets are more similar, and it is in principle difficult to favour one over the other or consider them independently. Continental transport to or from ports could also be an interesting segment, but with the available data it is not easy to separate such traffic in the context of EUFRANET scenario assessment.

The impact of the scenarios on spatial distribution will be considered at two levels:

- international links, which give a European scope for the challenges rail has to face; international links are also where potential traffic is increasing more rapidly and where rail's current modal share appears particularly low;
- interregional links, in order to locate network constraints and the origins and destinations of demand more accurately.

5.4.1 International distribution of rail traffic

Bulk rail traffic

EUFRANET's demand analysis has shown that bulk flows often decrease at national level, although not necessarily at international level, as a result of the relocation of basic industries in Europe. This might increase imports through ports - most major ports are bulk ports with major concentrations in the northern ports and, sometimes, strong competition between them.

Another important point is that rail transport is in a much stronger commercial position than road transport for the transport of bulk products, in particular when longer distances of more than a few hundred kilometres are involved. Demand analysis requires specific logistic considerations including whether or not there are private sidings connected to the main network.

It is therefore not surprising that the scenarios do not affect international flow patterns for bulk products. Implementation of the dedicated rail network does not alter the volume of bulk products transported by rail to any major degree. The Comparison of the O/D matrix for bulk products between basic scenario and scenario CIQ1 shows that at best, with a simultaneous improvement in quality, there is only an increase of about 10%.

The conclusion we have reached is that bulk products should be a priority for rail strategy and be considered in the context of implementing a dedicated network; bulk products often constitute a profitable sector and should not be neglected. However, commercial policy must concentrate on specific logistical considerations and routes should be chosen carefully with reference to the capacity constraints of the links.

Non-bulk products and combined transport

In recent years the temptation has often been to consider combined transport, as the operating system most likely to attract road traffic. The result is that combined transport has often been expanded at the expense of conventional rail transport and wagon load techniques have undergone little improvement.

It is interesting to consider these two techniques in a wider context of logistic organisational, bearing in mind that combined transport requires specific terminal and transport equipment on an operational level.

In comparison with the basic scenario, in C1 there is an increase in the volume measured in tonnes of more than 15%, while scenario C2 leads to a 40% rise. When the intermediate network is added to the core network (spatial extension) the impact is an almost 9% increase in the tonnes transported. Under the most favourable hypothesis (CIQ2) (table 5.5), traffic more than doubles (+ 110%).

	B	**DK**	**D**	**E**	**F**	**I**	**L**	**NL**	**A**	**P**	**Fin**	**S**	**GB**	**CH**	**N**	**PL-CZ**	**Total**
B		100	365	298	308	207	122	196	174	100	100	188	100	263	193	126	250
DK	168		201	259	218	160	100	295	145	100	147	118	155	183	203	100	157
D	330	216		206	177	143	249	422	189	141	165	148	215	225	108	125	194
E	217	118	154		176	128	814	274	113	200	100	121		149	100	188	170
F	268	169	197	182		151	169	251	217	100	156	115	238	384	148	209	209
I	213	132	214	132	267		269	183	235	100	278	135	100	390	160	257	237
L	131	100	191	126	232	129		490				100	343	101		100	162
NL	319	156	481	361	270	161	204		145	100	100	100	172	167	100	206	295
A	217	141	203	231	152	201	100	260		100	150	152	258	366	182	116	200
P	100		111	155	100	100			100					100			147
Fin	100	359	329	100	218	193		100						117			157
S	282	288	146	104	117	117	100	116	107	100			100	105			124
GB	100	100	241		207	100	380	174	120		100	100		100		100	221
CH	335	221	221	138	322	186	103	203	256	100	245	104	100		586	144	222
N	804	223	100	100	148	178		100	189	100				196			178
PL-CZ	150	100	241	120	155	179	100	161	134	100			100	143			200
Total	249	179	253	194	234	161	148	260	163	182	174	136	214	244	160	129	209

Table 5.5. Index of non-bulk rail traffic with CIQ2 compared to basic scenario

These results mean that international traffic demand for non-bulk products reacts very significantly to the EUFRANET scenarios, and that most countries benefit from these scenarios.

With the EUFRANET scenarios the countries in the centre of Europe benefit more from the improvement of rail services than peripheral countries (which nevertheless also have a very significant increase in rail traffic). Table 5.6 shows the ratio of international rail and combined traffic in the basic scenario and scenario CIQ2: total rail and combined traffic increases by a factor of between 1.17 and 2.93 which will change the pattern of rail flow. The major flows in the centre of Europe, in particular to and from Germany will be increased by a factor of between 2.02 and 2.62.

The country which appears to benefit most from the EUFRANET strategy is the Netherlands, in particular for exports (exports increasing by a factor of 2.93, imports by a factor of 2.76).

	B	DK	D	E	F	I	L	NL	A	P	Fin	S	GB	CH	N	PL-CZ	Total
B		450	360	216	304	218	122	204	169	100	100	157	100	263	193	163	256
DK	220		298	259	224	226	100	465	215	100	147	118	155	212	203	100	213
D	326	249		208	186	162	254	450	189	128	165	138	215	235	169	138	202
E	217	114	151		176	128	814	274	113	200	100	117	261	149	100	172	170
F	264	181	208	182		154	169	251	232	100	156	115	223	384	138	221	207
I	274	251	262	132	298		269	257	235	100	278	149	597	390	202	257	281
L	131	100	190	126	232	129		490				100	343	101		100	163
NL	318	154	465	361	270	207	204		166	100	100	100	172	185	100	166	293
A	260	160	197	206	155	201	100	212		100	150	150	238	366	145	116	198
P	100		112	155	100	100			100					100			139
Fin	100	359	329	100	218	193		100						117			157
S	183	288	135	107	124	110	100	113	105	100			100	107			117
GB	100	100	232	183	207	388	380	174	113		100	100		100		100	245
CH	329	236	293	138	322	186	103	204	256	100	245	104	100		454	175	242
N	362	223	256	100	135	179		100	147	100				171			205
PL-CZ	147	100	249	113	163	179	100	153	134	100			100	155			211
Total	257	211	256	192	232	171	150	276	171	172	174	134	233	241	168	139	216

Table 5.6 Index of rail and combined traffic with scenario CIQ2 compared to the basic scenario

Belgium is also an important beneficiary with both imports and exports increasing by a factor 2.56. Germany is an interesting case, with imports increasing by a larger factor than exports (2.62 versus 2.02). Italy seems to benefit from the EUFRANET scenarios for exports more than imports (2.81 versus 1.71), which should restore the balance between import and export rail flows.

France appears to be in a fairly good position with an increase by a factor of more than 2 (2.07 for exports and 2.32 for imports). These results are comparable with those of the UK which, however, starts from much lower volumes.

More peripheral countries like Spain and Portugal seems to benefit less, in relative terms, from EUFRANET scenarios, although rail traffic should be multiplied by 1.7 for exports and by almost 2 (1.92) for imports. Spain trades with all European countries and also benefits from “dedicated” network scenarios even if the country only gains "intermediate” links in the scenarios. For Portugal, the relative gain is lower and the fairly low current flows would be multiplied by 1.72 for imports and 1.39 for exports.

In conclusion, the estimated modal rail share for non-bulk and combined transport traffic varies within Europe although all international links benefit from the EUFRANET scenarios. Rail acquires a stronger position on links between countries in the centre of Europe and for links with Scandinavian countries. This modal share can exceed 50% for non-bulk products and 30% for combined transport (which is included in non-bulk transport). As has been stated before, the EUFRANET scenarios significantly increase these modal shares but do not reduce the variations within Europe.

These results are due to the fact that the dedicated rail network is more developed in the centre of Europe where international rail transport is already relatively strong. Extension of the “dedicated” network towards western and southern Europe would probably bring more opportunities for rail development but would also require a great deal of investment and commercial adaptation if it were to be implemented before 2020. A possible solution would be to investigate in greater detail how improvements could be made to the intermediate links which penetrate quite deeply into some more peripheral regions, mainly the west of France, Spain, Portugal, the UK and some central and southern parts of Italy.

In terms of European rail geography, Germany has a central position with exchanges with countries to the Northeast, East, South and West. Eastern countries import more non-bulk products (in tonnes) than they export, but this situation is reversed in their trade with Italy. Figure 5.8 shows the most important rail links with the basic scenario. In addition, Figures 5.9 compare the effects of different scenarios on the distribution of rail traffic flows by showing the traffic increase (tonnes per year) with the scenarioCIQ1 compared with the basic scenario. Figure 5.10 presents the most important international combined transport links with the basic scenario.

This elicits a second remark, namely that European rail geography reflects the major patterns of international trade, and most of the increase in traffic, in absolute terms, involves countries between which flows are already very high.

5.4.2 The interregional distribution of traffic

The interregional analysis confirms that EUFRANET scenarios also have an impact on these short distance flows: for short distance bulk transport it will be essential to determine the chosen route and time of day so that capacity problems can be managed without penalising traffic which might be less sensitive to transport time or transport schedules.

Improvements in frequency and quality have a clear impact on longer distance traffic and increase traffic on new links, especially towards northern Europe and Austria. On longer distance links the volume of flows is lower and consolidation policies become essential; this should also be investigated in more depth at a later stage when rail strategies are discussed in detail.

For combined transport these consolidation policies have always been crucial with the development of gateways which mean that longer road transport legs are possible.

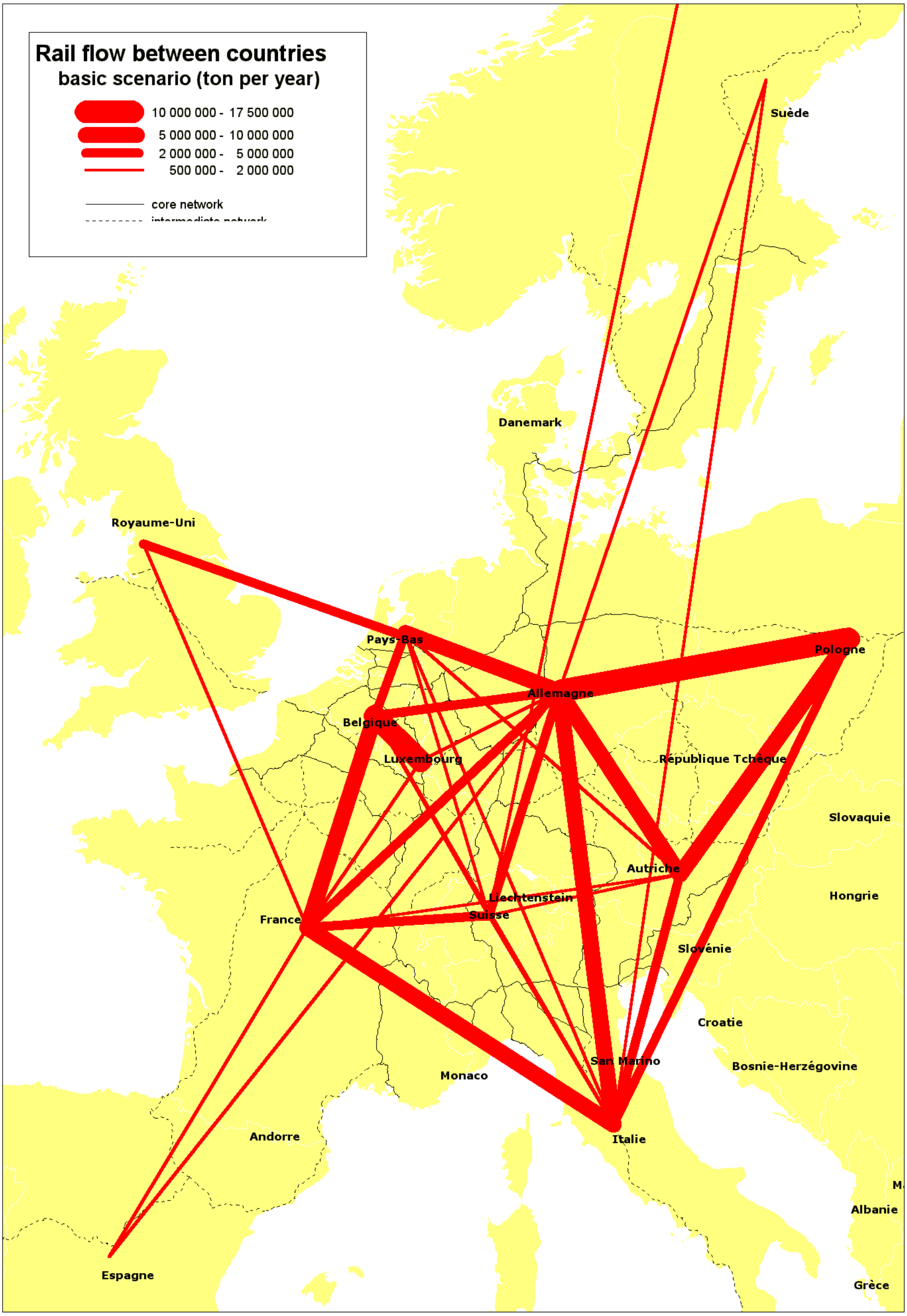


Figure 5.8. International rail flow: basic scenario

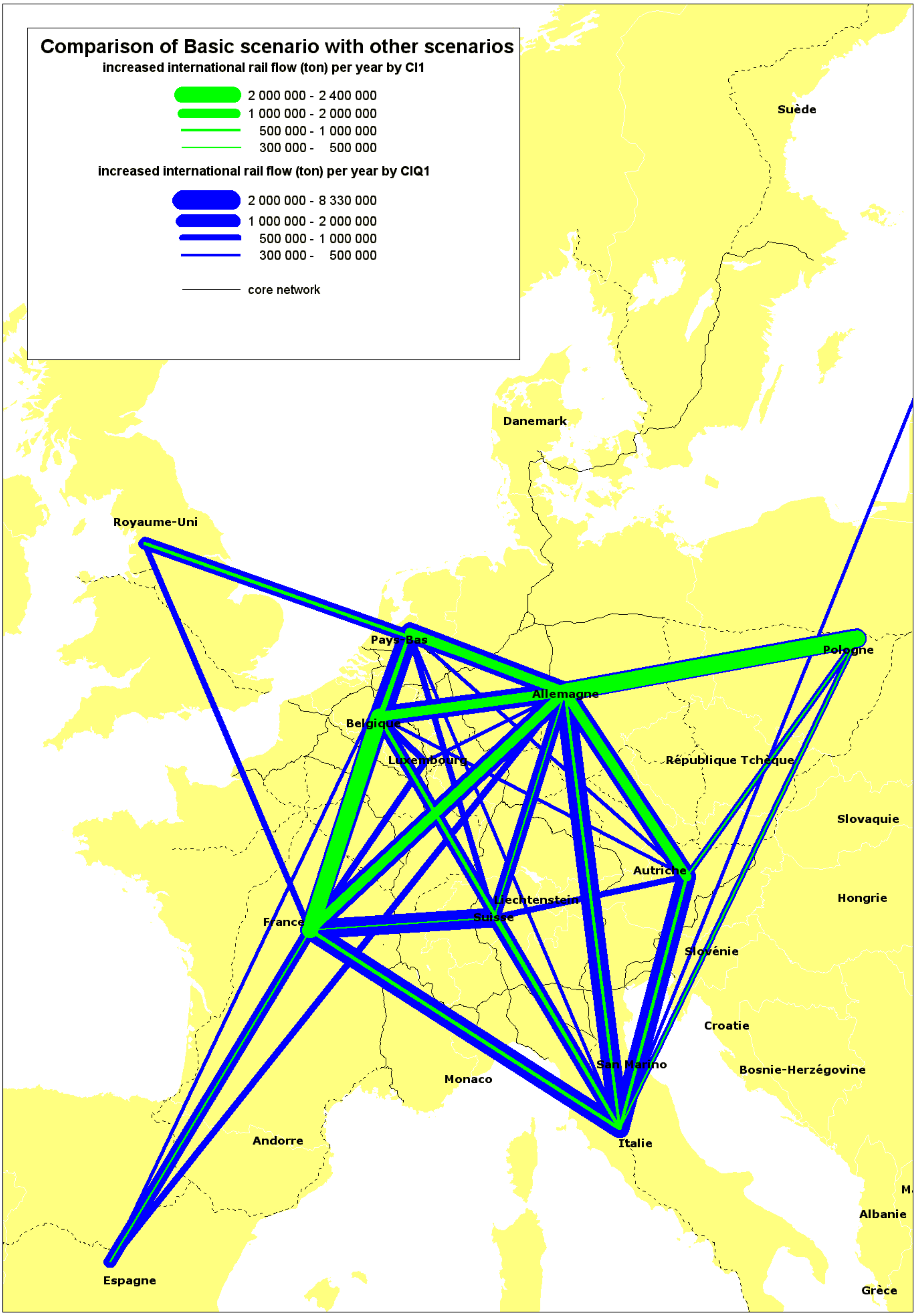


Figure 5.9. The increase in international rail flow with C1 and C2 compared with the basic scenario

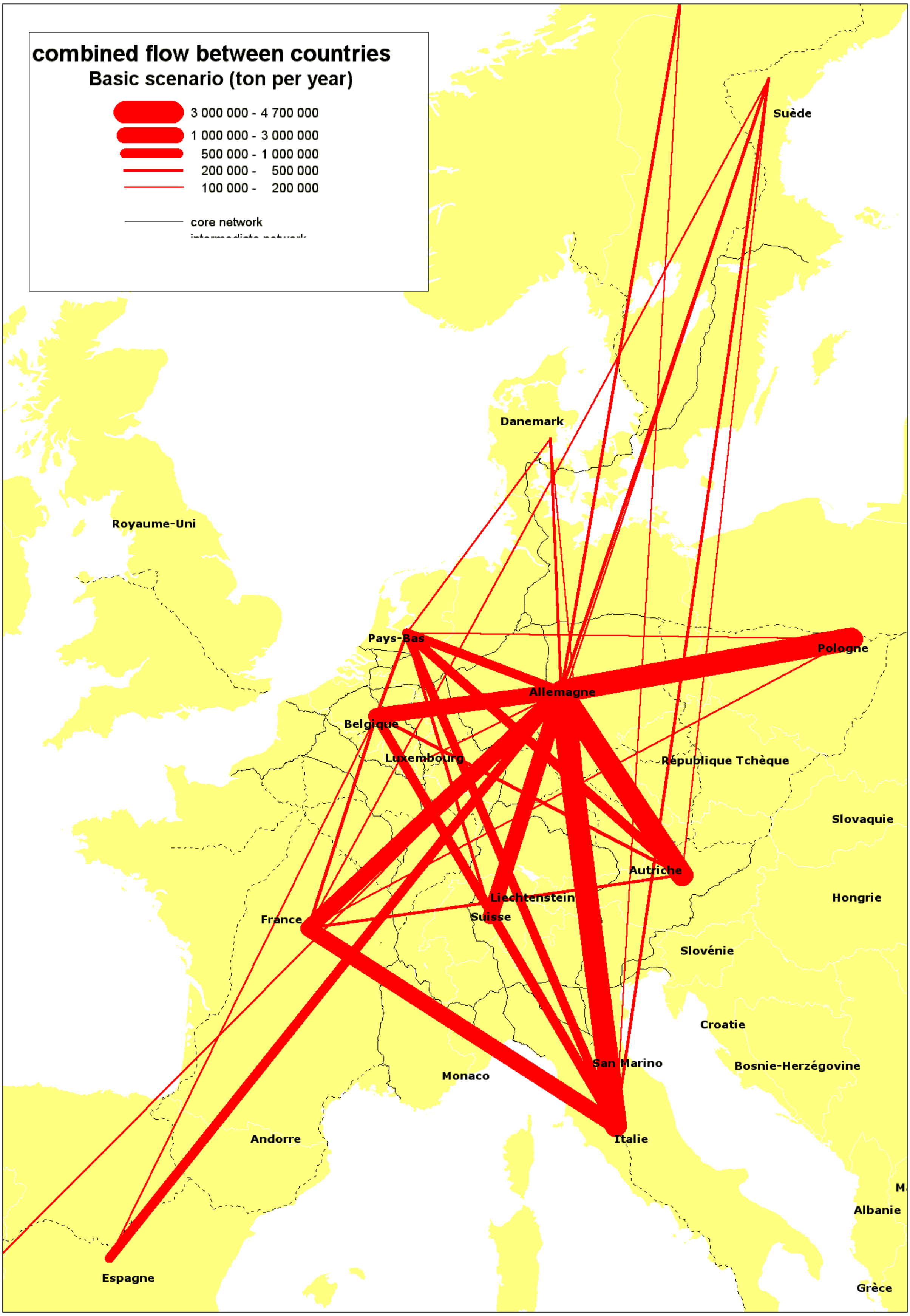


Figure 5.10. Combined international flows: basic scenario

5.5 Network Assigenement

In the network assignment, the traffic flows in tonnes are converted into the number of trains on specific links which pass through nodes. It provides an opportunity to examine both capacity problems and environmental impacts.

5.5.1 Characteristics of Rail

The improvement of the characteristics of rail freight compared to the Reference Case as a result of the scenario assumptions is shown in figure 2.11. The average transport time is decreasing by -14.6 % to -34.1 % for conventional transports and -27.5 % to -51.1 % for combined transports. The transport price is decrasing by -17.0 % and -16.0 % while reliability is increasing by 4.7 % points to 6.9 % points.

The figure 5.11 shows that the introduction of the core and intermediate network and the assumed rail strategies are very successful in improving the quality of rail freight.

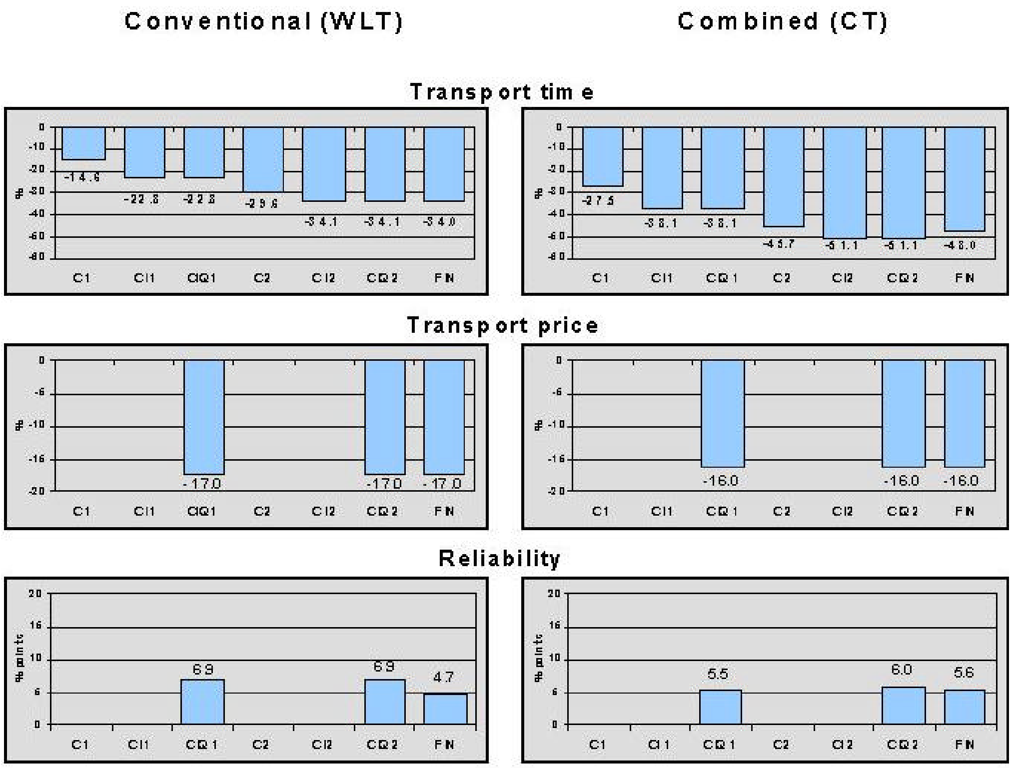


Figure 5.11: Improvement of Rail Freight Quality

5.5.2 The percentages of the different types of trains

Although bulk products account for almost 60% of rail traffic in tonnes (in the basic scenario) and 43% in tonne-kilometres, the percentage in terms of the number of trains is much lower, less than 9% because of the loading factor of the wagon and the length of the trains.

In the EUFRANET scenarios bulk trains account for a decreasing percentage of total traffic because bulk train traffic does not increase while there is a significant increase in other types of traffic.

However, bulk trains usually run at a lower speed so they considerably reduce the capacity of the links when they are operated with trains capable of running at higher speeds. Table 5.7 shows the percentage of bulk trains attracted onto the dedicated network. It can be seen that 75% of bulk trains can be attracted onto the core network and around 10% onto the intermediate network.

	core network							**intermediate network**						
	B	C1	C2	CI1	CI2	CIQ1	CIQ2	B	C1	C2	CI1	CI2	CIQ1	CIQ2
A	39%	60%	48%	53%	45%	49%	43%	37%	35%	43%	44%	50%	48%	52%
B	5%	53%	52%	62%	61%	61%	61%	0%	0%	0%	0%	0%	0%	0%
CH	0%	70%	66%	74%	70%	74%	70%	0%	0%	0%	0%	0%	0%	0%
CZ	0%	0%	0%	0%	0%	0%	0%	65%	72%	70%	100%	100%	100%	100%
D	52%	83%	82%	82%	81%	83%	81%	5%	4%	4%	5%	6%	6%	6%
DK	83%	100%	100%	100%	100%	100%	100%	0%	0%	0%	0%	0%	0%	0%
E	0%	0%	0%	0%	0%	0%	0%	38%	100%	55%	100%	55%	100%	34%
F	47%	81%	78%	91%	87%	89%	84%	22%	7%	7%	8%	11%	10%	13%
GB	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
I	62%	77%	76%	98%	98%	98%	97%	5%	3%	4%	2%	2%	2%	3%
N	0%	0%	0%	0%	0%	0%	0%	100%	0%	0%	0%	100%	0%	100%
NL	29%	33%	34%	35%	34%	30%	32%	0%	0%	0%	0%	0%	0%	0%
P	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
PL	48%	54%	52%	60%	51%	57%	50%	0%	0%	0%	27%	24%	29%	25%
S	30%	53%	51%	29%	35%	29%	35%	43%	37%	30%	68%	57%	68%	57%
Total	40%	75%	73%	76%	74%	76%	73%	10%	7%	8%	11%	12%	11%	12%

Table 5.7 Percentage of bulk trains attracted onto the dedicated network

The resulting impact on demand is not very significant. From Table 5.8 the short train hypotheses are clearly not appropriate for bulk trains. They considerably increase traffic in train-kilometres on the core network (by a factor of 2.9) and thereby significantly reduce the capacity of the network without providing many advantages as regards demand. On the intermediate network, traffic is increased by respectively 32% and 96% in scenarios C2 and CI2 which might create major problems for passenger traffic operation.

Optimisation for bulk trains would therefore rather involve the operation of longer trains which can decrease operating and traction costs. A specific analysis would also be conducted to select the optimal route.

	B	C1	C2	CI1	CI2	CIQ1	CIQ2
Core	33700	76%	243%	73%	239%	96%	288%
Intermediate	21779	-40%	32%	-10%	96%	-1%	116%
Diffuse	64014	-72%	-37%	-79%	-52%	-76%	-42%

Table 5.8 change in train-kilometres for bulk transport on the dedicated network

As regards wagon load traffic, it shows the percentage of this in total train traffic. Table 5.9 shows that the attraction of the core network is also considerable when operating conditions are improved; traffic rises from 42% in the basic scenario to a level of 70%, which remains fairly stable with the various alternative scenarios. The attraction of the intermediate network is also strong, once improvements have been made to it.

	core network							**intermediate network**						
	B	C1	C2	CI1	CI2	CIQ1	CIQ2	B	C1	C2	CI1	CI2	CIQ1	CIQ2
A	24%	39%	37%	38%	36%	35%	35%	49%	48%	45%	53%	54%	56%	55%
B	36%	83%	82%	91%	91%	92%	92%	13%	6%	5%	4%	4%	3%	3%
CH	6%	79%	78%	80%	77%	78%	76%	0%	0%	0%	0%	0%	0%	0%
CZ	0%	0%	0%	0%	0%	0%	0%	84%	84%	85%	100%	100%	100%	100%
D	53%	84%	85%	82%	83%	83%	83%	5%	3%	3%	7%	6%	6%	7%
DK	83%	100%	100%	100%	100%	100%	100%	0%	0%	0%	0%	0%	0%	0%
E	0%	0%	0%	0%	0%	0%	0%	43%	48%	48%	56%	56%	53%	52%
F	30%	58%	59%	58%	57%	57%	58%	43%	36%	34%	39%	39%	39%	39%
GB	9%	25%	26%	25%	26%	25%	26%	0%	0%	0%	0%	0%	0%	0%
I	89%	89%	89%	92%	91%	92%	91%	0%	0%	0%	1%	1%	1%	1%
N	0%	0%	0%	0%	0%	0%	0%	100%	0%	0%	100%	100%	100%	100%
NL	40%	59%	65%	58%	64%	62%	65%	2%	4%	4%	4%	3%	3%	3%
P	0%	0%	0%	0%	0%	0%	0%	88%	84%	84%	85%	84%	86%	85%
PL	69%	70%	76%	100%	100%	100%	100%	0%	0%	0%	0%	0%	0%	0%
S	39%	60%	57%	50%	48%	49%	49%	36%	28%	30%	44%	45%	44%	43%
Total	42%	69%	70%	69%	69%	68%	69%	19%	15%	15%	19%	19%	19%	19%

Table 5.9 The percentage of wagon load trains attracted by the dedicated network

The mechanism of transfer must therefore be analysed in more detail since the number of wagon load trains on the core network increases by 68% in scenario C1 to reach 122% in scenario CIQ1, which amounts to a doubling of capacity requirements (Table 5.10).

On the other hand, some significant reductions in traffic might occur on the intermediate network (- 30% in scenario C1 but a 22% increase when quality on the intermediate network is improved) and there may a considerable reduction on the diffuse network (- 56% in scenario C1).

	B	C1	C2	CI1	CI2	CIQ1	CIQ2
Core	324956	68%	306%	71%	300%	122%	410%
Intermediate	289769	-30%	55%	-4%	117%	22%	171%
Diffuse	418092	-56%	7%	-62%	-11%	-48%	20%

Table 5.10 change in wagon load train-kilometres on the dedicated network

The operation of short trains again entails a very sharp increase in the number of wagon load trains on the core and intermediate networks: the number of trains running on the core network is increased by a factor of 3 in scenario C2 and by a factor of 4 in scenario CIQ2, with traffic on the intermediate network more than doubling in scenarios CI2 and CIQ2.

Therefore, the short train option must be analysed carefully in order to avoid congestion problems which might reduce quality of service. Since the benefit of the short train hypothesis was an increase in frequency and a reduction in the number of marshalling points, a possibility would be have long train operating systems on the main arteries of the network, combined with shorter train solutions where capacity remains available, so that the performance of the rail system is not affected significantly and the capacity of links is better used. In some cases rapid train coupling could provide a means of introducing a more flexible operating system and optimise the use of the network.

The situation for combined transport trains is similar to that for wagon load trains, except the changes are amplified. First, although combined transport accounts for only 15% of tonne-kilometres it accounts for 30% of train numbers: this means that combined transport will require a relatively large number of slots, in particular on the core network, in view of the fact that combined transport trains can also be run at a higher speed.

Concentration on the core network increases from 47% in the basic scenario (the main combined transport corridors are geographically concentrated) to around 80% in the alternative scenarios .

Quality improvements result in a very marked increase in the number of combined transport train kilometres, which doubles (+ 120%) in scenario C1 and almost triples in scenario CIQ1 with a long train operating system. This is compatible with the estimated increase in traffic, although the train traffic on the core network will increase rather faster than the total number of tonne-kilometres.

With the short train operating hypothesis the increase in train traffic is very marked, increasing by a factor of more than 5 in scenario C2 and by a factor of 6 in scenario CIQ2. Increases on the intermediate network are also significant, amounting to a doubling or tripling of traffic. A reduction in train traffic can be expected only on the diffuse network, but the initial level there was fairly low.

The fact that combined transport train traffic will increase on the intermediate network from its currently not very high level is in itself rather encouraging, and demonstrates that combined transport can be more diffuse throughout Europe.

But these results also stress that strategies must be adapted to available capacity and that the optimal solution will be a combination of short train and long train operation.

5.5.3 Network traffic assignment

The bulk traffic map shows how the problems are quite highly localised with, in particular, exchanges between Belgium and Luxembourg as well as along the Rhine Valley from Rotterdam to the industrial regions of the upper Rhine. Traffic from the port of Hamburg is also clearly apparent as is some bulk traffic from the eastern part of Germany. The increase in bulk train traffic rarely exceeds 20 to 50 trains on links which are fairly easy to localise. Alternative routes can be identified with these maps, between northern France, Belgium and Luxembourg and along the Rhine Valley. Dedicated network solutions, which consider the investment required for new configurations, have already been studied for these parts of Europe. Brenner pass traffic must also be carefully investigated, as must East-West links between the Ruhr area and Berlin.

The wagon load assignment maps (Figures 5.12 and 5.13) provide a different picture of European rail geography from the bulk assignment maps. The main French North-South route appears as a major corridor as do the North-South links from Benelux through the Rhine Valley which cross the Alps to reach towards the centre of Italy. Northern Germany features an important triangle between Essen, Frankfurt and Hamburg which extends towards Berlin to the East, Denmark to the North and Munich to the South.

Links at European level mainly increase within the northern part of Europe. East-West links between France and Germany or between France and Italy develop less. For France the problem of crossing or by-passing the Paris area is clearly apparent and can be partially solved by the choice of alternative routes. Major bottlenecks at Dijon and Lyon are highlighted and will have to be removed.

The increase of the number of trains for CI and CIQ1 scenario compared with basic scenario expected on these major links is quite significant - from 100 to 200 or even more trains per day.

This means that on major corridors of this type the short train hypothesis cannot be envisaged without further investigation, and that in some corridors double track lines will be insufficient. When new high speed lines are constructed the question of mixed operation with both freight trains and high speed passenger trains has to be considered.

However it is interesting that the short train operating hypotheses highlight, for the first time, a potentially important East-West link between Paris and the Rhine Valley.

Finally, the connections with Spain do not reflect the potential increase of exchanges; rail's modal share is still low and the question of the improvement of the intermediate network towards Spain is raised. This is not an easy problem since there are already capacity limits in southern France and the solution has probably to be found with a “mixed” line, using the capacity of new high speed lines.

The combined transport maps are also very interesting; this is the first time a preliminary estimation of combined transport network assignment could be made and an improvement of service tested. Combined transport traffic and potential traffic remain centred on major European corridors as in the previous case but extension through the Alps and further penetration occurs into Western France, Spain, Italy, the UK and Sweden.

On the other hand, the expected increase in train traffic is very large on some major links, especially with the short train operating hypothesis: (100 or even more trains per day which again will pose capacity problems). The conclusion that should probably be reached is that peripheral services must be preserved with a high quality of service and frequency but that in central Europe train consolidation is possible with the formation of longer trains as a result of the creation of effective consolidation rail hubs. For the periphery, consolidation at gateways is essential.

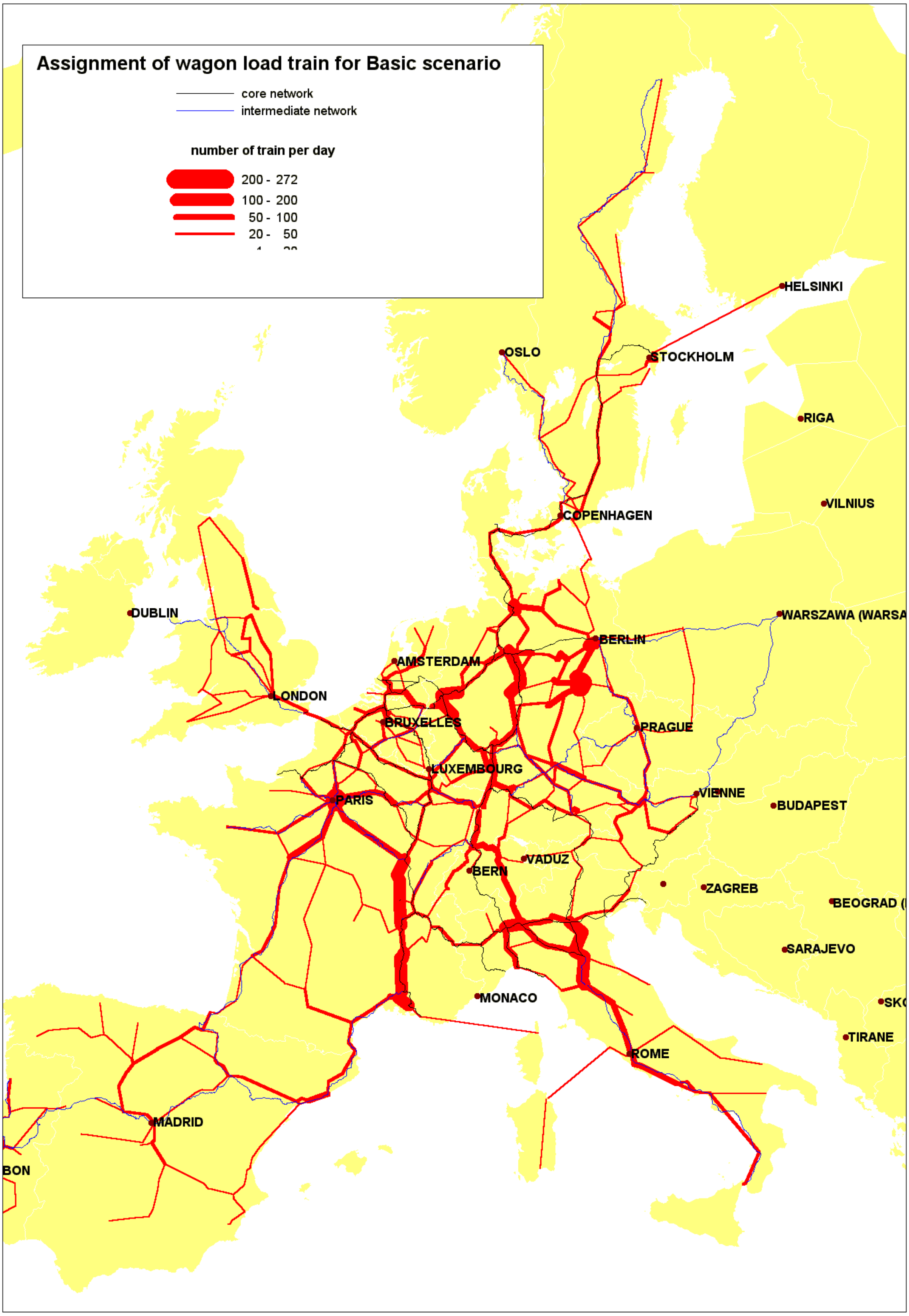


Figure 5.12 Assignment of wagon load trains with the basic scenario

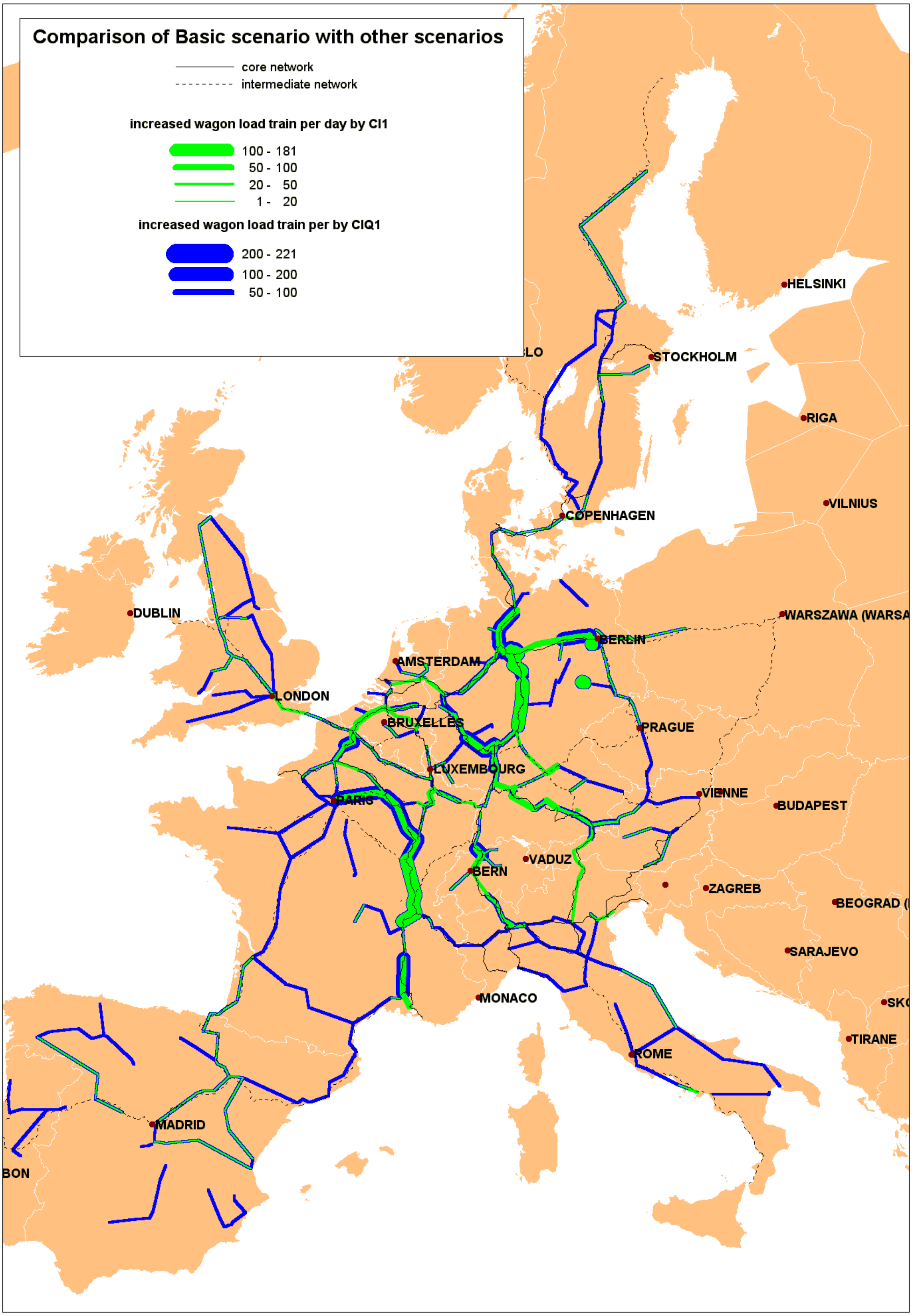


Figure 5.13 Increased wagon load train traffic in C1 and C2 compared with the basic scenario

Chapter 6 Definition of Strategies for Freight on European Rail Services

In last chapter all scenarios were analyzed by comparing their traffic, modal split and assignment on the network. This chapter will rank these scenarios in order to determine the most beneficial and affordable service and operating scenarios for European rail transport system, that is to say, to determine a final scenario in regards to given criteria and weights for each criterion.

6.1 Ranking of Scenarios

The core of the strategic ranking was an interactive analysis where the service and network attributes for each scenario and the interaction between infrastructure, demand and operations were appraised simultaneously. Once the interactive analysis output was optimized for each scenario, the results were then “compared” using a set of screening criteria to determine the best scenario for the European freight transport, under the given criteria of the assessment framework.

6.1.1 Criteria of ranking

The screening criteria reflect service and system-related factors that were identified as critical to the success of the dedicated network. The definition of criteria for a transport system, mode, facility or service requires the specification of usually many desired objectives. So comparison of scenarios should be made to assess each scenario's effectiveness in meeting the project's objectives and solving the identified project problem. The comparison purpose is the understanding that there is a scenario’s "effectiveness" to accommodate or shift freight demand. Other effects relate to potential impacts on air quality and energy consumption. When people state that they want this combination of goals to be achieved, they are in effect saying that they wish to have a fast, cheap, safe, pollution-free, energy-efficient transport system that is affordable.

A set of criteria were developed for the EUFRANET project. Ranking criteria were identified to include measures which reflect identified community interests and concerns, as well as traditional performance indicators. Some criteria provide a quantitative basis for comparison of scenario. Other criteria are qualitative in nature and required subjective judgments.

The main criteria of ranking include mode choice, attraction of dedicated network, level of service. These criteria allow a comparison of the various scenarios to evaluate which option(s) should be recommended for implementation of strategic network. Ranking criteria developed and their indicators are:

- *Environment*

Several attributes and indicators can be considered in environmental evaluation studies. the amount of total traffic associated with each scenario can provide an indication of the environmental problem (average yearly traffic on network in 2020) between scenarios.

- *EU cohesion*

Cohesion is a major concern in the building of the European Union. Several of the parameters and indicators previously proposed under the quality of service objective, can be used to measure whether the behaviour of the system is geographically even or not. An additional specific indicator is proposed in this respect, this being the “rail share on total increase of transport demand”. This means, the part of the additional transport demand, generated in a defined geographical area through a defined period of time, which is captured by the rail system. The improvement of the rail offer, if evenly designed, should, in theory, produce a not dissimilar figure for this indicator in different European areas.

- *Market share*

This is the ratio between rail traffic volume and the total traffic volume (including all transport modes).The predicted change in the percentage of traffic using railways indicates the volume of traffic diverted from the roadway because of improvement of quality service.

- *Traffic attraction*

Traffic attraction is measured by the percentage of rail traffic on the dedicated network. It is an important indicator with which to compare the impacts of scenarios. The increase in the numbers of train on the dedicated network (core and intermediate network) is a tangible measure of the dedicated network’s success, and consequently of the improvement in quality of service, speed, reliability and cost on the network.

- *Congestion*

This criterion is based on an assessment of existing congestion problems. Existing congestion can be evaluated by looking at the number of trains operating on the network. Changes in the number of trains on the network with different scenarios provides a comparison of this aspect. An increase or decrease in the number of trains is used to measure the effectiveness of the dedicated network.

The table 6.1 summarized the performance of the scenarios in EUFRANET project for these criteria :

Criteria	Performance of scenarios					
	C1	CI1	CIQ1	C2	CI2	CIQ2
Traffic attraction (Wagon load train)	69%	69%	68%	70%	69%	69%
Modal share (international tkm)	10,9%	11,8%	15,9%	12,8%	13,4%	17,6%
Environment (traffic volume, tkm)	258	278	373	299	312	409
Congestion (train-km on core network)	68%	71%	122%	306%	300%	410%
EU cohesion (increase of rail traffic, ton)	10,3%	17,8%	58,5%	26,2%	31,6%	74,0%

Table 6.1 the performance of the scenarios

6.1.2 Methodology of Ranking

With ranking methodology, the scenario is assigned a raw score using the points allocation system. The point value is based upon the extent to which the scenario supports the various strategic goals and performance measures. Then each scenario receives a weighting factor based on the amount of usage. The product of the raw score and weighted score yields a total score, which is then normalized to produce scores ranging between zero and 100. This is done by calculating the average score and standard deviation for all projects being ranked; and then adjusting the scores to fit a "normal" distribution for all scores awarded during the evaluation, with a mean score of 50 and a standard deviation of 10 points.

- Computation of Raw Score

Each scenario is assigned a raw score using the points system. The point value is based upon the extent to which the scenarios support the various EUFRANET goals and performance measures. Using the evaluation results of the effects or impacts of scenarios, values will be assigned to each performance measure for each scenario. The range of values will depend on the judgement of how important each performance measure is, and on how much variation between scearios is expected for each performance measure. The table 6.2 shows the raw score of scenarios for each criteria. If the performance is presented as a percentage, then the raw score is equal to the percentage. If the performance of the scenario is presented in absolute value, then the score of the scenario with the maximun or minimum value was assumed as 100%, then the score of the other scenarios can be calculated.

Criteria	**Raw score of scenarios**					
	C1	**CI1**	**CIQ1**	**C2**	**CI2**	**CIQ2**
Traffic attraction (Wagon load train)	69	69	68	70	69	69
Modal share (international tkm)	22	24	32	26	27	35
Environment (traffic volume, tkm)	100	93	69	86	83	63
Congestion (train-km on core network)	100	96	56	22	23	17
EU cohesion (increase of rail traffic, ton)	10	18	58	26	32	74

Table 6.2: raw score of scenarios for each criteria

- Weighting

The raw scores for scenarios will be weighted (multiplied) by a factor that represents the magnitude of the activity being served (Table 6.3). A simplified weighting system will be used. The assigned weights will be a percentage, lower values represent a low magnitude of activity and higher values represent a high magnitude of activity. But the sum of all percentages should be equal to 100%.

Criteria	**weight**
Traffic attraction (Wagon load train)	25%
Modal share (international tkm)	35%
Environment (traffic volume, tkm)	20%
Congestion (train-km on core network)	15%
EU cohesion (increase of rail traffic, ton)	5%

Table 6.3: weighting of criterias

- Final score

The product of the raw score and weighted score yields a total score, which is done by multiplying the raw score by weight. The resulting final scores will show which scenarios will meet the objectives(or most of them) in the most cost-effective manner. The ranking of scenarios will be based on the final scores, with the highest priority given to the scenario with the highest score.

$$FinalScore = \sum RawScore*Weight$$

The table 6.4 represents the final score of scenarios:

Criteria	Raw score of scenarios						weight
	C1	CI1	CIQ1	C2	CI2	CIQ2	
Traffic attraction (Wagon load train)	69	69	68	70	69	69	25%
Modal share (international tkm)	22	24	32	26	27	35	35%
Environment (traffic volume, tkm)	63	68	91	73	76	100	20%
Congestion (train-km on core network)	100	96	56	22	23	17	15%
EU cohesion (increase of rail traffic, ton)	10	18	58	26	32	74	5%
Total score	**53,05**	**54,55**	**57,7**	**45,8**	**46,95**	**55,75**	

Table 6.4 final score of scenarios

6.2 Final strategic scenario / Rail strategy

According to the results of scenario ranking, the best scenarios are CIQ1 and CIQ2, so in order to define the European rail strategy, a final scenario should be worked out to combine scenarios CIQ1 and CIQ2.

6.2.1 Hypothesis for final scenario

- *Length of train*

One of the big differences between CIQ1 and CIQ2 is the length of train, 60 wagons for CIQ1, and 30 wagons for CIQ2. The higher impact on modal share and traffic is produced by a short train strategy. Under the short train scenarios, compared to the basic scenario, the increase in train-kilometres on the core network is much more than under the long train scenario, which will actually increase the congestion on the network. On the other hand, on the intermediate network, under the long train scenario, the train kilometre will decrease because the number of trains on the intermediate network has decreased.

So for the final scenario, the length of the train was adjusted to 40 wagons, but also added was the WLT conventional long train of 60 wagons and the short /shuttle train (cargo sprinter) of 5 wagons.

- *Maximum velocity*

The decrease in transport time on the core network has a very important effect on international rail freight flow, so the improvement in transport time should be achieved. One of the alternatives is to increase the speed of the train. So for the final scenario maximum velocity for the WLT conventional train and CT block train are faster than CIQ1 and CIQ2: e.g. 100 km/h vs. 80 km/h and 140 km/h vs. 120 km/h. In addition, the speed for the WLT conventional long train and WLT and CT shuttle train are assumed respectively to be 100 km/h and 120 km/h, and marshalling time on the diffused network is decreased from 6h to 3h.

- *Mega-Hub terminal*

The scenarios can change the possible place of future Hubs or terminals for rail and combined transport. For example, compared to the basic scenario, the train-kilometre on the core network will increase more quickly for bulk train until to 410% for short train and 171% for long train, which are higher than for bulk transport. This can mean that for the wagon load train the transport distance on the core network will be longer than for bulk train. It is also possible that the length of train assumed is too short: therefore on congested segments the number of trains can be reduced by using longer trains. MegaHub terminals help to optimise a solution as regards the frequency of service and the consolidation of flow; they are assumed in the following terminals: Hanover, Würzburg, Mannheim, Antwerp, Lyon and Milan.

6.2.2 Simulation result of final scenario

The final scenario is a combination of CIQ1 and CIQ2, so in order to assess the final scenario the simulation result was compared with CIQ1 and CIQ2.

With the final scenario, traffic attraction and modal share on the network didn't change so much compared with CIQ2 but the train circulation on the network has decreased, which is an important result in regards to the congestion problem on the rail network.

6.3 The Analysis of network strategy

6.3.1 Accessibility of Dedicated Network

To evaluate network strategy, this section analyses accessibility of network from a geographical point of view. A set of accessibility indicators permit evaluation of the cohesion and the equity aspects which cannot be incorporated into a normative monetary valuation. value structure and social impacts.

6.3.1.1 Raster-Net tool

"Raster-Net" is a prototype of an original tool to forecast different sources data and transportation network models in a unique and independent layer: a grid "Raster-Grid" of 10 km border cells covering all of Europe. The work does not consist in describing precisely the reality but much more in determining layers consisting of different data sources and original results.

"Raster-Net" deals with inter-urban and inter-regional accessibility in looking for:

- basic indicators : iso-chronals, outer layers of time transportation, population or GDP reached in a time limit. This access indicator measures the size of a market inside a time limit. It is possible to show how the market is progressing when the time of transport increases.

- synthetic indicators : The Pointer Indicator gives the destination interest depending on the population reached and the remaining time; the equity measures the endowment of accessibility of a zone, weighted by its levels of underdevelopment, and the people cohesion measures the improvement in potential for interaction between people.

The aim of the geographical “raster-grid” is to create a descriptive map with different geographical socio-economic data. “ Raster cell” needs a population database, a network description and its relative Origin/Destination matrix, GDP database or another socio-economic database like unemployment. Such a “raster-grid” has different qualities :

- One of them is consisted of distributing another socio-economic variable over all the cells in relation to this first variable. Therefore it was possible to distribute GDP over the population of each raster-cell. Thus the possibility exists to distribute other different sources like unemployment or salaries in a specific group. Then socio-economic data could be used to calculate weight of accessibility indicators.

- All the cells of the “raster-grid” are connected with the nodes of a network to calculate a distance and an approximate time to reach the closest node. Due to the Origin/Destination matrix of transportation times between each node of the network, it is possible to compute the time to connect each cell with another of the "raster-grid".

6.3.1.2 Analysis of accessibility

With the result of accessibility analysis, the core network is in charge of dealing with concentrated flows. It links high density of population and GDP regions such as south eastern England with Benelux or Ruhr area and with the North of Italy. The core net is ‘knitted’.

The intermediate network is in charge of direct flows from low density areas to the core net. This network links big towns of low density areas with the core net. The South Western peninsula of Europe is connected to the central areas. Lisbon, Porto, Madrid, Saragoza and Barcelona are linked on peripheral lanes and then connected to the core net near Marseille and via Paris. The intermediate and peripheral net is ‘concentric’. Cohesion indicators show that Portugal and Spain are low density areas which mostly need to be connected to central and high densities areas.

The road simple accessibility indicator is computed for GDP and many time limits (1 hour, 2 hours, 3 hours, 4 hours, 6 hours, 8 hours, 10 hours) on the whole of Europe. The 1 hour time limit is too short a time limit because only the agglomeration of big towns have got a market larger than 100000 ecus. It does not concern a freight rail network problem. It could however be reliable for messaging.

The 2 hour time limit is an interesting time limit because we can see in which direction big cities are grouped in big zones. For example, the region between Paris and the Benelux have a good accessibility. All South-eastern England and Benelux and the western Germany and the north of France are grouped in a 2 hour market higher than 300000 ecus.

The 2 hours and 3 hours time limit corresponds with the road terminal time to reach rail terminals. Terminals under a 2 or 3 hour time limit could be reached twice per day. The 4 hour time limit corresponds with a one day time delay to reach terminals. 6, 8 and 10 hour time limits show the way the detail is progressing. The Iberian Peninsula will therefore stay connected with the rest of the Europe thanks to the peripheral and intermediate freight network, as will Ireland.

Simple road accessibility indicators are exhaustive for the totality of Europe. The simple accessibility indicator allows an extraction series for only one cell. In keeping back only a set of values for each terminal of the freight dedicated network, we are able easily to compare their road market and understand the competition between them. The shut down of markets is very quick. It is possible to establish a group of terminals of central areas and a group of terminals of peripheral regions. The difference between terminals in Benelux and in other places in Europe is very high. Terminals of Benelux and the North of France are able to concentrate traffics flows.

Figure 6.1 give an idea of the territory unable to benefit the terminals of the freight dedicated network. Figure 6.2 give a good image of competition by combining time transportation and GDP in order to see where can be reached in different time limits for all terminals.

6.3.2 Dedicated network and bottlenecks

Now we can examine the interrelation between the core network and some spatial factors. Figure 6.3 shows the most important bottlenecks and black spots on the dedicated network. The objective was to identify the most important black spots in a very selective manner: the choice was made from answers given by rail companies in the consortium.

Figure 6.4 show the main entry points and combined traffic terminals. These maps help to verify if the dedicated network can cover the most important industrial region or not. Figure 6.5 shows the existing and planned high speed lines for passenger transport. The transport planning objective is to avoid overlap between the freight network and the HST network (in EUFRANET we have not considered high speed freight). However, in the “intermediate” part of the freight network, high speed freight could benefit from the dedicated freight network when high speed passenger lines are not planned.

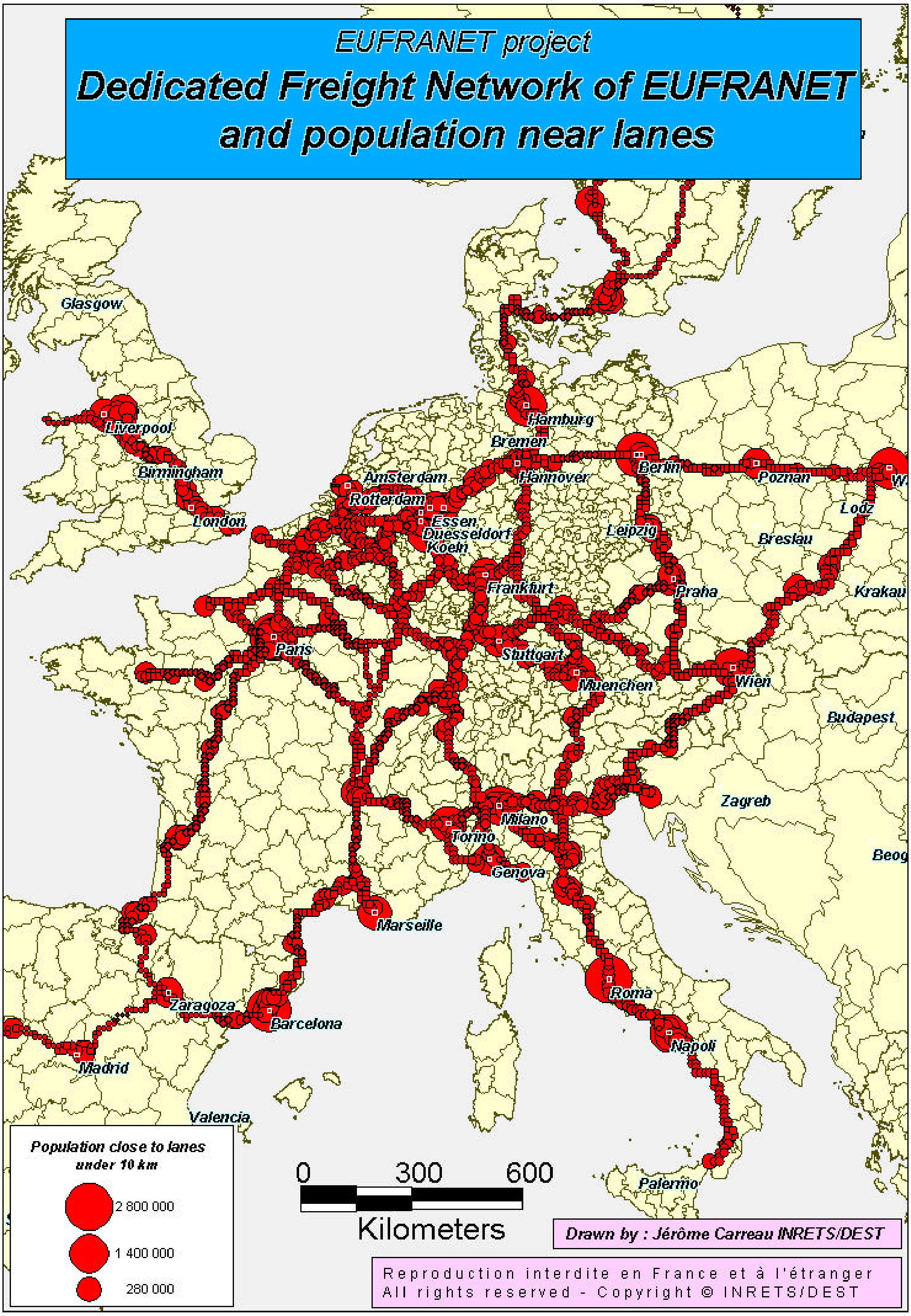


Figure 6.1: population near lanes of dedicated network

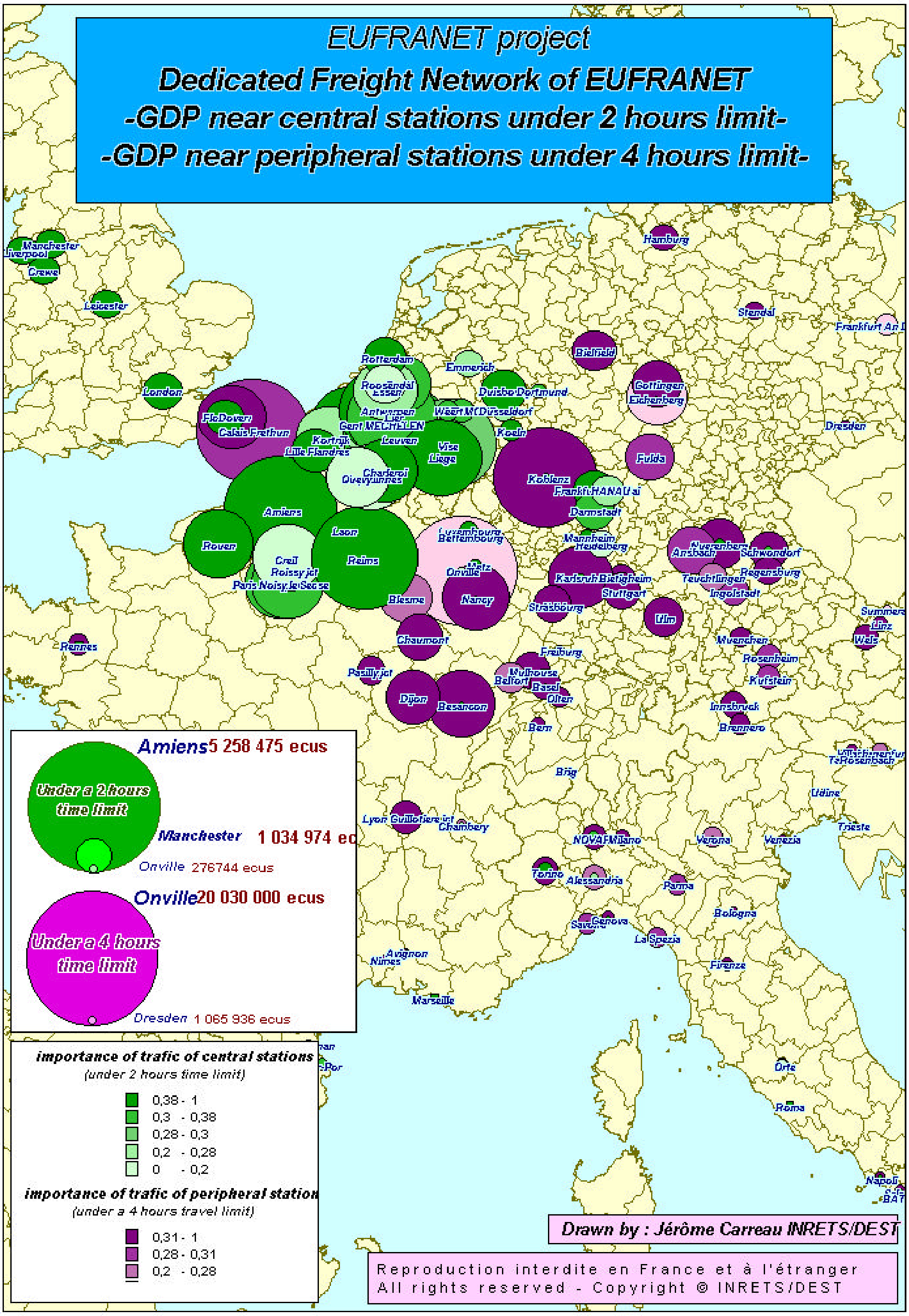


Figure 6.2: GDP near station

Figure 6.3. Map showing dedicated network with bottlenecks and black spots (source : SNCF, DB, EU)

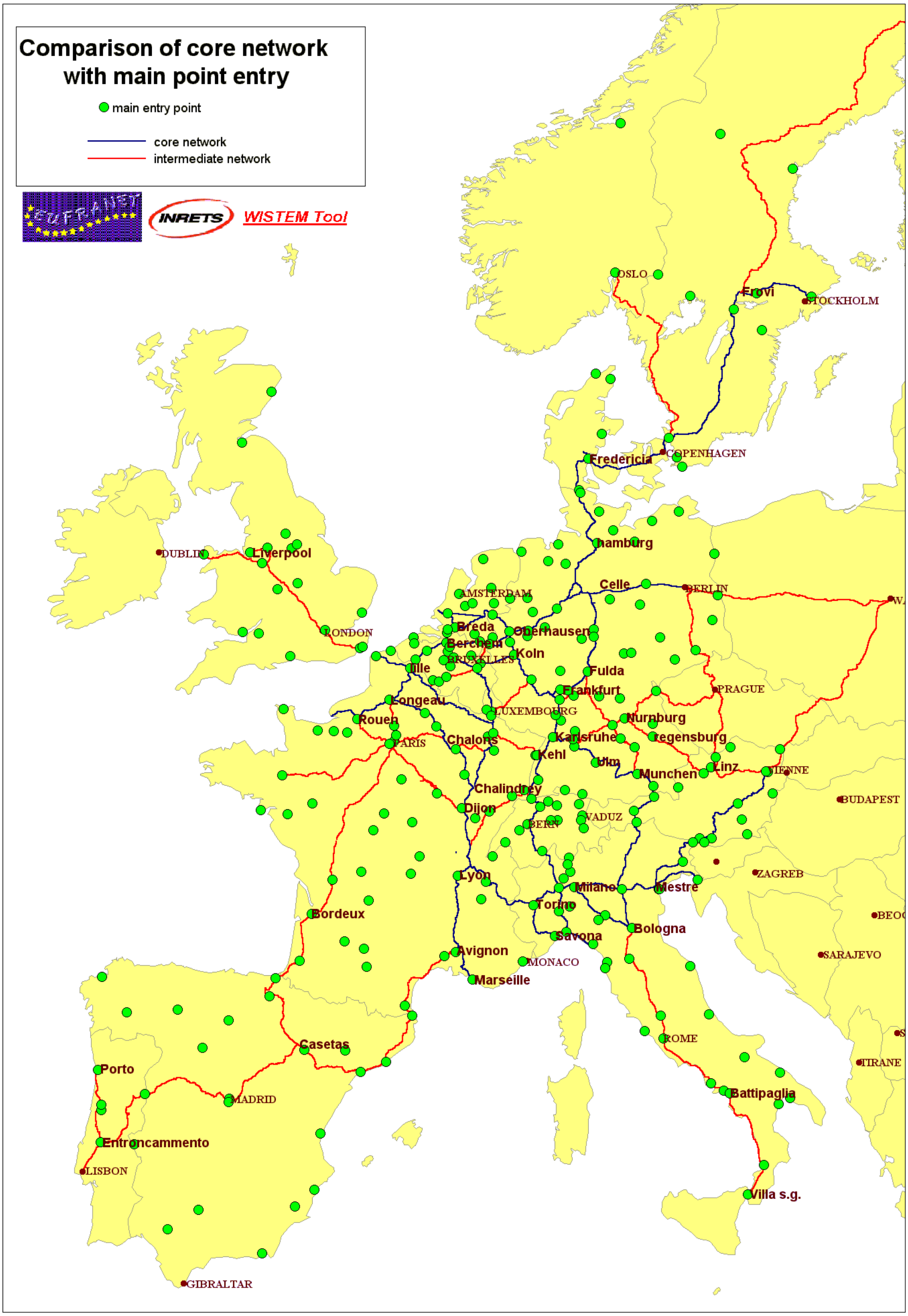


Figure 6.4. Map showing dedicated network with principle entry points (source : IVE)

Figure 6.5. Comparison of dedicated network with high speed passenger lines

6.3.3 From "freight freeways" to EUFRANET dedicated network

Presently defined "freight freeways" can be considered as a first step towards a final European rail freight transportation system. In fact, these lines constitute a subset of the EUFRANET network proposed in the previous chapter and thus can be seen as " back bones" of the EUFRANET network.

Now, the progress must be aimed at the introduction of the concept of "European freight rail network" and its acceptance by the main driving forces in the rail scene. Correspondingly, the concept of "European rail freight transportation service" must also be introduced and accepted. In this respect, the decisions and preparatory work already developed by the European political authorities, should be taken into consideration.

In order to ensure harmonious development of the core network, investment on bottlenecks should be co-ordinated, particularly between France, Benelux and Germany. If not, a lack of co-ordination in bottleneck investment risks constituting an additional bottleneck, hindering international traffic growth. This problem will also receive further consideration.

From a system –but also practical– point of view, the functioning of the “core” network can not be considered in isolation from the "intermediate". In fact, an important part of the traffic in the core network is presently fed through "intermediate" arteries connecting the central European countries to the peripheral ones. Furthermore, the importance of this centre-periphery traffic is foreseen to increase as the improved quality of transport service, provided by the upgraded performance of the core network, is put into practice. Just to use an example, France is presently working on a hypothesis of doubling its rail freight in five years, most of which will come from neighbour countries, including Italy, Spain and U.K.

This means that, within five years, the "intermediate" links (centre-periphery) should be carefully considered in order to both ensure connectivity and appropriate interoperability, and resolve the most constraining bottlenecks. This does not imply that the whole intermediate network ought to receive the same attention and investment. On the contrary, applying the concept of "progressive implementation", efforts must be duly differentiated and sequenced, according to a pragmatic approach of promoting traffic increase (ton·km).

6.3.4 Making TERF and EUFRANET converge

In accordance with the proposed "progressive" implementation process, it would be possible to make what is at the outset highly desirable: that the TERF process and the EUFRANET process converge. Both processes deal with the same subject, namely, European rail freight transportation; but TERF is a political process, where infrastructure description prevails and is not sufficiently linked to a rail service strategy; whereas EUFRANET proposes a realistic rail strategy based on sound forecasts and analytic research work, taking into consideration all the facets of the problem.

Both of these processes have their own merits and, in fact, should be complementary and mutually reinforcing in order to push the implementation process forward. In any case, it would be difficult to progress without a minimum of understanding on the underlying need to use not only a "market" approach, but also an "institutional" approach, in order to develop a regulation appropriate to the purposes of the new market.

Particularly important issues in this respect are: slots scheduling and assignation, investment co-ordination and programming, and interoperability conditions for the different components of the system (set in a time scale).

It is to be recalled that EUFRANET approaches with the development of high quality competitive international rail freight services, by means of a multi-actor system strategy process, taking into account the interests (both conflictive and cooperative) of the different kinds of actors, and examining the most relevant problems in each significant system facet. Thus, implementation problems concerning slots and capacity, commercial aspects, rolling stock, operating strategies and infrastructure, have been duly analysed. In particular, the EUFRANET network proposed, as compared to the TERF network (see the corresponding maps), is supposed to be a sound foundation on which to develop a TERF policy. The conclusion is thus, that the EUFRANET approach and process are probably an important step towards a successful TERF policy.

6.3.5 Key problems to be dealt with

From the perspective acquired throughout the EUFRANET research work, the success of the effective development of international rail freight services in Europe, is highly conditioned by how appropriate is the way in which a few key problems are dealt with. The following will therefore be addressed: bottleneck removal, slot management, interoperability and “mix”.

Bottleneck removal

The process of freight network implementation implies investment for bottleneck removal and, as a consequence, a variety of actors will have to take the initiative to finance different projects. In this respect, there is a risk that two main problems may emerge:

- lack of technical or operational coherence or compatibility between a project and the network standards;
- inefficient use of scarce resources due to inadequacy between the time or space of a project, and the dynamics of development of the whole transport system.

The consequence is clear: co-ordination among the different "master plans" for bottleneck removal is necessary. This concerns the core network and at least a part of the intermediate network. To deal with this problem, different organisational solutions can be envisaged. Ideally, some kind of European "institutional" approach should be undertaken.

Slot management

Slots available for international freight services must be scheduled and assigned from a European perspective. In addition, the needs and aspirations of the end users and logistic operators of international traffic, must be taken into account.

Also, to deal with this problem, different organisational solutions can be envisaged, but the present idea of leaving the problem to be solved by the infrastructure managers seems rather "wishful thinking". On the contrary, some kind of organisation with Europe-wide coverage and representing the interests of the most involved actors, could possibly deal with this problem in a more effective way.

The slot management activities of the suggested organisation, should start at the core network and extend progressively through to the whole TERF network, as the corresponding implementation process progresses.

Interoperability

Interoperability is another key problem for the development of international freight transport services on a European scale. Interoperability problems include gauges, rolling stock, train length, traction, signalling, command and control,...

The most important issues in relation to this problem are:

- the precise definition of the concept "interoperability", in its practical application to the European freight network;
- the way to progress from the present situation to the desired one.

In relation to the first issue, it is to be noted that, without restrictions of cost and delay, two different networks can always be considered interoperable. As cost, delay and other conditions are set more stringently, interoperability is more difficult to achieve.

The consequence of this is that, in order to deal with this problem in an effective way, firstly, standards and conditions must be agreed upon and set, in relation to what interoperability means in practical terms, both within each sub-network and among different types of sub-networks.

Secondly, a way to progress must be decided. In this respect, and in accordance with the proposed "progressive" implementation approach, it is suggested that the interoperability solutions be looked for, firstly, with respect to the "core" network and then, progressively, with respect to the core-intermediate links. These solutions would include all the aspects of interoperability problems: technical, organisational, informational, institutional,...

Mixing Ability

Capacity constraints appears to be very tight in certain European areas, as in the case of crossing the Pyrennées and the Alps. One possible way of solving the problem could be found by means of using "mixed" traffic, particularly, in certain specific high speed lines which are hoped to be implemented within the EUFRANET implementation period (by 2020).

This is a very specific key issue conveying important implications for various actors and causing not negligible impacts on different facets of the rail system. Consequently, it is suggested that a debate should be opened on "mixity" amongst the different players involved at the European scale.

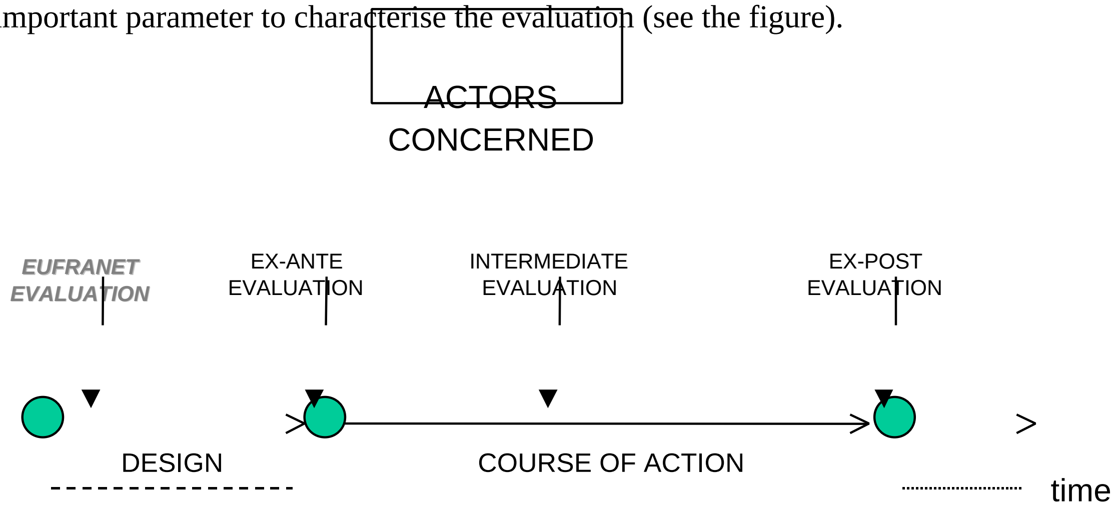
Chapter 7 Evaluation and Implementation of dedicated Network

7.1 Evaluation methodology

The evaluation methodology has in fact evolved throughout the development of the EUFRANET project, to become a design-evaluation methodology, both processes design and evaluation, having shown to be, in practice, closely inter-related.

An evaluation methodology is supposed to be a tool, or means, appropriate for facilitating, to one or several persons or organisations concerned with a course of action taking place in a certain context, an easy-to-discern perception of certain aspects of the final situation, which conveys value for such persons or organisations –actors or decision makers.

The time, in relation to the referred course of action in which the evaluation is made, is an important parameter to characterise the evaluation (see the figure).



In the case of EUFRANET, not only is the course of action not started, but even designed. In addition, there is not a clear reference to what and how a satisfying future European rail freight transportation situation could or should be.

From this perspective, the functions of an evaluation methodology, appropriate for EUFRANET, have been defined as: analysis of the current problematic situation; aid to identify the characteristics of a satisfying future situation; aid to generate alternative offer strategies; aid to select a "preferred" offer strategy; aid to produce a global assessment of the final strategy to be proposed by EUFRANET to all interested actors.

7.2 Approach to strategic system redesign

As it has been previously pointed out, rail freight transportation should become a more and more competitive business activity. It implies that the different actors involved will manage decisions on future activities as an up-to-date business organisation would do, that is to say, using a strategic approach.

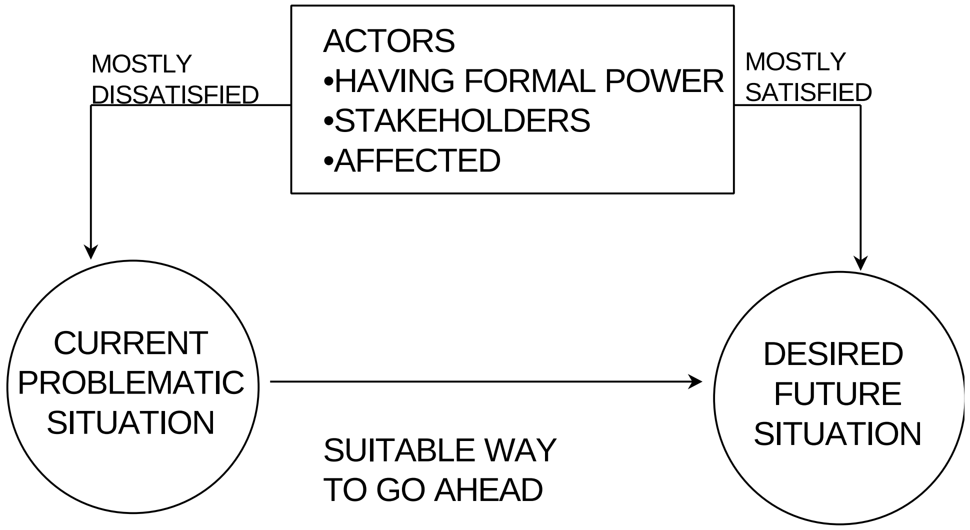
In D4, the prevalent trends in strategic thinking and their adequacy to the case under study, have been analysed. The conclusion was that the actors involved would preferably use the

"Strategic Management" approach, according to which, priority would be given to long term general orientations and short term management flexibility. However, organisations dealing with a rigid resource, such as rail infrastructure, would have to use elements of the "Strategic Planning" approach, according to which, priority is given to long term objectives definition. But this should be made in a creative and flexible way; for instance, stratifying decisions on future activities, from general plans to detailed projects, and putting off decision taking to a later date as it corresponds to the lower levels.

In this context, the need for co-operation amongst the different kinds of actors involved, particularly to deal with the infrastructure redesign problems, has been made apparent.

7.2.1 Sketch of the redesign approach

Briefly stated, the proposed redesign approach is sketched in the following figure.



This means that, once the characteristics of the current problematic situation are analysed, an appropriate image of a long term future situation mostly satisfying for the actors involved, is proposed to be designed, and then, a suitable way to go ahead in order to reach the desired future situation, must be thought up.

The long term situation image proposed, would not be an accurate picture, but rather a general description of the key facets characterising the situation. Thus, this image would play a guiding role in order to take lower level decisions from now on, so as to respect constraints and approach general objectives.

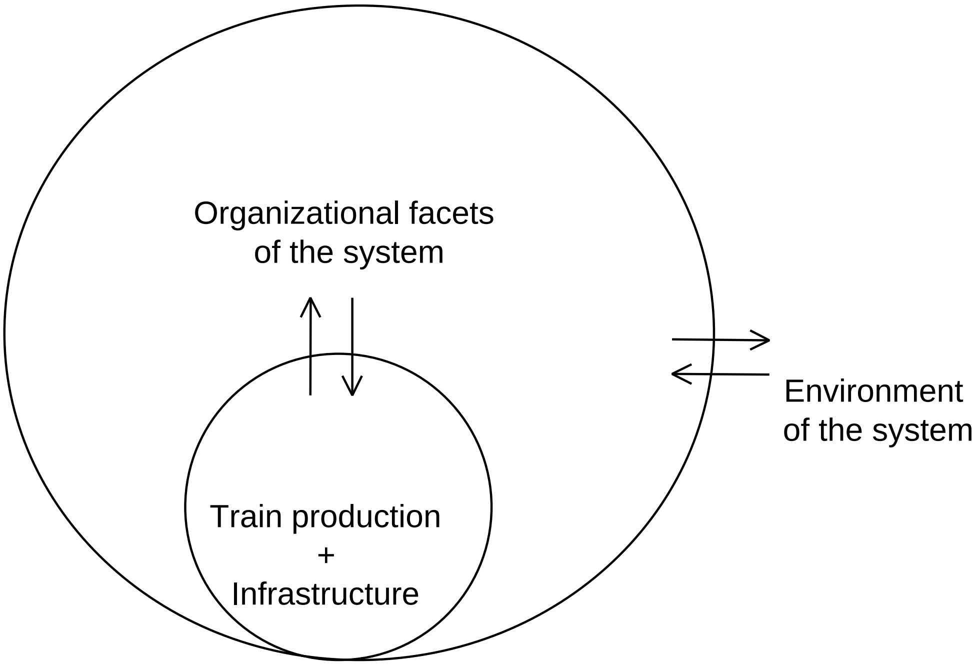
The proposed approach shares, therefore, characteristics from both strategic redesign approaches (strategic planning and strategic management).

In the remainder of this chapter, the ways to generate and evaluate the desired future image and the implementation process will be addressed.

7.2.2 The 2020 image of the system

In the EUFRANET project, the desired future situation refers to the year 2020. The most significant references to be used as foundations to design this image, have been found in the 1996 EC white Paper, which are being adopted as fundamental hypothesis. The basic idea inspiring this document is that, in future, the European rail system will have to operate as an open market system. Since the time of aforementioned paper, the decisions taken by the EU and also the documents developed by the EC, follow this main policy line.

The supply side of such market has been considered to be integrated by two closely interrelated parts: the "hard" part, composed of the infrastructure and the train production system; and the "soft" part, composed of the organisational facets of the system. The next figure sketches this idea.



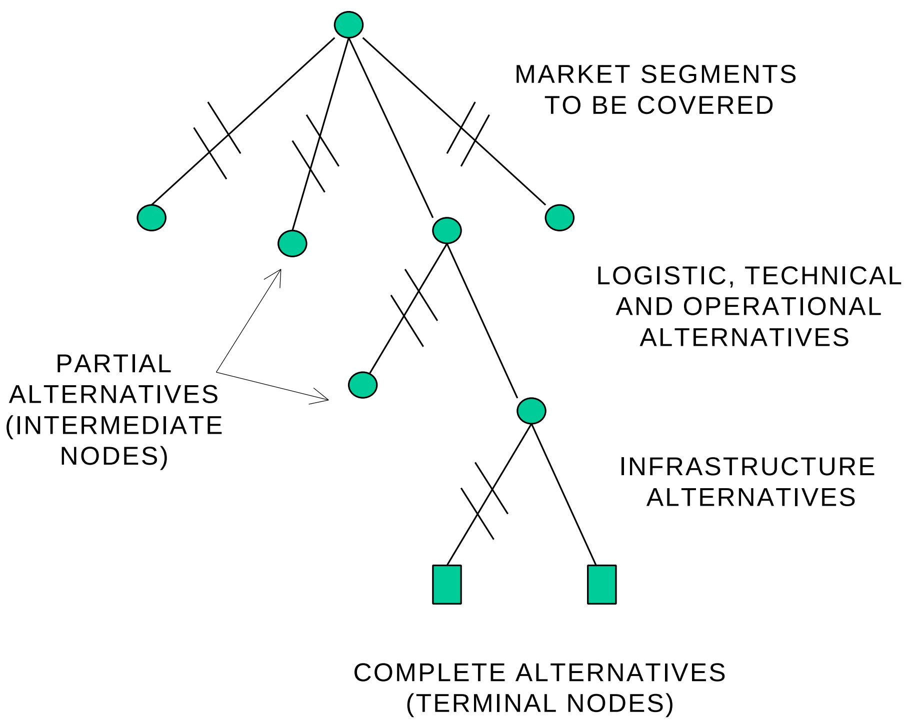
7.2.3 Structure of the "hard" alternatives

In order to define an alternative of the "hard" part of the system, several interrelated facts must be defined: market segments to be covered; types of transport services to be offered, in order to cover the selected market segments; infrastructure requirements for the functioning of the above transport services; spatial deployment of the transport services to be offered.

The following figure (tree graph) shows the structure of the complete "hard" alternatives. Thus, each complete alternative is composed of several "partial" alternatives, each one of which corresponding to one of the different facets, and the whole set of complete alternatives being of a combinatorial nature.

This implies that the number of complete alternatives possible is very large and, therefore, that to try to generate and evaluate this whole set of complete alternatives is an impossible task. On the contrary, an efficient process of alternative generation and evaluation must be conceived.

STRUCTURE OF THE "HARD" ALTERNATIVES



7.2.4 The "bottom-up" design-evaluation process

This process has been used to efficiently produce a satisfying image of the "hard" part of the system, and is based on the following underlying ideas:

- The design-evaluation process consists of two main processes, generation and evaluation of alternatives, both to be developed in a progressive and interrelated way.
- Generation of alternatives is a collective and progressive process: on the one hand, every EUFRANET partner contributes, in a co-operative and concurrent way, to the definition and analysis of the different alternative facets to be retained for further consideration; on the other hand, the generating process develops along the branches of the associated tree graph, from the first to the last of the facets, until reaching completely defined alternatives. Backtracking loops are produced whenever considered convenient.
- The criteria of the actors involved in the rail freight transportation field, as known by the EUFRANET partners, are used to "inspire" the generation of appropriate alternatives.
- A key component of the evaluation process is the filtering process. At each stage of the alternative generation process (i.e. whenever new facets are defined to complement the partial alternatives previously defined), a particular evaluation process –the filtering process– is developed in order to eliminate, from further consideration, less promising branches.
- In the filtering process, appropriate criteria from the above mentioned actors are used to select a few promising partial alternatives.
- The use of threshold values, when applying the criteria, increase the efficiency of the filtering process.

This design-evaluation process accounts for the most part of the EUFRANET research effort and has proved efficient in order to facilitate the progressive definition and selection of a preferred complete alternative, as is proposed in this EUFRANET final rapport.

7.2.5 Structuring the system objectives

As mentioned in 7.3.4, the criteria of the actors involved have been used to “inspire” the generation and early filtering of “hard” (train production plus infrastructure) alternatives and also to select the preferred alternative.

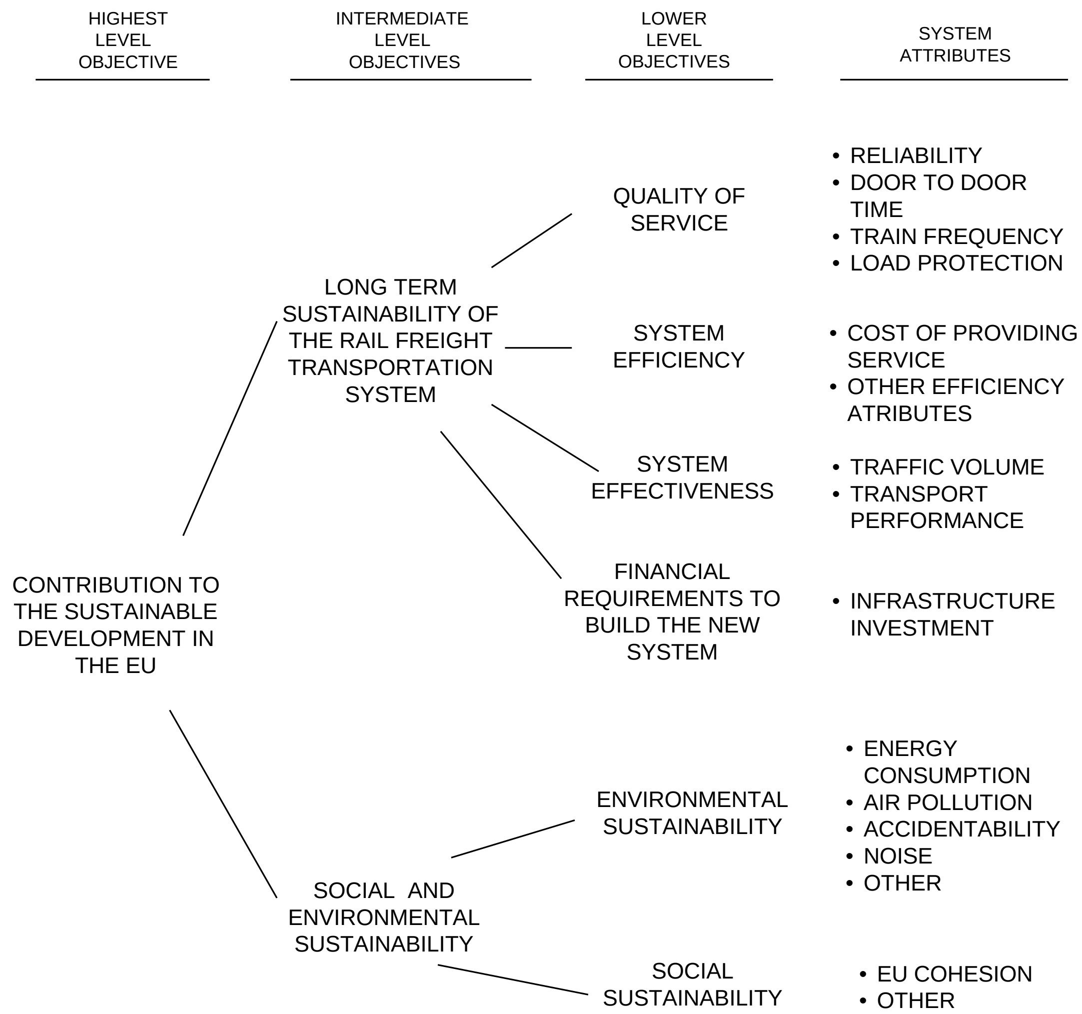
To this purpose, the actors can be gathered in three main groups: end users, service providers and the rest of the actors representing people and the environment. The system should be designed and implemented so as to be the most positive possible for the interests of these three groups of actors. Correspondingly, the system objectives can be defined.

An appropriate expression of the system objectives has been derived from the 1996 and 1998 EC White Papers. These objectives refer to features of the rail freight system of “common interest” and thus would have to be shared by all actors even if each individual actor or group of actors, were to adhere differently to the diverse objectives.

The following figure displays the proposed hierarchical structure of system objectives. Several significant system attributes have been selected, corresponding to each “lower level objective”.

This structured set of system objectives and attributes has been helpful in order to make the rather abstract actors’ criteria correspond to the more concrete characteristics which need to be defined in relation to both the system –including its “hard” and “soft” parts– and its implementation process.

Additionally, the above mentioned set could be helpful for the design and implementation stages that would follow on after the EUFRANET project.



7.2.6 The "top-down" design-evaluation process

This process is aimed at producing a satisfying image of the "soft" parts of the future system, i.e., its organisational facets. The process of generation of alternatives seeks to conceive appropriate, broadly defined key features for the system as a whole and for its different organisational facets.

"Inspiring" inputs in this process have been: the characteristics of the current problematic situation; the preferences of the actors involved; existing successful rail experiences in Europe and abroad; the findings on promising "hard" alternatives.

The process of evaluation has tried to ensure: the internal coherence among the different "soft" facets defined; the suitability of interrelations between the "soft" and the "hard" facets of the system; the possibility of appropriate interactions among the different in others; the compatibility between the system and its corresponding environment. The alternative proposed has been selected by consensus amongst the EUFRANET partners.

7.2.7 The system implementation process

This process deals with the conception and selection of practical ways in order to progressively bring about the future European rail freight transportation system, whose 2020 image has been previously designed.

Generally speaking, this process will have to include means (policies, plans, projects, practices, procedures,....), resources (types, quantities, ways to ensure their acquisition) and control of the implementation process. But, within the EUFRANET project scope, only a selection of key aspects of the implementation process have been addressed.

7.3 Conditions for successful system implementation

The feasibility and attractiveness of the 2020 image of the system previously presented in this report, will certainly induce the collaborative actors' behaviour, necessary for effective system implementation. But the likelihood of system achievement success is strongly conditioned by the way the transitional implementation process is defined and managed.

In this respect, certain conditions can ease the effective launching, development and deployment of the system, the most important of which can be considered grouped in the following classes:

- Concerning the actors: political decisions and system regulations; institutional framework; financially involved actors; role of new technology.
- Concerning the system: conditions on the functional systems, previously analysed in section 7.4.
- Concerning the implementation process: implementation stages; implementation priorities.

7.3.1 Political decisions and system regulations

The design and implementation of the proposed European rail freight transportation system requires a collaborative effort by the main service providers, but their spontaneous behaviour in this respect has proved to be not sufficiently effective to that end. Consequently, the following political conditions are considered to be crucial:

- **System launching political decision**. EUFRANET has been considering of utmost importance, that a formal political decision were taken by the Council of Transport Ministers, including both a "mission statement" for the new transportation system and an expression of the European engagement to support its implementation both politically and financially. The decisions already taken by the Council of Transport Ministers on 9, 10 December, 1999, can be considered as an important first step in this respect.
- **System regulatory framework.** As a complementary step to the above decision, the EU should complete, within as shorter time as possible, a regulatory framework adapted to the specific circumstances of rail freight transportation in Europe. Among the most important are: public funding, charging structure for infrastructure use and organisation for international traffic scheduling (see deliverable D7, point 3.2.2).
- **EU and Member States funding scheme**. Following the lines of the 1998 EC white Paper "Fair Payment for Infrastructure Use" and the decision taken at the above referred session of the Council of Transport Ministers on Bottlenecks in the Trans-European Rail

Network, the EU, the Member States and the Regional Authorities should complete a funding scheme, preferably, self-committing and concrete in quantitative terms.

7.3.2 Financial and new technology resources

Appropriate fulfilment of the previously mentioned conditions, in unison with others to be considered later, would diffuse a feeling of system credibility and context stability, very important to lever the necessary contribution from means suppliers, financing entities and developers of new technology. These refer to both parts of the system, “hard” and “soft”.

7.3.3 System implementation process

The implementation process must gather a set of characteristics that ensure its sustainability. First of all it must provoke a rise in spontaneous commitment and adhesion from the majority of the different classes of actors concerned. Thus, it must ensure direct or influential decision power to the main rail service providers (infrastructure managers and railway operators).

The process should start by diffusing determination and commitment by main actors: the EU, Member states and main railways. In this respect, the public authorities would make the “system launching political decision” (see point 7.6.1); as a follow-on, the main railways would produce a “core actors agreement”.

These decisions should be reinforced, on the one hand, by the public authorities, by means of determining a funding scheme; on the other hand, by the main railways, by means of engaging in collaborative preparatory activities.

The process of implementation should be organised in two stages, which have been called the system “birth” stage and the system “maturity” stage.

The “system birth” stage is aimed at achieving, in as shorter time as possible, the practical existence of a functioning system endowed with its main attributes, albeit reduced in geographical coverage. Throughout this stage, the essential features of the future high quality system must be defined, and the corresponding instrumental systems developed, tested and partially implemented.

At the end of this stage, the new system will hopefully have reached excellent conditions for its sustainable development and geographical deployment, on the basis of its own merits, having been duly diffused.

The “system maturity” stage is aimed at the full development and deployment of the system. Throughout this stage the remaining core network and also the intermediate network would be progressively implemented. The different common functional systems would be fully developed and implemented (for additional details on both stages, see D7, section 3.7).

7.4 Global assessment of the proposed European rail freight transportation system

As a final overall result of the EUFRANET project, a high quality competitive European rail freight transportation system has been proposed, whose main characteristics have been defined in varying degrees of detail. Two main elements have been used to configure the proposal: a long term (2020) image of the system and a transitory implementation process.

As a last contribution in this chapter, the global assessment of the system proposed, is considered in this selection.

Appropriate criteria to assess the system proposed are considered to be the following:

- **Adequacy** to remedy the drawbacks of the current problematic situation.
- **Efficacy** to reach the desired system objectives in a future satisfactory situation.
- **Integrality** of the system, as compounded of necessary parts.
- **Coherence** with respect to both, matching the different functional, operational and technical parts composing the system, and appropriate interactions –competitive in some respects, co-operative in others– between the actors integrated within it.
- **Compatibility** of both relations between the system and the different elements outside the system (for instance, passenger rail transport), and, interactions between the system and external actors (for instance, public authorities, competitors).
- **Desirability** for actors of the positive consequences of the functioning of the system, in terms of both desired results and unsought effects.
- **Tolerability** of the negative system impacts on the different kinds of actors.
- **Implementability** of the proposed system throughout the time from now until 2020.

These global assessment criteria have to be considered as “first level criteria”, which can be deployed as necessary. For instance, “interconnectivity”, “interoperability”, and “intermodality” could be considered appropriate second level criteria for first level criteria “coherence”.

In relation to the solution proposed by EUFRANET –a European rail freight transportation system, in the definition stage presented in this final report–, the above mentioned criteria have been used systematically –throughout the different processes of strategic system redesigning carried out (section 7.4)–, in order to: “inspire” the generation of partial alternatives made by the different EUFRANET partners; discuss the relative pros and cons of every partial alternative; discard less promising partial solutions as early as possible; select a preferred offer strategy.

This way of behaviour ensures that the solution proposed, in its present stage of definition, satisfies, as far as has been found possible, the above global assessment criteria.

It is worthwhile pointing out that the EUFRANET research and design effort should be continued and developed in order to achieve a more detailed definition of the different facets of the future European rail freight transportation system. To this purpose, other actors, apart from possibly those of the EUFRANET consortium, would engage in the corresponding task, including actors endowed with formal power to take design decisions.

This task should be undertaken using a “concurrent engineering” approach. In this context, the proposed global assessment criteria, duly deployed when appropriate, can be further helpful in order to both “inspire” the generation of alternatives of increasing level of detail, and select the most interesting among them.

Conclusions

The EUFRANET project has evolved due to the problems of the decline in rail usage for freight in Europe and the insufficient quality of current rail service offered in competition with that offered by road. These projections tend to show that the portion of the market held by rail in Europe will decline from about 14% to under 9% by 2020; therefore meaning rail will no longer be a viable alternative. Faced with this situation, the EUFRANET concept has therefore been developed after extensive analysis in the specialisation of transport networks and with a view to a better utilisation of infrastructures.

Identification of European rail network "dedicated to freight"

This definition has been done relative with railway companies so that the European railway network could attract a large part of rail traffic on a limited proportion of the rail network. Furthermore the concept of the network dedicated to freight should allows a certain progressiveness towards the priority accorded to freight and at the same time a diffusion across European space. The network " dedicated to freight" is therefore defined as follows:

- The core network is mainly dedicated to freight. In principle, no passenger train will be allowed to run on this network. In practice there might be some passenger trains, and in this case "freight priority" might be a more appropriate specification.
- The intermediate network is mainly dedicated to freight, but some local passenger trains will also be allowed to run on it. Freight trains will have more priority than in the present situation, but this will not be absolute.
- The third is of a "mixed network" or diffused network – where passengers and freight share the use of the network. The diffused network can be used by freight trains, but passenger trains will usually have priority.

European Rail Operating Strategy

The strategies for rail operations were explored in a context of reconstructing the sector. The EUFRANET study could not be undertaken without proposing simultaneously new ways of exploiting technological progress and especially industry innovation and breaking down of established barriers, that could be done in the most efficient way:

- ❑ By reducing cost in significant proportions (by 20 to 30% for example); or at least in certain markets under certain conditions where possible.
- ❑ Improve quality as regards to the length of time needed to transport, regularity, viability and information circulation.
- ❑ Limit negative impacts on the environment. The railways are already reputed to be the least environmentally damaging but it is still necessary to assure this point by significant improvements.

With these hypotheses, operating scenarios have been described as "nested" because their effects are cumulative, with incremental increases in traffic occurring in parallel with a gradual improvement in the quality of service:

- improvement on a "core" network and improvement on a core + intermediate network (which was made possible by the definition adopted for the dedicated network): this means a spatial extension of the quality of service

- improvement in quality of service which not only involves speed but also reliability and lower prices: as it has been assumed that the reliability of rail transport becomes comparable to that of roads.

Perspective of European rail freight transport

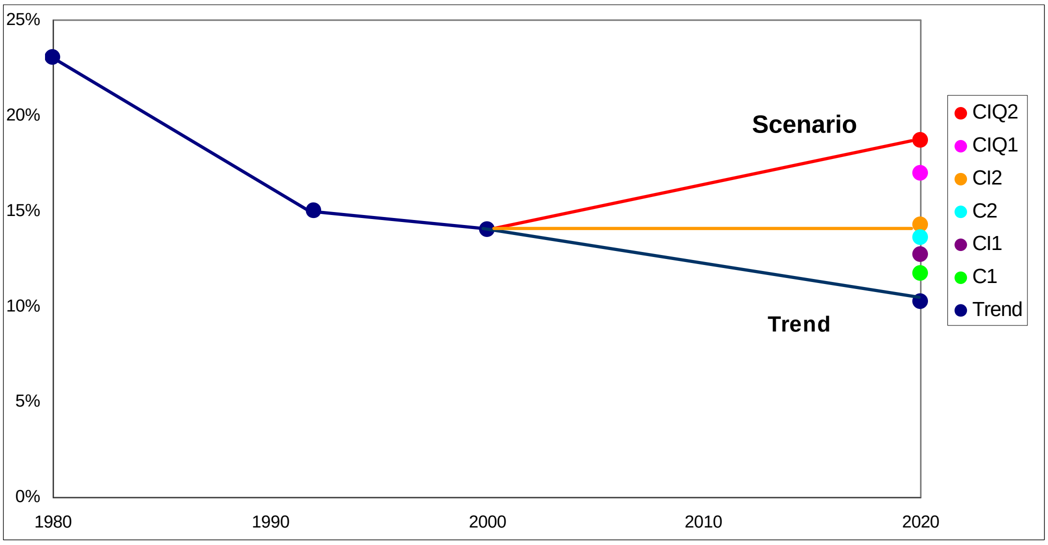
Rail projection and traffic assignment on the network for bulk, conventional and intermodal traffic have been made using innovative tools. With reference to the basic scenario at horizon 2020, the EUFRANET scenarios provide a different outlook along the following lines.

♦ An opportunity for rail "renewal"

Rail renewal refers to a potential doubling of traffic, in particular wagon load traffic which has often been a declining component of rail activity. Increases in combined transport can be even more important. The opportunity for growth is largely due to the increase in international transport where rail is placed in an attractive position to conserve and re-enforce it's place for the future.

♦ A possible reversal in the modal share trend

The present situation of about 14% is diminishing steadily , but under certain constrained hypotheses, a gain in market share will reposition rail at the same level as the beginning of the eighties (up to 20% or more) by the year 2020.



♦ A challenge for rail transport in Europe

A European challenge initially signifies a new rail policy for all countries where the portion of rail market is modest to say the least. But the European challenge also signifies that the future contribution of rail in Europe lies in complete integration between countries. From this point of view there are a certain number of measures that still need to be defined but it appears that rail is in a good position to retrieve it's position in long distance transporting and where countries at the periphery can be included. The renovation of rail is definitely a test to re-organise the sector at a whole European scale.

Annexe : List of publications, conferences and presentations

1. C. Reynaud, F. Jiang (2001), *The concept of dedicated "Trans-European network" for freight, a strategic rail network*, papers accepted by the next WCTR (World Conference of Transport Research) in July in Seoul.

2. C. Reynaud, F. Jiang (2001), *L'adaptation des modèles de simulation et des outils d'évaluation pour des stratégies d'exploitation d'un réseau ferroviaire Européen a priorité fret*, papers accepted by the next WCTR (World Conference of Transport Research) in July in Seoul.

3. C. Reynaud, F. Jiang (2000), *Thematic network of the strategic programme*: two presentations of EUFRANET in the Think Up in September and December in a seminar organised by NEA and INRETS on the modelling tools available at European scale.

4. C. Reynaud, F. Jiang (2000) *Club d'échange sur la modélisation de transport marchandises: Méthode Eufranet*, SES-DAEI, Ministère de Transport

5. C. Reynaud, F. Jiang (2000) *la recherche européen aux services des traversées alpine – présentation Eufranet*, Acte de séminaire d'Annecy, publication INRETS

6. C. Reynaud, F. Jiang (2000) *concept, modèle, évaluation*, note synthèse INRETS

7. C. Reynaud (2000) *modélisation de transport intermodal de marchandises et concept de réseau dédié au fret en Europe dans prospective des réseaux intermodaux européen*, document INRETS

8. C. Reynaud, F. Jiang (1999) *Club d'échange sur le transport de marchandises: présentation de projet Eufranet*, SES-DAEI, Ministère de Transport

9. C. Reynaud (1999), *Rail Transport Demand and Dedicated Network*, the European Transport Research Conference - pavings the way for sustainable markets, Lille, November

10. C. Reynaud (1999*) dedicated European freight rail network*, 2ND annual European rail freight conference, Frankfort.

11. C. Reynaud, F. Jiang (1999) *Présentation de projet EUFRANET*, journée sur les recherches européen et transport ferroviaire, UIC, Paris

12. C. Reynaud, F. Jiang (1998) *Eufranet, Intelfret and Hispeedmix co-ordination meeting*, Rome.

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C. Reynaud (2000). *« Scénarios - Prévisions: Bilan - Perspectives »* - Symposium CEMT - Tessaloniki
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