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Study On
Infrastructure Capacity Reserves
For Combined Transport By 2015

Prepared for

International Union of Railways

Combined Transport Group (UIC-GTC)

Final report

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TRANSPORT CONSULTANTS

Foreword

By Eric Peetermans

Chairman of the UIC Combined Transport Group

The Combined Transport Group of the UIC is happy and proud to present this Study on Infrastructure Capacity Reserves for Combined Transport by 2015, prepared by Kessel + Partner Transport Consultants, and KombiConsult GmbH.

This project has been initiated and financed by the UIC (Union Internationale des Chemins de Fer), with the participation of the UIRR (Union Internationale des Sociétés de Transport Combiné Rail-Route), the main European association of Combined Transport operators. This partnership reflects the joint concern of the Combined Transport community for the conditions of the optimum development of this exciting transport mode.

This work is the first of this scope since the landmark AT Kearney study of 1989, and, seeing the results, we are sure that the reader will find it as capital as AT Kearney has been in its time.

A lot of concern has been given, in different corners, during the recent years to the relative decline of the market shares of Rail Freight. We can see that the market share of Rail Freight has fallen from 21% in 1970 to 8.4% in 1998.

But we can also see that the Railways have increased their volumes in Freight from 163.5 Billion Tonne-kilometres in 1950 to 250.3 Billion Tonne-kilometres in 2000 (EU+EFTA). And this with 1/3 of the people employed in 1950 and on a railway network that has shrunk by 22% since then and which represented, in 2000, less than 4% of the road network in the same geographical area. Additionally, during the same period, passenger traffic, using the same railway infrastructure, has doubled.

Can we speak of a decline of the Railways? “A chacun sa vérité” - beauty often being in the eye of the beholder, but what we know is that the Railways are facing a market that, following the evolving industrial and economic structures of Europe, has developed in typically road-oriented segments, while the Railways have, in a great measure, over the years substituted their traditional core businesses, like coal, cokes, ores, and semi-finished industrial product flows with substantial market shares in the downstream steel industry, the automotive and petrochemical industries, paper and forest products, and, most importantly, the Combined Transport business.

Inexistant at the end of the Sixties, Combined Transport now represents around 25% of the activity of most Railways, expressed in Tonne-kilometres, and has trebled in tonnage since 1986, exceeding the projections of the AT Kearney study of 1989.

It can then be seen that Rail Freight has, in terms of market achievements over the past decades, performed relatively well in the segments where transport by rail is relevant and has completely renewed its portfolio, and that, with Combined Transport, it has penetrated those typical road segments mentioned before.

Is that enough? Can the Railways be satisfied that the world has changed around and without them but that they have managed to keep a place in the sun? Of course not.

Is the Community that the Railways serve entitled to expect more and better from them? Certainly, and we now see that a renewed political interest is directed at Rail Freight.

Indeed, there is a fear for a transport collapse in Europe if road transport continues to grow as it does. The 2001 EU White Paper projects that, if nothing changes, road transport will increase by 50% by 2010, and the costs related to congestions will by then increase by 142%, representing then 1% of the EU GDP of the time. This could very adversely affect the competitiveness of the European economy and the quality of life of the EU citizens.

So the European Commission; under the Marco Polo Programme, aims at shifting the expected annual increase of international road transport of 12 Billion Tonne-kilometres to non-road modes, and expects Rail Freight to do its share by expanding its market share to 15%.

Whether these ambitious goals are realistic and achievable or not, we all know that most of the growth of Rail Freight will come from Combined Transport. We also know that Combined Transport represents, for all actors involved, including the Railways, a difficult economic equation, especially in the domestic flows, and that productivity has become a key word, with an even greater urgency in this domaine.

It was with these thoughts in mind, and while discussing with our partners and customers, notably the UIRR operators, that we realised that this study was necessary to answer one very fundamental question:

What capacity will be available for Combined Transport on the European Railway Infrastructure by 2015 considering the expectations placed on Rail Freight and particularily on Combined Transport, given the most realistic growth previsions, taking into account the projected or foreseeable evolutions of the other Railway activities and visualising, on the basis of the current and planned infrastructure realisations and projects, the railway infrastructure available in 2015? Will it be sufficient and appropriate? If not, what should be done, in terms of investments and organisations, including those related to terminals?

At the end of a very broad consultation process, the Combined Transport Group of the UIC asked the association formed by Kessel + Partner and KombiConsult, both well known in this field, to carry out the study.

We have wanted the study to focus on international Combined Transport, even though, as the reader will find, it has drawn a complete picture in order to come to useful findings and conclusions for the international Combined Transport.

The Consultants came, in all fields (network infrastructure, operations, terminals) to important, sometimes surprising, but always interesting and useful findings and recommendations, as the reader will discover.

The Combined Transport Group of the UIC intends to work to keep these issues very high on the agenda of all interested and involved parties, Public Authorities, Railway Undertakings, Infrastructure Managers, Terminal Managers, Intermodal Operators.

We believe that all parties, also those beyond the circle of the sponsors of this study, that are genuinely interested in the development on Combined Transport, will share our excitement at the perspective of working out with us action plans and further investigations resulting from these findings and recommendations and of acting together upon them.

Executive Summary

Objectives and scope of the study

The primary objective of the present study, which has been commissioned by the *Union Internationale des Chemins de Fer (UIC)* and supported by the *UIRR*, was to respond to the following question: Will sufficient infrastructure capacity in terms of rail network and terminal transhipment capacity be available to meet an increased demand for international combined transport, and if not, which investments or other actions are required to overcome infrastructure capacity bottlenecks?

Methodologically, the capacity analyses were applied to 18 trans-European freight corridors, which have been determined by the UIC for the purpose of this study. In fact these corridors portray nearly the entire European network of intermodal transport services thus covering almost the total cross-border combined transport volume, except of a few Intra-Scandinavian and Intra-Eastern European flows. With regard to these corridors the study performed the following tasks:

- Analysis of the volume and structure of existing international combined rail-road transport (base year: 2002).
- Prognosis of the volume and structure of international combined transport by 2015.
- Investigation into the enlargement investments scheduled or already in progress for the rail network and combined transport terminals by 2015.
- Evaluation whether the 2015 infrastructure capacity (rail network, intermodal terminals) will be sufficient to absorb an increased international combined transport.
- Recommendations on additional enlargement investments, which would be required if, in 2015, infrastructure capacities were insufficient.
- Recommendations on services and products, which should be implemented by intermodal actors to overcome infrastructure capacity limitations recognized.

By pursuing such an approach, the present investigation is the first since AT Kearney's 1989 report, which undertakes both to take stock of existent international combined rail-road transport and elaborate a prognosis on the future development. Even more so, the present study was due to produce a complete inventory of these 18 trans-European corridors concerning the 2002 and 2015 rail network and intermodal terminal capacities, enlargement investments, and capacity bottlenecks disclosed.

Analysis of existent international combined transport

The year 2002 has been selected as the appropriate basis for analyzing the existing international combined transport (CT) on the 18 trans-European corridors. The volume totalled to 4,741,653 TEU or 54.5 million tonnes. Of which 44.1 mill tonnes (81%) were carried on unaccompanied CT services and 10.4 mill tonnes on accompanied CT services (cf. Table A).

Table A: International combined transport 2002

Market segment	TEU	Net tonnage
Unaccompanied CT	3,483,653	44.1 mill. t
Accompanied CT	1,258,000	10.4 mill. t
Total international CT	4,741,653	54.5 mill. t

The database on **international accompanied CT** includes the 2002 results of all 17 existent “rolling highway” services at that time. They conveyed 547,000 trucks. Of which one third were using services on the Brenner corridor, some 20% on the Tauern axis.

Counted in TEU the volume of **international unaccompanied CT** amounted to approximately 3.5 mill TEU. The investigation into the structure of this market segment resulted in the following findings:

- In 2002, some 40 companies were supplying international unaccompanied CT services on the corridors involved. 49% of the total was allocated to intermodal operators associated in the UIRR, 19% to Intercontainer-Interfrigo (ICF), and 32% to various “other” operators. In contrast, some 15 years ago at the time of the AT Kearney report, the European “intermodal world” was almost completely shared by UIRR companies and ICF. Thus the analysis gives evidence that competition is at work in this industry.
- The current volume of unaccompanied CT is pretty concentrated not only on individual corridors but also on services. 100 intermodal services (both ways), which represent 10% of all recorded services, make up more than 80% of the total TEU.
- In 2002, 60% of total European unaccompanied CT was generated by continental services, and 40% by the hinterland transport of maritime containers. Given that, it is striking that in services between CEEC countries and the EU-15 member states maritime containers made up about 80% of total volume, while continental shipments reached 20%.

Prognosis of international combined transport by 2015

According to our prognoses international combined transport (CT) on the 18 trans-European corridors will increase from 54.5 mill tonnes (2002) by +113 % to 116.0 mill tonnes in 2015. (cf. Table B).

Table B: International combined transport 2002/2015

Market segment	TEU (mill)		Net tonnage (mill tonnes)		
	2002	**2015**	**2002**	**2015**	**2015/2002**
Unaccompanied	3.48	8.7	44.1	103.6	+ 135 %
Accompanied	1.26	1.5	10.4	12.4	+ 19 %
Total	**4.74**	**10.2**	**54.5**	**116.0**	**+ 113 %**

A forecast of international **accompanied CT** must be considered a risky undertaking since the development of this CT market segment is primarily dependent on the political framework, which, until recently were pretty favourable in the Alpine states of Switzerland and Austria in particular. Our 2015 prognosis is based on the expectation that these conditions are due to be changed radically. Both subsidies for rolling highway services and quota restrictions on road transport will be significantly reduced or eliminated. On the other hand more qualitative controls of road vehicles and a comprehensive road toll scheme will be enforced. According to our expertise this will lead to a considerable cut down of the number of accompanied CT services, which provide for the following features:

- Focus on high-frequency services, calculated as one departure every three hours, 7 days both ways.
- Services, which provide for value to road operators, e.g. compliance with driving hours.

However, international accompanied CT has a chance to survive. It could even grow to a volume of 652,000 trucks carrying 12.4 mill tonnes, which is +19% compared to 2002.

International **unaccompanied CT** is supposed to clearly be the more dynamic market segment, which, in the 2002-2015 period, will increase to almost 9 mill TEU with a netload of 103.6 mill tonnes, which corresponds to an average annual growth rate of 6.8%. The forecast was based on following assumptions and analyses:

- Advancing from PROGNOS forecasts on different but CT modes of transport we evaluated the annual growth rates of international CT 2015/2002 per country. In this step we assumed that CT increases will likely to be above road growth figures for most countries due to major enhancements in rail and intermodal transport such as improved quality, efficiency, and interoperability, and, on the other hand, increased controls of road vehicles and charging of road infrastructure usage.
- In a second step specific conditions of the freight corridors have ben evaluated whether they might promote or impede CT development (transport policy, topography etc.). Further we took into account recent research on the transport-related effects of the EU enlargement and carried out interviews with railways and intermodal operators on the issue “East-West”. This resulted in following conclusions:

- A significant CT increase is facilitated on „mature“ CT markets in Western Europe owing to the existent market penetration, and the robustness of services against economic weakening.
- A less than proportionate CT growth is to be expected on East-West corridors. Even a decline is likely in the next years to come after the EU enlargement (cheap trucks etc.). Unaccompanied CT on these corridors is due to rise only in a medium-term perspective from a current low level.

Compared to 2002 international unaccompanied CT will have more than doubled by 2015. An increase of +135% within 13 years, however, wouldn't be so extraordinary as it might appear when this prognosis is considered in context with the result of the 1988-2002 period. Taking account of the 1988 figure recorded by AT Kearney (1989), having in mind that the geographic scope is not completely congruent with ours, in that 14-years period international CT actually grew by about 215% (see table C).

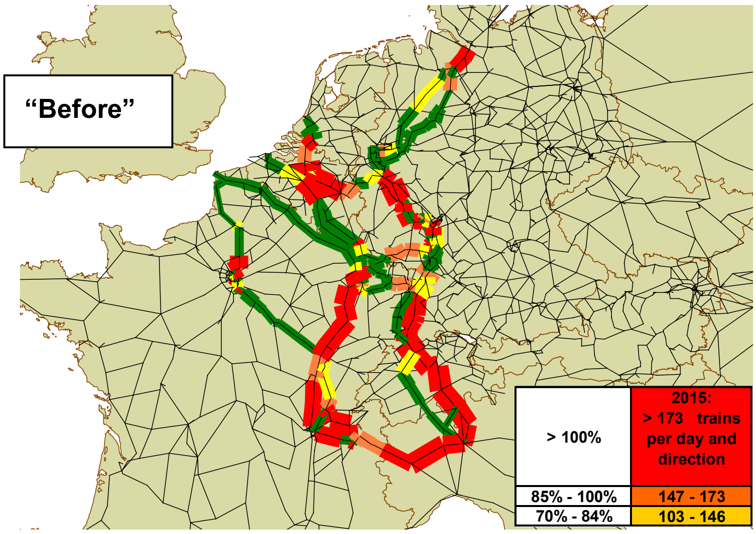
Table C: International unaccompanied combined transport 1988/2002/2015 – a comparison of AT Kearney (1989) with Kessel+Partner/ MVA/KombiConsult (2004) records and prognoses

	1988 (mill t)	2002 (mill t)	2002/1988 (%)	2015 (mill t)	2015/2002 (%)
AT Kearney report	14.0	38.7	+ 176 %	64.0	+ 65 %
Kessel+Partner/MVA/ KombiConsult report	-	44.1	+ 215 %	103.6	+ 135 %

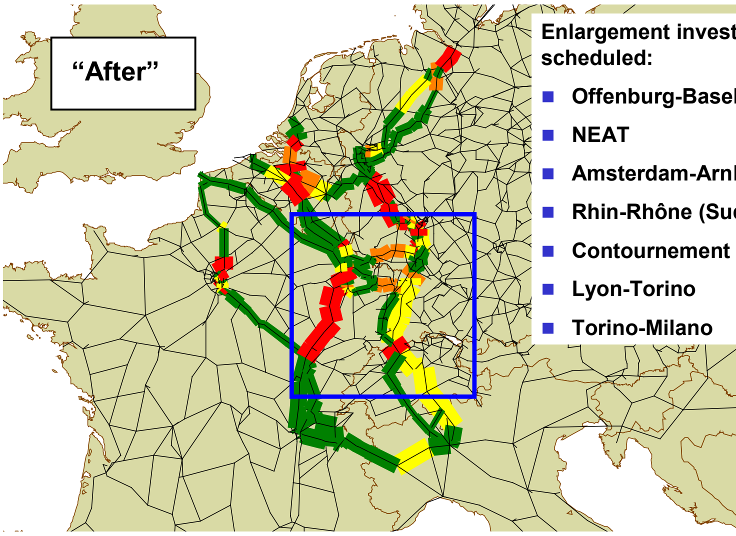
Evaluation of rail network capacity by 2015

The evaluation of the rail network capacity by 2015 was carried out in consecutive steps:

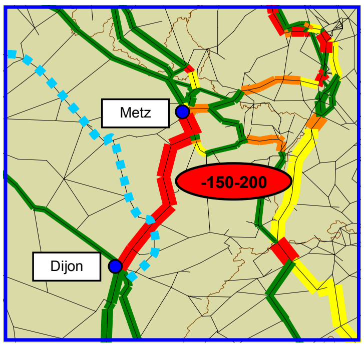
- Assignment of the international combined trains 2015 together with passenger services and other freight trains (national intermodal, national and international conventional freight trains) by 2015 on the European railway network.
- Evaluation of total network capacity requirement per corridor 2015 and identification of capacity bottlenecks **before** considering enlargement investments (cf. example below for consolidated corridors 2,3,15,16,17 UK ⇔ Benelux ⇔ France/Germany/Switzerland ⇔ Italy)



- Evaluation of total network capacity requirement per corridor 2015 and identification of capacity bottlenecks **after** considering scheduled enlargement investments.



- Evaluation of **consisting bottlenecks** and detailed recommendations of actions (cf. example below for the Metz-Dijon area in France)



Actions:

1. Enlarge Metz-Dijon
2. Magistrale Eco Fret

Further down in this report are presented these evaluation steps for each corridor in detail, thus a full inventory of all upcoming capacity bottlenecks by 2015 is available with this study. Particularly, it provides for each of the 18 trans-European corridors

- rail network capacities (train operating capacity),
- national/international network enlargement schedules,
- rate of employment (for each section) broken down by type of rail product particularly including the prognosis on international CT trains, thus complementing EURAILINFRA work,
- numeric result of capacity bottlenecks (lack of train paths) before/after enlargement investments scheduled.

This report additionally contains:

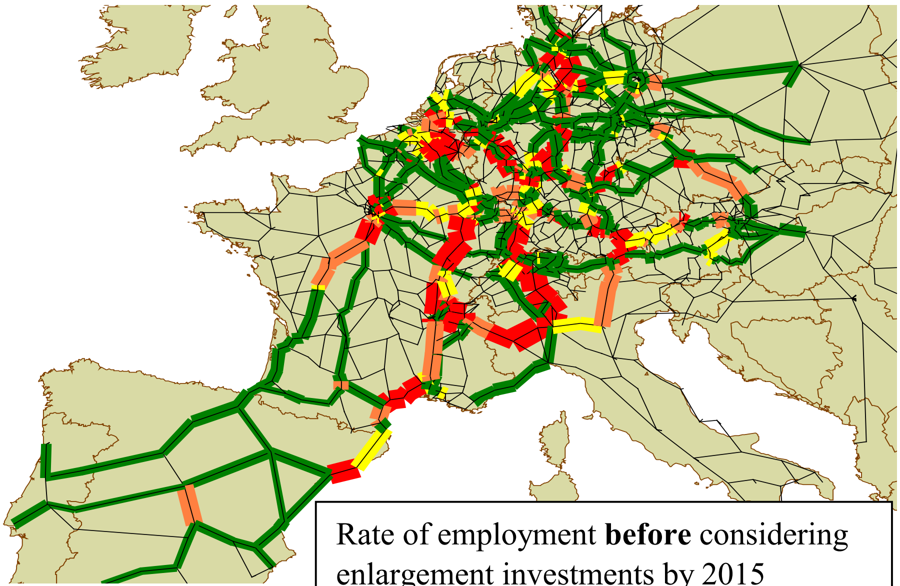
- recommendations for further rail infrastructure enlargement actions aimed at ensuring traffic shift envisaged,
- recommendations for alternative routings on less-employed lines if applicable.

While achieving this study, the UIC Infrastructure group presented their scenarios for the development of rail transport. As table D clearly shows, our results fits extremely well with the UIC-Infra prognosis as regards absolute figures and average annual growth rates.

Table D: Development of rail feight transport 2001/2015/2020 - a comparison of UIC-infra scenarios with Kessel+Partner/MVA/KombiConsult prognoses for UIC-GTC

	Scenario	2001 (billion tkm)	2020 (billion tkm)	Average annual growth rate (% per year)
UIC- Infra	Conservative	258,0	400,0	2,3
	Medium	258,0	500,0	3,5
	High	258,0	750,0	5,8
UIC- GTC		2002	2015	
		284,2	423,7	3,2

To serve the purpose of this summary, the following figures give an overview of the rate of employment for the European rail network, as a whole, **before** and **after** considering enlargement investments.

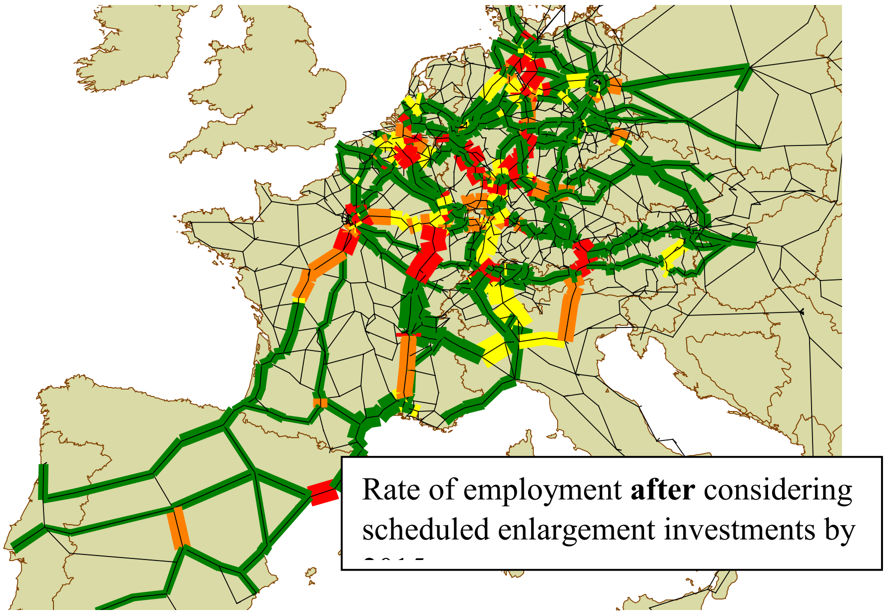


Rate of employment **before** considering enlargement investments by 2015

The study clearly works out that, even if all planned infrastructure investments were realised until 2015, considerable bottlenecks in terms of a lack of capacity for operating daily trains would remain (cf. figure below). This is even more true, if capacity-raising enhancements regarding train and line capacity parameters, which are considered ambitiously, will not be achieved. In that case network bottlenecks would increase further. This summary can but point out to major bottlenecks (see table E).

Table E: Main international rail axes with bottlenecks by 2015

Country	**Main axes with bottlenecks**
Germany	Hamburg – Rhein/Main
	Köln – Rhein/Main
	Saarbrücken – Stuttgart
France	Metz – Dijon
	Lyon – Avignon
	Paris – Orléans – Tours
Belgium	Freight corridors from/to Anvers
Switzerland	Greater Basel area
Spain	Barcelona-Tarragona



- In combination with the figures the table E very clearly shows that these bottlenecks are located on the major European freight corridors and that, consequently, the elimination of these obstacles is of great strategic significance for European transport. Consequently, the planned infrastructure investments must focus on eliminating these bottlenecks, which are crucial for entire CT network („Achilles' heels").
- The study shows the evidence on the necessity to implement enlargement schedules at all and on time. If this were not achieved, the growth of CT and rail would be impeded.
- Since the study provides for numeric result of capacity bottlenecks (lack of train paths) before/after enlargement investments scheduled, it enables to calculate the losses in volume (and revenues) likely to be incurred if network train capacity is restricted.
- To conclude, it becomes evident that, together with the enlargement programme, as assumed in the capacity analysis, the results of the investigation have proved very conclusively that considerable efforts will be required until 2015 to cope with the increased volume of transport.

Evaluation of intermodal terminal capacity 2002-2015

The assessment of the intermodal terminal capacities has been performed in six sequential working steps:

- Identification of representative European intermodal terminals.
- Analysis of existent total handling volume (2002).
- Analysis of 2002 handling capacity and rate of employment.
- Investigation into capacity extension and terminal investments scheduled.
- Deduction of 2015 capacity need (target) from prognosis.
- Determination of additional terminal infrastructure investment needed to comply with the prognosis volume.

For the analysis of existent terminal capacities and handling volumes, data had to be collected for individual terminal sites. It goes without saying, however, that a 2015 prognosis on terminals on 18 trans-European corridors must acquire a kind of macroscopic view. A global prognosis of the volume of combined transport, as required for this study, will provide forecasts for transport flows between greater European **economic areas** and can't take account of local differentiations. Owing to that for the purpose of investigating into the infrastructure capacity of intermodal terminals we applied a so-called **transport area** concept. Methodologically terminals of a selected area have been assembled to a "transport area" and their international transport flows have been aggregated. For example all Paris terminals are consolidated in "Paris" or the terminals in Mannheim and Ludwigshafen in "Mannheim/Ludwigshafen".

This study analyzed 34 transport areas on the 18 trans-European corridors, which were selected as representative for the network of terminals for unaccompanied combined transport services. They include the 25 largest transport areas and 9 end-of-corridor areas, which are relevant for intermodal services beyond the limits of the 18 corridors elected. These areas cover 70 individual terminal sites representing some 85% of the total 2015 volume of international unaccompanied combined transport (see table F).

The result of the 2002-2015 investigation is a unique inventory composing of

- 2002 handling volume broken down by international and domestic services.
- 2002 transhipment capacity, handling features (handling equipment & tracks etc.), and rate of employment.
- Prognosis of 2015 transhipment capacity need.
- 2015/2002 enlargement schedules.
- „Capacity gap“: additional capacity need by 2015.

Table F: **Top 25 transport areas with respect to international unaccompanied CT by the year 2015**

N°	Transport area	Export [1,000 t]		Import [1,000 t]		Growth rate	
		2002	2015	2002	2015	2015/2002	p.a.
1	Milano	4.402	11.477	4.908	12.566	158%	7,6%
2	Rotterdam	3.176	6.960	3.450	7.717	122%	6,3%
3	Köln	3.338	7.811	2.184	4.870	130%	6,6%
4	Verona	2.123	5.225	2.642	6.522	147%	7,2%
5	Antwerpen	2.574	6.355	2.283	4.934	132%	6,7%
6	Hamburg	2.384	6.335	2.241	4.585	136%	6,8%
7	Novara	1.677	4.382	2.238	5.862	162%	7,7%
8	Praha	1.141	2.277	1.288	2.580	100%	5,5%
9	Mannheim/Ludwigshafe	1.279	3.070	646	1.521	138%	6,9%
10	Zeebrügge	953	2.441	730	1.849	155%	7,5%
11	Paris	830	2.004	759	1.866	144%	7,1%
12	Basel	982	1.923	978	1.863	93%	5,2%
13	Barcelona	517	1.460	662	2.047	197%	8,7%
14	Valencia	558	1.328	587	1.714	166%	7,8%
15	Genk	663	1.769	449	1.217	169%	7,9%
16	Nürnberg	602	1.436	551	1.297	137%	6,9%
17	Neuss	710	1.500	529	1.084	109%	5,8%
18	Bremen/Bremerhaven	623	1.643	463	874	132%	6,7%
19	Roma	301	781	586	1.519	159%	7,6%
20	München	479	1.200	395	989	151%	7,3%
21	Duisburg	605	1.275	440	894	108%	5,8%
22	Wien	311	678	623	1.370	119%	6,2%
23	Wels	379	795	495	1.073	114%	6,0%
24	Budapest	408	749	553	1.051	87%	4,9%
25	Ljubljana	466	736	518	840	60%	3,7%
Subtotal 1.-25. (~72%)		31.480	75.609	31.196	72.706	137%	6,9%
Other transport areas		12.391	28.017	12.549	28.794	126%	6,5%
Total volume		43.870	103.626	43.744	101.499	134%	6,8%

The total transhipment **volume** in these 34 transport areas is forecasted to increase by 80% from 6.3 mill intermodal load units (2002) to 11.4 million units (2015). Investigations into enlargement programmes proved that a large scope of investments is scheduled or already in progress, both extending existent or building new terminal sites. According to that the nominal total transhipment **capacity** is due to rise from 9.6 million units (2002) by 39% to 13.3 mill load units. Despite these ambitious enlargement programmes capacity gaps are likely to arise in 20 out of 34 transport areas by 2015 (table G).

As a consequence, on top of the investments scheduled another 13% of transhipment capacity enabling to handle 1.7 mill units p.a. is required to meeting the increasing demand for unaccompanied CT services, and maintaining a high quality of service towards intermodal customers.

Table G: Terminal capacity bottlenecks (gaps) by transport area by 2015

Country	Transport area	Capacity 2015	Total volume 2015	Rate of employment	Probable capacity gap 2015
AT	Graz	130.000	137.000	105%	33.000
	Villach	110.000	121.000	110%	33.000
	Wels	132.000	181.000	137%	75.400
	Wien	300.000	282.000	94%	42.000
BE	Antwerpen	940.000	614.000	65%	
	Genk	122.000	150.000	123%	52.400
	Zeebrugge	365.000	306.000	84%	14.000
CH	Basel	390.000	238.000	61%	
CZ	Praha	200.000	288.000	144%	128.000
DE	Bremen/Bremerhaven	1.060.000	813.000	77%	
	Duisburg	318.000	166.000	52%	
	Hamburg	1.200.000	1.222.000	102%	262.000
	Koeln	300.000	517.000	172%	277.000
	Luebeck	140.000	101.000	72%	
	Muenchen	320.000	283.000	88%	27.000
	Neuss	140.000	146.000	104%	34.000
	Nürnberg	320.000	195.000	61%	
	Mannheim/Ludwigshafen	346.000	443.000	128%	166.200
DK	Taulov	120.000	130.000	108%	34.000
ES	Barcelona	348.000	307.000	88%	28.600
	Madrid	192.000	140.000	73%	
	Valencia	236.000	288.000	122%	99.200
FR	Le Havre	39.000	127.000	(a)	(a)
	Paris	658.000	270.000	41%	
HU	Budapest	300.000	263.000	88%	23.000
IT	Bologna	235.000	155.000	66%	
	Milano	1.057.925	1.130.000	107%	283.660
	Novara	805.000	478.000	59%	
	Verona	780.000	551.000	71%	
NL	Rotterdam	1.400.000	993.000	71%	
PL	Gliwice	32.000	57.000	178%	31.400
	Poznan	65.000	53.000	82%	1.000
	Warszawa	60.000	79.000	132%	31.000
SI	Ljubljana	150.000	87.000	58%	
Total terminals		13.271.925	11.184.000	84%	1.675.860

Conclusions and recommendations

This study's investigations into international combined rail-road transport on 18 trans-European corridors show that this market is likely to expand within the 2002-2015 period from 54.5 to 116 mill tonnes.

The likelihood that the 2015 prognosis on accompanied CT services, estimating a moderate 19% increase to 12.4 mill tonnes, will come true, to a large extent is dependent on the implementation of administrative and transport policy measures described in the report.

In contrast to that, international unaccompanied CT is less dependent on a favourable political framework than on immanent improvements of the intermodal and rail industry, particularly as regards service quality, efficiency, and cross-border coordination. This market segment has a long-time experience responding to market requirements appropriately. So this report's prognosis on unaccompanied CT, expecting a 135% increase from, in 2002, 44 to 104 mill tonnes by 2015, appears to be rather conservative, particularly compared to the previous 215% growth in the comparative 1988-2002 period.

To ensure this growth of international CT – not even taking account of a likely increase of domestic CT volumes, which were not included in the terms of reference of this study – combined transport rail services, amongst others, require for capacities regarding two infrastructure components, i.e. rail network and intermodal terminals.

Rail network

With respect to the rail network this study came to the following general conclusions and recommendations:

- This study proves how crucial it is to implement the planned infrastructure enlargement investments at all and on time within the years to come by 2015.
- Further rail infrastructure enlargement actions, which are described in detail in this report, should urgently be scheduled and enforced ensuring the traffic shift envisaged.
- If these measures were not achieved, the growth of CT and other rail freight would be impeded.
- Infrastructure investments should particularly focus on eliminating bottlenecks, which are crucial for the entire European CT network („Achilles' heels").
- The results of the capacity analysis enable to calculate the losses in volume (and revenues) likely to be incurred if the network capacity is restricted.

In addition to these most significant "messages" resulting from this study's investigation, we recommend further actions primarily towards **infrastructure managers** such as

- Construction of dedicated freight lines (e.g. B-Cargo: Athus-Meuse).
- Priority networks for rail freight services including adaptation investments (e.g. DB Netz „Netz 21").
- Avoid dismantling of overtaking tracks or flyovers, which currently are underemployed, to maintain operational flexibility.
- Investigate the cost and benefits of enlarging the loading gauge on a few main routes to P/C 400 particularly in France and Central/South Italy.

If, despite of all, railway undertakings and intermodal operators were forced to cope with rail infrastructure bottlenecks we would recommend various "soft tools". The "tool box", which we elaborated, contains various intelligent actions applicable by **railway undertakings and/or infrastructure managers** such as

- Homogenization of train path scheduling (B-Cargo/CFL/SNCF: Anvers-Basel)
- Bi-directional traffic (ÖBB)
- Interoperable production system (Railion/SNCF: KMML project)
- Increased train length (LIIIFT project)
- High and sustainable reliability of service

In this respect the authors of this report are convinced that, with the railways involved, there is less a lack of „best practices“ as concerns coping with limited infrastructure capacity than a lack of dissemination and mutual learning.

Apart from infrastructure managers and railway undertakings, the **intermodal operators**, too, have a variety of measures to improve the utilisation of rail infrastructure:

- Substitution of the original/final road leg by rail (Verona to Bologna etc.) or shifting of volumes from international key terminals to other locations and extending the rail service network.
- Enforcement of capacity management system (CMS) of intermodal operators aimed at increasing the capacity load factor of trains.
- Substitution of less efficient rail products for international CT services e.g. accompanied by unaccompanied CT services.
- Efficient production systems to bundle volumes, like GATEWAY, Y-shuttle or other hub services.
- Examining the application of mixed trains to raise the bundling effect.
- Advanced wagon technologies to raise payload factor.
- Finally, raise customer satisfaction to catch shippers’ base volumes currently carried by trucks to achieve more regular volumes.

Intermodal terminals

According to the findings of the study, there will exist a transshipment capacity gap for 1.7 mill load units by 2015. In relationship to the enlargements planned an overall extra capacity of 13% would be required to meet the CT demand and ensure a high quality of services. However, this capacity gap at intermodal terminals by 2015 appear to be less severe than on the rail network, provided that the enlargement schedules are realized on time. We therefore recommend the following actions towards **terminal investors**:

- It is crucial that enlargement investments will come into operation on time to avoid temporary capacity shortages: calculate sufficient time for planning, approval procedures and financing, construction and opening of the enlarged terminals and their access infrastructure.
- As the interface between road and rail the terminal is the most crucial part of the CT supply chain sufficient handling capacity is a prerequisite for ensuring high performance: allow capacity reserves to prevent the terminal from becoming the bottleneck.

Though, transhipment capacity must not become a severe bottleneck, when enlargement schedules will be realized, and since **terminal operators** could employ various “soft tools” to grapple with infrastructure limits:

- The first and decisive factor is a qualified terminal management and staff working inside a terminal. The “human factor” is likely to be the most important driver for an efficient use of infrastructure.
- Actions to optimize the capacity employment of intermodal terminals, e.g. by enhancements of process organization and operations (clear definition of roles and interfaces) supported by an IT terminal management system
- Creation of “public” terminals operated by “neutral” companies permitting non-discriminatory access to any intermodal operator, since this will create a bundling effect.

Apart of capacity-related aspects we recognized two other issues, which we’d like to propose to the **commissioners of this study** investigate in future:

- Owing to a lack of international coordination of terminal investments the growth of international CT may be jeopardized. This could be overcome by setting up bilateral/trilateral cross-country coordination groups or, on a larger scale, elaborating a “UIC Master Plan”, i.e. an European development programme on CT terminals.
- The domestic combined transport in various European countries plays an important role, which could even grow by 2015. Investigations into domestic CT were explicitly excluded from the detailed prognosis within the scope of this study. Since, of course, domestic flows do require infrastructure, we recommend to initiate an extension of this study, which would integrate this market segment.

1. Overview

1.1 Objectives and scope of the study

With its White Paper “European Transport Policy for 2010: Time to decide”, the European Commission has designed a strategy and an action programme to ensure sustainable mobility in the European Union. Amongst other objectives the Commission aims at decoupling the growth of transport volume from economic growth, and bringing about a change of modal split in the freight sector.

The Commission aims at maintaining the road transport volume in the decade to come by shifting the expected increase of international intra-European freight traffic to non-road modes of transport. One of the instruments is the Marco Polo Programme. By supporting non-road projects the EC is seeking to achieve a shift of 12 billion tonne-kilometres off the road each year during the 2003-2010 period.

In this strategy, rail freight and combined rail-road transport in particular shall play a key role. The present study, which has been commissioned by the *Union Internationale des Chemins de Fer (UIC)* and supported by the UIRR, undertakes to contributing to the development of a coherent European transport policy by addressing the following issues:

(1) To what extent may international combined transport contribute to the modal shift objective by the year 2015?

(2) Will sufficient infrastructure capacity in terms of rail network and terminal transhipment capacity be available to meet an increased demand for international combined transport, and if not, which investments or other actions are required?

In order to achieve these overall project objectives it was a prerequisite to fulfil the following tasks:

- Analysis of the volume and structure of existing international combined rail-road transport (base year: 2002)
- Prognosis of the volume and structure of international combined transport by 2015
- Investigation into the enlargement investments scheduled or already in progress for rail network and combined transport terminals by 2015
- Evaluation whether the 2015 infrastructure capacity (rail network, intermodal terminals) will be sufficient to absorb an increased international combined transport
- Recommendations on additional enlargement investments, which would be required if, in 2015, infrastructure capacities were insufficient
- Recommendations on services and products, which should be implemented by intermodal actors to overcome infrastructure capacity limitations recognized

By pursuing such an approach, the present investigation is the first since AT Kearney's 1989 report, which undertakes both to take stock of existent international combined rail-road transport and elaborate a prognosis on the future development. The framework conditions, however, have changed substantially particularly as concerns two issues:

- In 1989, the market for international combined transport services was absolutely transparent. More or less it was shared between the UIRR member companies and Intercontainer, who also were willing to supply transport flow data and development schedules. Now, with the liberalization of this industry various intermodal operators and railways are serving this market. Owing to the increased competition most of these companies prefer to keep confidential detailed information on their traffic volumes and on their future intermodal supply strategies.
- The AT Kearney report wasn't able to include the recent fall of the Iron Curtain. Both in analysis and prognosis, combined transport was limited to Western Europe. It is obvious that the present study, though commenced before the enlargement of the European Union, has taken account of this event and extended the geographic scope correspondingly.

1.2 Work methodology

Methodologically, the capacity analyses were applied to 18 trans-European freight corridors, which have been determined by the UIC in the terms of reference for the purpose of this study (cf. Table 1.1 and Figure 1.1). As a matter of fact these reference corridors portray nearly the entire European network of intermodal transport services thus covering almost the total cross-border combined transport volume except of a few intra-Scandinavian and intra-Eastern European flows.

With regard to the two main infrastructure items required to performing intermodal services, the project work was composed of two phases of analysis and a final section of recommendations, as follows:

Phase 1: Prognosis and rail network
Analysis of existent and prognosis of 2015 volume of international combined rail-road transport; analysis of current and 2015 rail network capacity requirements and capacity bottlenecks for combined transport by 2015

Phase 2: Terminals
Analysis of existent transhipment capacity, 2015 capacity requirements, and capacity bottlenecks of representative combined transport terminals by 2015

Phase 3: Recommendations
Conclusions and recommendations for actions drawn from the results of phases 1 and 2

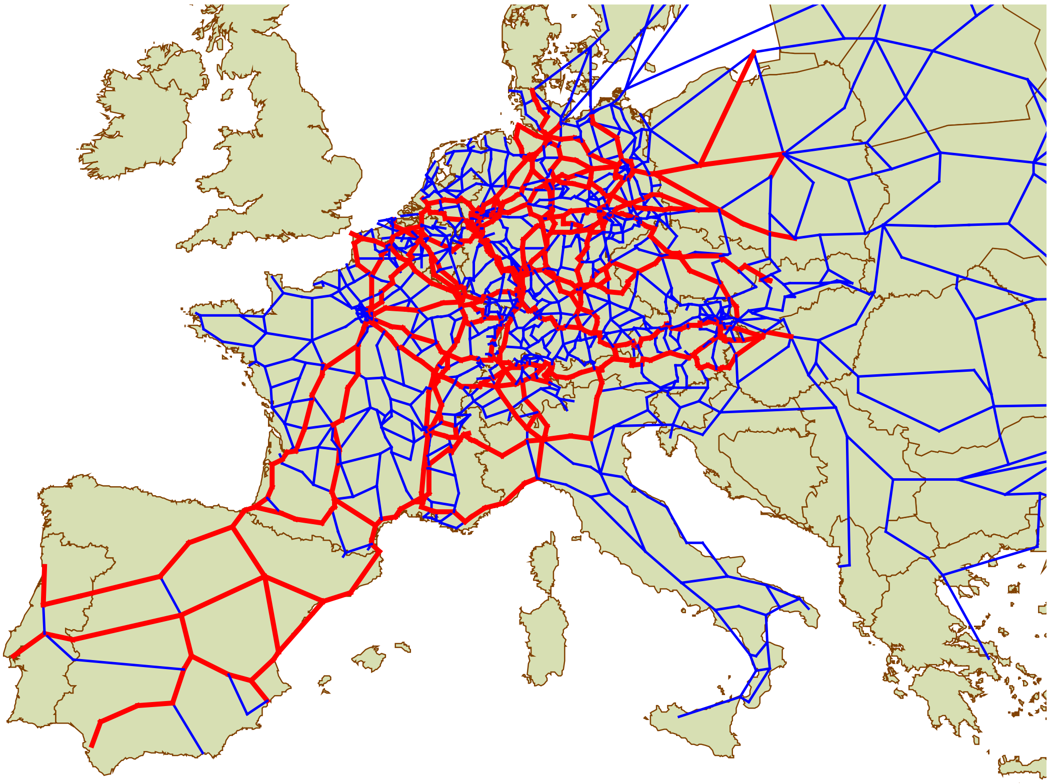
The study was carried out by a team of consultants from Kessel+Partner, KombiConsult, and MVA, headed by Kessel+Partner. For the execution a working group, which met regularly, has been established composing of representatives of the commissioners and the consultants, as follows:

- Ms. Sandra Géhénot, UIC-GTC
- Mr. Eric Peetermans, UIC-GTC (B-Cargo)
- Mr. Javier Casanas, UIC-GTC (Trenitalia Cargo)
- Mr. Martin Burkhardt, UIRR
- Mr. Hans-Paul Kienzler, Kessel+Partner
- Mr. Rainer Mertel, KombiConsult
- Mr. Klaus-Uwe Sondermann, KombiConsult

Table 1.1: Trans-European reference corridors of this project

Corridor		Via…
1	Benelux, Germany, Switzerland, Italy	
2	Benelux, France, Switzerland, Italy	Bettembourg/Athus, Metz, Basel
3	Benelux, France, Italy	Bettembourg/Athus, Metz, Modane
4	Benelux, France, Italy	Paris, Modane
5	Scandinavia, Germany, Austria Italy	
6	Germany, Poland	
7	Benelux, Germany, Czech Republic, Slovakian Republic	
8	Benelux, France, Spain	Paris, Bordeaux, Hendaye
9	Benelux, France, Spain	Paris, Dijon, Lyon, Cerbère
10	Germany, France, Spain, Portugal	Cerbère and Hendaye
11	France, Germany, Austria, Hungary	Le Havre/Forbach or Paris/ Basel
12	France, Hungary	Switzerland
13	United Kingdom, France, Spain	Cerbère or Hendaye
14	United Kingdom, France, Germany, Austria, Hungary	Calais, Metz or Forbach
15	United Kingdom, France, Italy	Paris or Metz or Modane
16	United Kingdom, France, Switzerland, Italy	Metz, Strasbourg or Basel
17	United Kingdom, France, Belgium, Germany, Switzerland, Italy	
18	Italy, France, Spain	Modane or Ventimiglia/ Cerbère or Hendaye

Figure 1.1: Trans-European reference corridors of this project (red links)



2. Analysis of international combined transport 2002

2.1 Approach

In the framework of the capacity study, this work package is aiming at the construction of a matrix composing of current combined transport flows per intermodal product, i.e. unaccompanied and accompanied combined transport, and specific markets such as hinterland transport of maritime containers, continental international and domestic transport.[1]

A matrix is a table or database composing all origin and destination itineraries (O/D-matrix) and their respective value, e.g. number of tonnes or shipments in either direction.

An aggregated and harmonized statistics on this matter does not exist. Railway undertakings, intermodal and terminal operators as well as port authorities and their respective organisations possess each a partly overlapping set of information. Due to liberalisation of the railway markets in previous years a couple of new entrants have appeared both as intermodal operators and railway undertakings so that the collection process becomes more and more difficult. All those bits of information had to be collected, harmonized, completed, and transferred into a unique **database** of current international intermodal transport flows for the purposes of the study. It was decided to apply the year **2002** as the referential year for this database.

For the purposes of this study a separation into unaccompanied and accompanied combined transport (rolling highway) was chosen.

2.2 Unaccompanied combined transport

The situation of unaccompanied combined transport is more complex than that of rolling highway services, because the number of services, countries, terminals and operators involved is much higher. This chapter reports on the sources and applied methods to record, compile and transform the data into the joint data base. For the purposes of this study, often different sources of information referring to the same underlying combined transport services have been examined and evaluated.

This database is strictly confidential, since the commercial data contained has been provided under the condition to use and publish them only aggregated and as anonymous figures.

1 The terms „intermodal transport“ and „combined transport“ (“CT”) are used as synonyms for the purposes of this study.

2.2.1 Standardizing the unit of recording

The investigations into the existing volume of unaccompanied combined transport proved that intermodal operators and railway undertakings are recording it by various statistical units of measurement. The following dimensions are primarily applied:

- TEU
- Kombi-shipment
- Load(ing) unit
- Intermodal transport unit (ITU/UTI)

Depending on the source we obtained statistical data in one or more of those units of measurement. It goes without saying that it was required to standardize the data on a common dimension to make them comparable, and enable cross-checks and plausibility checks and the aggregation of traffic flows.

It became obvious that the most suitable common dimension is **TEU** rather than load unit or shipment. Firstly, all companies operating intermodal container services and some terminal operators do record their volume in TEU. Secondly, TEU is a pretty "objective" dimension since it defines a transport capacity in terms of the length of a load unit as clear as possible. In contrast to that, the notion Kombi-shipment reflects a rather complex calculation based on the length and the gross weight of a load unit carried.

Therefore it was necessary to key up all sources of more detailed information and agree upon a calculation method to transform an original dimension into TEU. In contrast to the UIRR approach calculating 2.3 TEU per Kombi-shipment, in our database the real length of each loading unit has been used and transformed into a respective TEU value, e.g. a 7.15 swap body shows up as 1.2 TEU.

In addition to the TEU data collection it was necessary to record all flows of international combined transport in terms of **tonnes** in order to make this database comparable with the data in the prognosis model and in transport forecasts for the year 2015 (see chapter 4 & 5).

If data sources were not able to supply tonnage figures, we applied an average value to transform the given unit into tonnes. Based on the long-time experience of maritime container operators, one TEU is estimated to carry an average of 12 tonnes.

2.2.2 Data sources and their contribution to the results of the analysis

Though the European intermodal industry, in contrast to the age of the AT Kearney report, no longer is shared between the "empires" of the UIRR member companies and Intercontainer, these two groups have continued to control a major share of total international combined transport. So it is obvious to start gathering data with these groups.

The **UIRR** collects and publishes an annual statistics on the transport flows of its member companies. This data file has been provided for the purpose of this investigation. The intermodal volume is given in number of Kombi-shipments and tonnes on a country-to-country basis, broken down by the following types of load units: 7m, and 9-12m containers/swap bodies, and semitrailers. Information on the associated company CNC is added as a sum in TEU. **Intercontainer-Interfrigo (ICF)**, too, has handed over a complete country-to-country matrix of intermodal transport flows in TEU.

While on the country-to-country basis overall figures can be gathered from UIRR and ICF statistics, for a more detailed analysis of international combined transport it was vital to provide for service-related, i.e. terminal-to-terminal data on intermodal transport flows.

In this respect the terminal-to-terminal database, which the UIRR member **Kombiverkehr** supplied in an early phase of the project, constituted a backbone for analyzing the entire UIRR volume, since a majority of UIRR unaccompanied transport volume affects services from/to Germany, operated by Kombiverkehr and its partners, or German transit services. Beyond the mere representation of transport volumes this database was also most suitable for cross-checking other files supplied. The database is broken down by net tonnes, load units, and type of load unit for all services, in which Kombiverkehr was involved.

Also the UIRR companies **Bohemiakombi, CEMAT, Novatrans,** and **Ökombi** supplied comprehensive records of terminal-to-terminal flows for specific country relations in load units per type of unit. **Combiberia'**s data is included in RENFE-figures which are given as terminal and operator data in TEU, so that a full matrix had to be elaborated using several assumptions with respect to clients and services affected.

These databases completed the "UIRR world" when the Kombiverkehr file was not sufficient. The size of a few remaining corridor-related flows of UIRR member companies, which were not supplied, could precisely be derived from comparisons between the UIRR country-to-country statistics and the individual companies' statistics mentioned above.

When aggregating the data of different UIRR companies from it was required to consider that intermodal units, which were transported over various countries by two or more operators, were counted twice or thrice. It is obvious that those double counts had to be eliminated before aggregation. Using Kombiverkehr as a main source was leading to an already high coverage of European flows. Although Kombiverkehr is named as "operator" in the database other operators were involved in the real transport as well. Above all a harmonisation with the UIRR country-to-country statistic was performed so that data gaps could be filled and double counts eliminated in the final table.

Apart from the "UIRR-world" **B-Cargo** made available another database, which is giving the volume of intermodal transports conveyed by B-Cargo to and from Belgium or in transit. B-Cargo has recorded the volume on a station-to-station basis broken down by shipments and tonnes. Since the definition of "shipments" differs from the UIRR definition (in fact a complete train could be one shipment) the number of TEU had to be estimated from the volume in tonnes using an average of 12 tonnes per TEU.

Trenitalia Cargo provided valid statistical information on the volume of intermodal companies outside the UIRR and ICF worlds, who are operating trains from/to Italy, whose rail traction is supplied by Trenitalia. The data is given in trains per week and year and had to be transferred into TEU per terminal-to-terminal matrix using assumptions on the length of trains and carrying capacity of wagon and their average capacity load factor. Luckily, some of these estimations could be cross-checked with other supplies of data. In fact, the estimations proved to be highly precise.

RENFE information was provided for the year 2001 stating that major changes didn't occur in 2002. The data is in TEU displayed in two tables. The first is per operator and country and the second per terminal and border station. By means of expert know-how on served routes and terminals these volumes could be transferred into the terminal-to-terminal database covering the transports between the Iberian peninsula and the rest of Europe. Some transports of key clients were counted as "intermodal" though, in fact, standard intermodal equipment was not employed.

European Rail Shuttle (ERS) is just publishing a total figure of transported TEU and a schedule of train services and their operating frequency on international and domestic German services. Due to the existent knowledge on the domestic volume the share of international transports could be calculated. Further the ERS volume on international services between Rotterdam resp. Antwerp and German destinations as well as with Praha could be investigated. Applying cross-checks e.g. with the Trenitalia database it was feasible to estimate the volume on all other international terminal-to-terminal services.

Information on **Metrans'** intermodal services, terminals, and the total volume in TEU could be gathered, e.g. on the internet. The volume is completely carried on connections between the German container seaports and the company's central terminal in Praha. Their relative share could be derived using expertise and some assumptions.

As regards **Intercontainer's** flows from/to Belgium resp. Portugal and Spain the statistics submitted by B-Cargo and RENFE have been entered in the overall database. All other ICF country-to-country flows were allocated to access points per country and transferred into the database, herby applying ICF's information on the block train and *Qualitynet* network of services as well as own expertise. Minor transport flows of less than 1,000 TEU per year e.g. with Baltic or Central Asian countries, as well as domestic flows have not been included in the database at all.

Conliner and **Alpe Adria** supplied their complete database on a terminal-to-terminal basis in TEU.

The intermodal volume of **other operators** such as Polzug, Hangartner, Ambrogio, GTS has been included by exploiting KombiConsult's know-how, secondary statistics or the business and rail press.

2.2.3 Results

Finally, the investigation into international unaccompanied combined rail-road transport took account of the services of more than 35 intermodal operating companies. Their volume of transport totalled to approximately 3.5 million TEU in our base year 2002 (cf. Table 2.1).

Table 2.1: International unaccompanied combined transport volume 2002 by type of source

Intermodal operators	TEU	% of total
UIRR member companies	1,694,874	48.7 %
Intercontainer (ICF)	669,978	19.2 %
Other operators	1,118,801	32.1 %
Total volume	3,483,653	100.0 %

Table 2.2 represents the O/D country-country matrix of international unaccompanied combined transport. It includes all transport data entered into the database but only the largest flows are shown by order of volume. The left column gives the country of origin, the top line the country of destination.

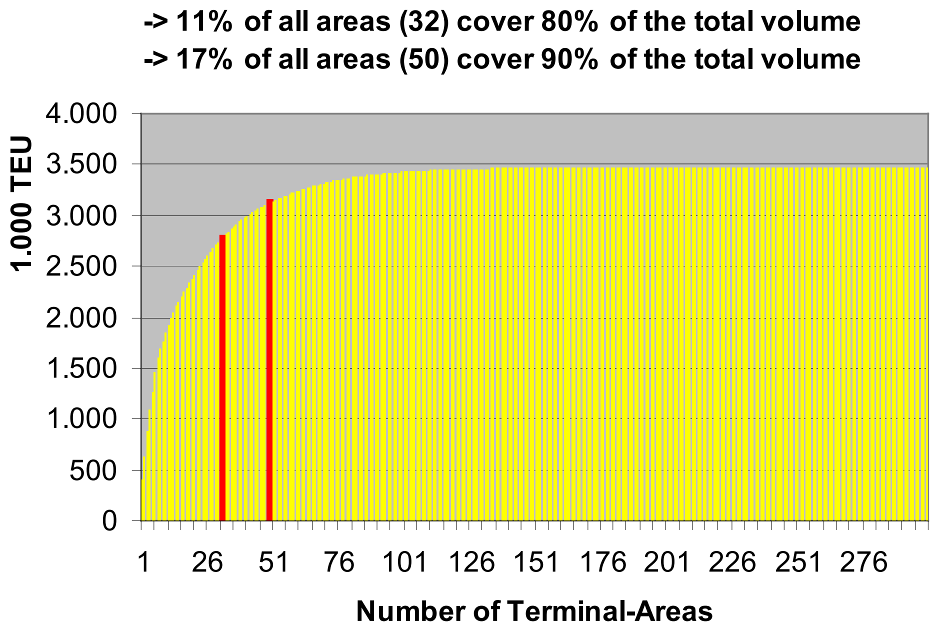
Table 2.2: International unaccompanied combined transport 2002 by country (largest flows only)

TEU	Destination													
Origin	Italy	Germany	Belgium	Netherl.	France	Spain	Switzerl.	Austria	Czech R.	Sweden	Hungary	Poland	OTHER	TOTAL
Germany	367.334		10.609	52.215	6.066	78.494	57.489	58.029	79.812	56.691	51.047	48.232	30.325	896.343
Italy		375.209	201.235	118.897	76.831	2.000	23.439	10.483	530	17.723	1.099	7.954	55.982	891.382
Belgium	214.340	12.052		54.123	40.827	29.720	18.722	11.495	108	10.707	2.004	1.031	9.865	404.996
Netherlands	75.830	45.449	70.221		9		21.420	5.766	9.123		4.592	16.423	10.014	258.848
Spain	2.000	59.258	25.195		32.021		678		1.015				39.768	159.934
France	73.797	5.050	38.719	8		18.680	3.435	3.353					15.485	158.526
Switzerland	25.416	50.988	23.839	31.286	3.474	625		1.258		2.526			1.495	140.906
Austria	15.149	55.354	1.034	4.585	3.504		551		9		3.311		9.932	93.428
Sweden	18.290	53.098	8.531				3.771						0	83.690
Czech Rep.	708	65.893	167	9.123				2.180			1.000	278	1.122	80.471
Hungary	1.355	32.650	480	4.387				12.465	1.055				16.658	69.049
Poland	6.350	46.450	104	12.266					347				0	65.519
Great Brittain	34.697	7	2.317			21.000							0	58.021
Slovenia	2.035	2.199	633		14.490			6.178	21		15.849		2.739	44.144
Denmark	13.681	12.076	56	798			1.977			760			0	29.348
Portugal		222	17			15.100							0	15.339
Turkey		2.335						6.684					0	9.019
OTHER	2.585	3.923	2.204	10.704	5	0	550	2.395	0	0	0	0	2.324	24.690
TOTAL	853.568	822.214	385.360	298.393	177.226	165.619	132.032	120.286	92.020	88.408	78.901	73.918	195.708	3.483.653

The database is containing station-to-station (UIC station number), terminal-to-terminal (UIRR terminal number) and town-to-town data, depending on the source of information. For the purposes of this part of the study which is portraying the current international intermodal transport flows on a European scale it is sufficient to aggregate flows of neighbouring stations or terminals to what we call it “transport areas”. These could be used as entry points for the trans-European rail network (capacity analysis). In the concept of “transport areas” different stations and terminals are grouped, e.g. all docks, terminals and the Main-Hub in the vicinity of the Port of Antwerp appear as “Antwerp”. Single stations and terminals outside of these areas appear as single areas.

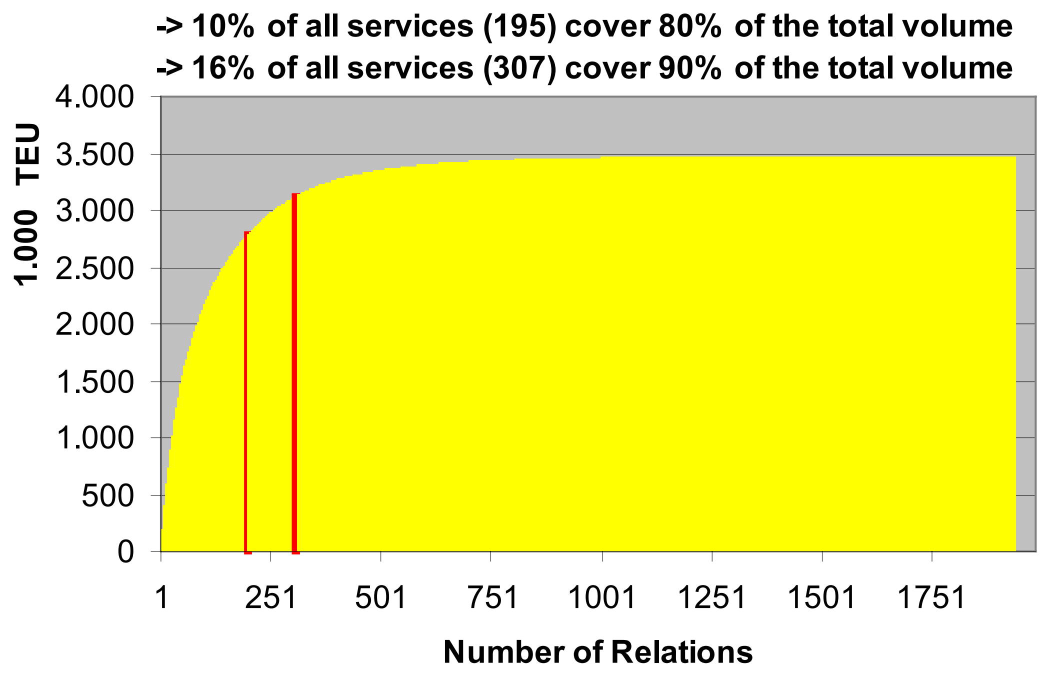
Figure 2.1 shows the distribution of all international transport flows included in the database over the transport areas. Ranked by their size a concentration diagram could be drawn which is showing that the top 32 transport areas (11%) accumulate 80% of total international unaccompanied combined transport, and the top 50 transport areas (17%) 90% of total traffic.

Figure 2.1: Distribution of unaccompanied CT 2002 by terminal area



A further concentration analysis relates to the number of services between the terminal areas. Figure 2.2 is showing the distribution of all international transport flows included in the database on all services. Ranked by their size a concentration diagram could be drawn. It shows that the top 10% (195) services make up of 80% of total international unaccompanied combined transport.

Figure 2.2: Distribution of unaccompanied CT by services



In order to be used by the forecast and assignment model system, which is able to transfer tonnes into trains for all itineraries that originally did not contain weight data an assumption on the weight had to be made. Again, the sources of information (railways, operators) if at all, provide different type of weight information: the railways provide gross-tonnage "above" wagon platform. The operators provide sometimes gross-tonnage including the weight of the loading units and sometimes net-tonnage (without tare weight).

The experience of intermodal and terminal operators result in an average ratio of 12 tonnes per TEU. This value was absolutely confirmed by an analysis of Kombiverkehr's database, which includes both types of data.

If this 12 tonnes per TEU ratio is applied it results in a total volume of 44.1 million tonnes having been carried on international unaccompanied intermodal services in 2002.

The complete database on international combined transport broken down by transport areas, TEU and tonnes has been entered into the forecasting model, and the capacity analyses of the rail network and the intermodal terminals.

2.3 Accompanied combined transport (rolling highway)

The data base on the current volume of international accompanied combined transport (rolling highway) was compiled of various sources:

- Intermodal operators of rolling highway services.
- UIRR: UIRR Report 2002, Bruxelles 2003.
- Bundesamt für Raumentwicklung (ARE): Alpinfo 2002, Bern 2003.
- Amt der Tiroler Landesregierung: Verkehrsbericht 2002, Innsbruck 2003.
- HaCon/KombiConsult/SGKV: Handlungsempfehlungen für den internationalen Kombinierten Verkehr, Berlin 2003.

Even though 2002 was determined as our statistical base year, the overview table doesn't only contain all rolling highway services operated in 2002, but also those suspended in 2002, or inaugurated in 2003 (cf. Table 2.3). This table, too, includes other topical 2003 information on these services, the max. capacity per departure (cap/dep) in terms of spaces for trucks, and the number of departures per week (dep/week). However, the volume recorded only relates to 2002 operations.

Thanks to intermodal operators' data we are able to give a very precise record of the volume of trucks or shipments conveyed on accompanied combined transport services in 2002 (cf. Table 2.3, column (d)). According to these sources, the volume totalled to 546,851 trucks, of that about 365,000 trucks (67%) were carried on transalpine services.

It was slightly more difficult to give an account of the tonnage shipped by accompanied CT services, since different counting methods are being applied:

- ARE statistics record the net tonnage of cargoes conveyed by intermodal rail services.
- Austrian authorities with regard to CT services affecting Austria, as well as the UIRR statistics apply a counting principle, which adds up both the tonnage of the cargoes and the tare weight of the intermodal load unit in question. This counting principle, in fact, makes sense for the railways since their transport service applies to both parts.

While in unaccompanied CT the effects of applying different counting methods may be considered "acceptable" since the tare weight as a rule amounts to 10 to 20 % in the case of containers/swap bodies, and to 20 to 30% in the case of semitrailers, in accompanied CT this difference is not a petty problem. To give an example: the 2002 volume of accompanied CT on the Brenner corridor is indicated with 3.3 million tonnes by ARE, and 5.7 million tonnes by Austrian authorities, which is 73% more!

For this study we decided to apply the net tonnage principle, i.e. recording the weight of the cargoes carried, since it enables a better comparison with road transport. Based upon market information we assumed an average 19 tonnes net load per truck transported by accompanied CT. This results in a total volume of 10.4 million tonnes in 2002.

Table 2.3: Accompanied combined transport 2002

Rolling highway service	2002 - actual volumes			
	cap/ dep	dep/ week	n° of trucks	net tonnage
(a)	(b)	(c)	(d)	(e)=(d)x(3)
Aiton - Orbassano	--	0	0	0
Sub-Total Modane			0	0
Freiburg - Novara	19	84	44.536	846.000
Freiburg - Lugano	20	10	5.860	111.000
Basel - Lugano	20	10	10.852	206.000
Singen - Milano	20	10	9.122	173.000
Sub-Total Gotthard/Lötschberg			70.370	1.336.000
Manching - Brenner	18	186	115.360	2.192.000
Wörgl - Verona	21	34	26.642	506.000
Wörgl - Bolzano	21	10	1.000	19.000
München - Bolzano	21	10	500	10.000
Wörgl - Trento	21	40	32.600	619.000
Sub-Total Brenner			176.102	3.346.000
Salzburg - Palmanova	--	0	0	0
Salzburg - Ljubljana	16	34	20.015	380.000
Wels - Maribor	17	50	23.013	437.000
Wels - Villach	18	96	77.070	1.464.000
Sub-Total Tauern/Phyrn			120.098	2.281.000
Wels - Sopron	22	70	53.082	1.009.000
Wels - Szeged/Arad	22	56	51.933	987.000
Wels - Budapest	--	0	0	0
Sub-Total Donau			105.015	1.996.000
Ljubljana - Szeged	18	6	2.756	52.000
Dresden - Lovosice	23	90	72.510	1.378.000
TOTAL	**19**	**796**	**546.851**	**10.389.000**

Assumptions

(1) Period of operations p.a: **48 weeks**
(2) Capacity load factor 2015: **85 %**
(3) Net-Tonnage per shipment (truck): **19 tonnes**
(2002: Gotthard: 19,7; Simplon: 15,3; Brenner: 18,6)

2.4 Total international combined transport 2002

The volume of international combined transport including both unaccompanied and accompanied services totalled to 4.75 million TEU resp. 54.5 million tonnes in 2002 (cf Table 2.4).

Table 2.4: Total international combined transport 2002

Market segment	2002 (net tonnage)	2015 (net tonnage)	2002/2015
Unaccompanied combined transport	**44.1 mill. t**	**103.6 mill. t**	**+ 135 %**
Accompanied combined transport (rolling highway)	**10.4 mill. t**	**12.4 mill. t**	**+ 19 %**
Total combined transport	**54.5 mill. t**	**116.0 mill t**	**+ 113 %**

3. Prognosis of international combined transport 2015

3.1 Unaccompanied combined transport

This prognosis of the 2015 volume of international unaccompanied combined transport (CT) has been elaborated in two stages :

- 1st prognosis of 2015 corridor volumes based on global input values
- 2nd prognosis of 2015 corridor volumes based on modified input values resulting from a detailed corridor-related appraisal of 1st prognosis

3.1.1 1st prognosis of 2015 corridor volumes

The first prognosis of unaccompanied CT advanced from existing forecasts of road and rail freight traffic by the year 2015 commissioned by the European Commission, the UIC, or governments of European states, and methodologically was performed in three steps.

Step 1:
During a working group meeting on 30th July 2003 those prognoses were selected for this study, which are well recognized and provide for an appropriate data structure. All prognoses supply an estimation of the development of freight traffic in terms of tonne-kilometres per country broken down by major modes of transport.

Step 2:
To avoid additional efforts it was mandatory to apply the given structure to the 2015 prognosis of unaccompanied CT. Also on 30th July 2003, the WG members derived CT growth rates per country from these global forecasts. It was clear enough that, at this stage, the WG members primarily could take account of general economic and political trends influencing the development of unaccompanied CT by the year 2015. The following considerations entered into the results presented in Table 3.1 :

- In the past CT development rather did correspond to the development of road than rail. So CT 2015 forecast generally should be oriented to road 2015.
- Instead of extrapolating current conditions in the rail and intermodal transport industry it needs to assess the opportunity and plausibility of long-term, macro-level changes of patterns. They would have a stronger and sustainable impact on unaccompanied CT development and enable higher growth rates than in road:
  - Enhanced and stabilized quality of service (punctuality, consistency)
  - Customer-driven transit times
  - Supply of seamless trans-European intermodal services
  - Enhanced efficiency of rail transport owing to increased competition in the rail sector, and achievements like improved corridor co-operation and management, and interoperable technologies and processes

- The effect of a more than proportionate growth of intermodal volume will be reinforced by measures taken by transport administrations, which increasingly contain the "free rider" mentality in international road operations:
  - Increased size of technical controls
  - Enforcement of "black box" registering truck drivers' driving periods
  - Stronger penalties for breaking the law
- Road pricing is due to be implemented in the EC, and induces a comparatively higher increase of road transport costs.
- Parts of conventional rail freight volume will be shifted to intermodal services due to shippers requirements and efficiency.
- EC and national states extend schemes of funding the start-up of CT services.

Table 3.1: Prognosis of average annual growth rates of tonne-kms 2000/2015 (%)

Country	All modes	Rail	Road	CT 2015
Austria	2.4	2.7	2.5	**3.2**
Belgium	2.5	1.6	2.8	**3.5**
Czech Republic	1.6	- 0.9	2.4	**2.9**
Denmark	2.0	1.5	2.0	**2.5**
Estonia	3.1	2.2	7.0	**3.6**
Finland	1.6	2.8	1.2	**3.3**
France	2.0	2.6	2.2	**3.1**
Germany	2.3	1.8	2.5	**3.5**
Hungary	2.5	0.9	3.0	**3.5**
Italy	2.3	3.5	2.2	**4.0**
Luxembourg	2.7	2.2	2.9	**3.5**
Netherlands	2.6	4.0	2.3	**4.5**
Norway	3.0	2.1	3.1	**3.6**
Poland	2.2	- 2.7	4.5	**5.0**
Portugal	2.9	5.3	2.5	**5.8**
Spain	3.3.	4.6	3.2	**5.1**
Sweden	3.2	2.2	3.8	**4.3**
Switzerland	2.6	2.1	2.8	**3.5**
UK	2.6	3.1	2.5	**3.0**

Step 3:

These global growth rates of combined transport have been applied to the origin/destination(O/D)-matrices of existent 2002 combined transport on the UIC corridors selected (cf. chapter 5.). Thus a first complete picture of unaccompanied CT in the year 2015 was generated including :

- intermodal transport volume broken down by international O/D routes, i.e. CT links between two intermodal terminals, bearing in mind, however, that we should think of origins and destinations more as areas than exact terminal locations ;
- intermodal transport volume per UIC corridor ;
- prognosis of a total of 83.1 million tonnes in unaccompanied CT by 2015.

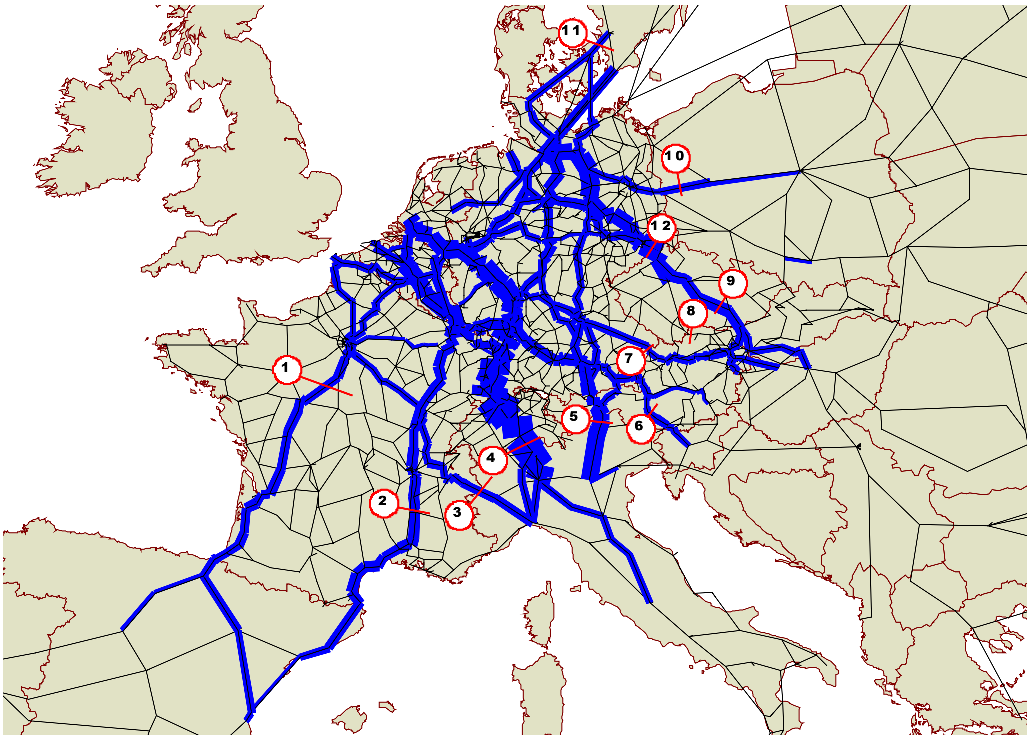
3.1.2 2nd prognosis of 2015 corridor volumes

The second prognostic round aimed at fine-tuning the 2015 forecast with respect to eliminating apparent shortcomings and enhancing the quality of the prognosis. Hence we thoroughly analyzed the corridor-related results of the first prognosis and evaluated the plausibility of the forecasted values. In this process we particularly took account of the following aspects :

- The experience of intermodal operators give evidence of the fact that a further growth of CT volume is facilitated on markets/corridors, where CT has achieved a significant market penetration. Relative growth of CT volumes may be higher on “under-developed” markets starting from a low base volume, absolute increase, however, is due to be larger on existing CT “strongholds”.
- In this respect the market share of unaccompanied CT on international origins/destinations (O/D) compared to road transport for the 2015 prognoses was calculated and assessed whether intermodal service suppliers might be capable to achieve an additional traffic shift. To this end we were required to generate O/D-matrices for road transport from the global 2015 prognoses selected in the first round, since they only provide for forecasts of development of modes of transport broken down by country.
- Specific conditions of the corridor in question, in particular regarding administrative measures, topographic obstacles, logistic requirements, or terms of competition, were considered to have a major impact. They may either promote or impede the development of unaccompanied CT services and volumes.

Methodologically, the detailed corridor analysis was performed as follows . We determined twelve locations or nodes within the European rail network, which appeared to be suitable for a «cross section» («coupure») of intermodal transport flows transiting these locations (cf. Figure 3.1). Those cross sections, too, were selected in a way to represent transport flows of various UIC corridors. Each of the cross sections enabled us to assess if the O/D intermodal flows were allocated to the proper rail route (infrastructure), and the prognosis of 2015 volume were plausible.

Figure 3.1: Location of cross-sections



This exhaustive evaluation process brought the following results :

- Some 95% of the total 2015 CT volume was properly allocated to rail routes. Every « wrong » routing could be identified and corrected.
- Only cross-section location n° 8 was not determined reasonably, and, as a consequence, eliminated since the relevant corridor flows could be better represented by location n° 9.
- The forecasts of 2015 CT volume at cross sections n° 1 (« Orléans »), n° 3 (« Modane »), and n° 10 (« Poznan ») were assessed as plausible and thus maintained.
- The prognoses concerning the 2015 CT flows transiting all other cross section locations, however, appeared to be not completely reflecting the expected development and underestimating the growth of CT volume.
- Owing to that the prognosis of 2015 CT volumes were raised, subject to the distinguished features and conditions of the individual corridors as follows:

Cross section n° 2 (Lyon)

- Currently small market share of CT though large market of very long distance transports, which are considered most suitable for unaccompanied CT services.
- Current lack of quality and efficiency in rail freight is to be eliminated due to improved co-operation of railways in particular.
- The Rhone route is supposed to develop at least as strongly as the Atlantic route (cross section n° 2), which sees a trebling of volume.
- Increased capture factor of road transports should contribute to achieve approx. 200% growth 2002/2015 instead of 160%.

Cross section n° 4 (Gotthard & Lötschberg)

- Swiss constitution (*Art. 84 BV « Alpenschutzartikel », as of 20 February 1994*) stipulates to shift transalpine heavy road freight transit through Switzerland to rail within ten years. The Swiss law on traffic shift *« Verkehrsverlagerungsgesetz »* as of 8 October 1999 stated more precisely that latest by two years after the completion of the Lötschberg base tunnel, which is scheduled for 2007, not more than 650,000 trucks p.a are permitted to transit Swiss Alps (*further objectives will have to be determined by 2010*).
- To ensure this goal Swiss government has taken care of enforcing various supporting rail-sided measures, and allocating a budget of 2.85 billion SFr for promoting rail freight services.
- Other accompanying measures relate to road transport through Switzerland. Amongst them are increased and more severe controls of vehicles and the imposition of the road toll « LSVA » due to be raised to the max. rate after the completion of the Lötschberg base tunnel.
- According to a BAV document «Verkehrliche Auswirkungen des bilateralen Landverkehrsabkommens », in the 2000/2015 period, it is scheduled to achieve an **additional** traffic shift from road to rail of 1,002,000 truck journeys. Assuming that the entire volume would be shifted to CT services, and taken an average net tonnage of 19 tonnes per truck, this traffic shift objective corresponds to a growth of approx. 200% compared to the 2000 total CT of 10 million tonnes.
- As a result we increased the 2002/2015 growth of unaccompanied CT from 90% to 150%.

Cross section n° 5 (Brenner)

- The enforcement of short- and medium-term measures included in the « Action Plan Brenner 2005 » is to bring about an increase of unaccompanied CT by about 50% in the 2002/2006 period (according to Austrain sourcies accompanied CT even should be doubled).

- A further momentum for the time afterwards will be given by actions, which have an impact on the competitiveness of CT services with a time-lag (infrastructure extensions and upgradings in progress ; improved corridor management ; extension of services to Central & South Italy).
- After the factual abandonment of the eco-point system, the Austrian administration is supposed to seize major other actions to restrict the volume of road transit through Austria (technical and driver controls ; increased road tolls etc.).
- In the long run the Brenner corridor, too, will become more important for unaccompanied CT services between Italy and the accession countries Poland and the Czech Republic (partly shift from rolling highway).
- As a result we increased the 2002/2015 growth of unaccompanied CT from 100% to 150%.

Cross section n° 6 (Tauern)

- Currently under-developed route which is due to become more important for unaccompanied CT. While, for the time being, competitive intermodal services are hardly supplied, this will change owing to the following effects: infrastructure improvements in Italy Tarvisio-Udine ; North East Italy and Slovania as major economic growth poles ; shortest route between post-Yugoslavian countries and countries North of Alps.
- After the factual abandonment of the eco-point system, the Austrian administration is supposed to seize major other actions to restrict the volume of road transit through Austria (technical and driver controls ; increased road tolls etc.).
- As a result we increased the 2002/2015 growth of unaccompanied CT from 100% to 200% considering that 2002 volume was close to marginal.

Cross section n° 7 (Passau)

- This route was completely underestimated in the 1st prognosis with a 50% growth 2002/2015. This was mainly due to the extrapolation of today's small volumes on links, which should become more important for unaccompanied CT services in a medium-term perspective, e.g. ARA sea ports – Austria/Hungary/Romania, Germany - Hungary/Romania/Turkey.
- Again the road transit through Austria will be subject to certain restrictions.
- As a consequence, a 2002/2015 increase of unaccompanied CT by 150% appears to be feasible.

Cross section n° 9 (Brno)

- Integration of volumes the links between German sea ports and Hungary in particular, mistakenly allocated to cross section n° 8.
- This route may be a good alternative for Scandinavia-South East Europe. It provides for a lot of free capacity compared to German and Austrian networks.
- The first prognosis of a 55% growth in the 2002/2015 period cautiously was augmented to 100%.

Cross section n° 11 (Malmö)

- Even though unaccompanied CT already has gained a comparatively good market position on the corridor with Scandinavia, market investigations recently carried through by Baltic Sea ports and intermodal operators affected, show that there is a vast potential for CT services both via ferry or the Danish landbrige.
- Even if now we assume a doubling of unaccompanied CT in the 2002/2015 period, instead of a 63% growth initially, this will leave a large market potential untouched.

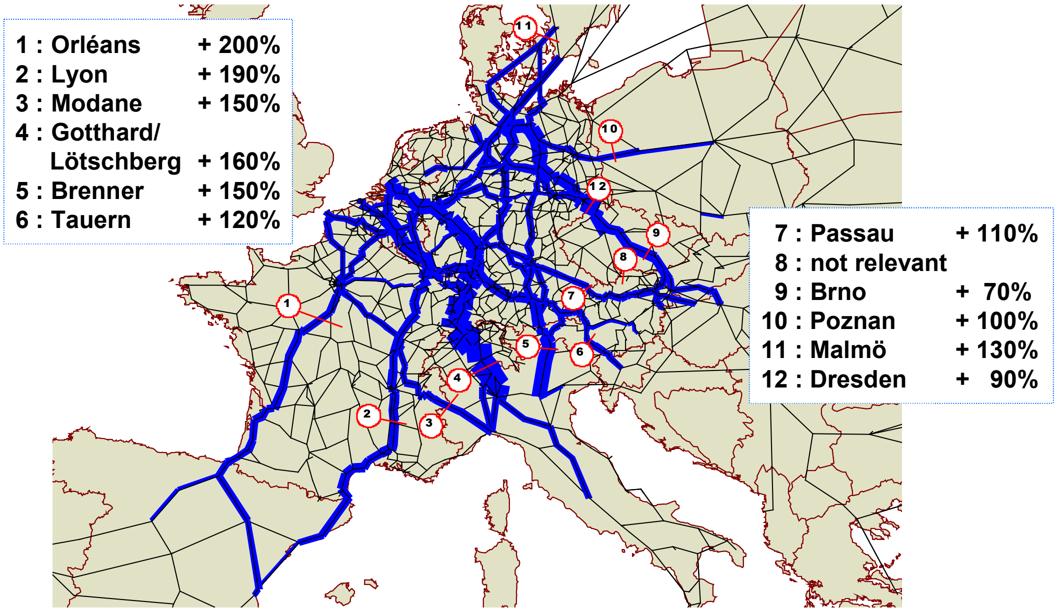
Cross section n° 12 (Dresden)

- This section relates to practically the same flows like n° 9. So it's reasonable to align both prognosis values to 100%.

Summary

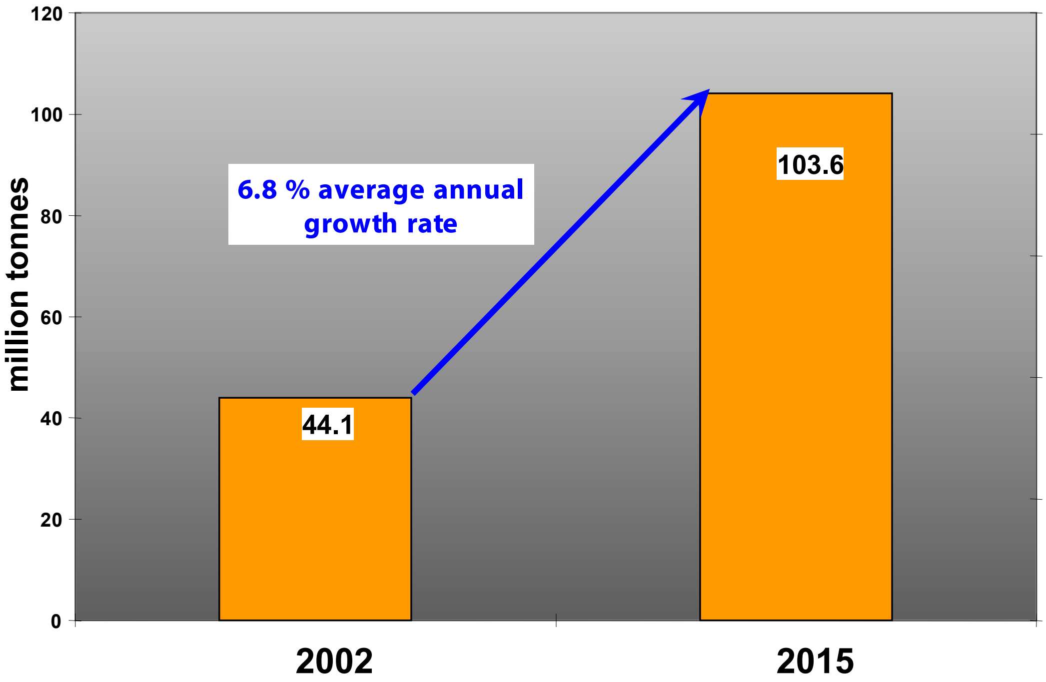
The modified values entered into the generation of new O/D matrices of unaccompanied CT in the year 2015. To achieve a consistent data base over the entire European network of links, the corridor-related growth rates had to be adapted again if, otherwise, they produced logical contradictions. Figure 3.2 gives an overview of the growth (in percent) on the different cross sections.

Figure 3.2: Corridor-specific growth of international CT on cross sections



Finally, the process resulted in a second prognosis of unaccompanied CT by the year 2015. Total volume is forecasted at 104 million tonnes now, which means a 60 million tonnes increase (+136%) compared to 2002 (cf. Figure 3.3).

Figure 3.3: Prognosis of 2015 unaccompanied CT (in tonnes)



3.2 Accompanied combined transport

Accompanied combined transport, as we know it, is an instrument of environmentally-oriented transport policy, as a matter of priority. Therefore the existence of rolling highway services, to a large extent, is dependent on restrictions of international road transport and/or major financial support. The Alps states of Austria and Switzerland particularly are eager or even compelled by legal provisions to achieve a traffic shift from road to rail, and in so far basically pursue a policy to promote accompanied CT if their objectives can't be realized by unaccompanied CT.

As long as those accompanied-CT-friendly framework conditions are not subject to a change this CT system is due to be maintained or even extended. Against this background we considered it useful, prior to the forecast of the 2015 volume, developing an interim prognosis for the year 2006. For the planning period of both the Austrian Ministry of Transport (BMVIT) and the Swiss Federal Office of Transport (BAV) provide indications on the number of "politically wanted" and therefore subsidized places on transalpine routes, and the Donau axis. Anything similar for 2015 doesn't exist yet.

3.2.1 2006 interim prognosis

The 2006 prognosis of the volume of accompanied CT (cf. Table 3.2) took account of the following data material and market intelligence:

- For the rolling highway services affecting Austria, ÖBB has designed a comprehensive concept. We copied the forecasted volume of trucks per service, and calculated the frequency of weekly departures from the total number of trains given. When we found consolidated data for two existent rolling highway services we distributed the volume according to the 2002 percentage share.
- The Swiss document gave distinguished data for the Lötschberg and the Gotthard route which could be easily adapted for our purposes.
- As regards the AFA/Modalohr Aiton-Orbassano service, we took the 50,000 trucks objective from documents issued for the public. According to them this service has a capacity of 18 complete trucks per train. If they operated this service only for unaccompanied semitrailers the capacity would be 28.
- The funding of the Dresden–Lovosice service is scheduled to be stopped with opening of the new motorway Dresden–Praha. However, service is likely to be suspended prior to that date, since owing to the liberalisation of road transport for CEE countries as of May 2004 the customer base of this service is due to dissolve.
- We've got no planning information for the Ljubljana-Szeged service, which anyway is out of the UIC corridors. So we assumed a certain increase of departures on our own expertise.

According to these assumptions the total number of trucks would almost double compared to the 2002 record and raise to 1.055.090 in 2006. We calculated a total net tonnage of some 20 million tonnes, supposing – as for 2002 - an average payload of 19 tonnes per road vehicle.

Table 3.2: Prognosis of 2006 accompanied combined transport compared to 2002 actual volume

Rolling highway service	2002 - actual volumes				2006 - planning			
	cap/ dep	dep/ week	n° of trucks	net tonnage	cap/ dep	dep/ week	n° of trucks	net tonnage
(a)	(b)	(c)	(d)	(e)=(d)x(3)	(f)	(g)	(h)	(i)=(h)x(3)
Aiton - Orbassano	--	0	0	0	18	72	50.000	950.000
Sub-Total Modane			0	0			50.000	950.000
Freiburg - Novara	19	84	44.536	846.000	25	176	178.500	3.391.500
Freiburg - Lugano	20	10	5.860	111.000	20	10	10.030	190.570
Basel - Lugano	20	10	10.852	206.000	20	10	10.030	190.570
Singen - Milano	20	10	9.122	173.000	20	16	10.030	190.570
Sub-Total Gotthard/Lötschberg			70.370	1.336.000			208.590	3.963.210
Manching - Brenner	18	186	115.360	2.192.000	18	186	148.500	2.821.500
Wörgl - Verona	21	34	26.642	506.000	21	72	62.790	1.193.010
Wörgl - Bolzano	21	10	1.000	19.000	21	40	35.000	665.000
München - Bolzano	21	10	500	10.000	21	40	35.000	665.000
Wörgl - Trento	21	40	32.600	619.000	21	82	73.710	1.400.490
Sub-Total Brenner			176.102	3.346.000			355.000	6.745.000
Salzburg - Palmanova	--	0	0	0	21	16	11.000	209.000
Salzburg - Ljubljana	16	34	20.015	380.000	18	36	29.000	551.000
Wels - Maribor	17	50	23.013	437.000	17	116	86.500	1.643.500
Wels - Villach	18	96	77.070	1.464.000	18	122	100.000	1.900.000
Sub-Total Tauern/Phyrn			120.098	2.281.000			226.500	4.303.500
Wels - Sopron	22	70	53.082	1.009.000	22	118	108.000	2.052.000
Wels - Szeged/Arad	22	56	51.933	987.000	22	68	65.000	1.235.000
Wels - Budapest	--	0	0	0	22	38	34.000	646.000
Sub-Total Donau			105.015	1.996.000			207.000	3.933.000
Ljubljana - Szeged	18	6	2.756	52.000	18	12	8.000	152.000
Dresden - Lovosice	23	90	72.510	1.378.000	--	0	0	0
TOTAL	**19**	**796**	**546.851**	**10.389.000**			**1.055.090**	**20.046.710**

<u>**Assumptions**</u>

(1) Period of operations p.a:	**48 weeks**	
(2) Capacity load factor 2015:	**85 %**	(2002: Gotthard/Simplon: 75%, Brenner: 89%)
(3) Net-Tonnage per shipment (truck):	**19 tonnes**	(2002: Gotthard: 19,7; Simplon: 15,3; Brenner: 18,6)

3.2.2 2015 prognosis

In order to make a reasonable prognosis different approaches are possible - extrapolation, or scenario technique. An extrapolation forecasts the future development by perpetuating past trends into the future. Such historic data is available for the services offered by UIRR-companies, only. Extrapolation, however, can't hardly take into account a changing framework or market trends. As mentioned above, the offer and use of rolling highways is depending on politically articulated desire, in particular to shift “harmful” road transit traffic to rail. In the past a set of push (driving restrictions) and pull (funding of intermodal infrastructures and services) measures has been inaugurated to facilitate this aim.

Considering the imponderabilities of economic and financial policy in a volatile global economy and a politically difficult environment we regarded an extrapolation less useful than the design of two sets of framework conditions (scenarios) for the development of European accompanied CT. We designated the scenarios as “Scenario 1: status quo (beneficial framework)” and a conservative “Scenario 2: reduced framework condition”.

Scenario 1 is almost a copy of the 2006 set of accompanied CT services. So it assumes that all countries involved will be able to maintain their beneficial framework on accompanied CT. Alternations compared to the 2006 planning framework conditions are as follows:

- AFA/Modalohr Aiton-Orbassano service: an official prognosis says that this service is to be extended to carry up to 300,000 trucks p.a.. This would result in a tremendous number of 434 departures weekly, or more than one train each hour both ways.
- Switzerland: latest by the opening of the Gotthard base tunnel train length should be expanded and accommodate for 25 places.
- Austria: also for the rolling highway services affecting we assume a general train capacity of 25 trucks except of the Manching-Brenner service, since an extension of the tracks at the Brenner seems to be extremely difficult.
- We expect that the capacity load factor may raise to an average of 85%.

The second conservative “reduced framework condition” scenario is characterised as follows:

- Increasingly, budget restrictions in all countries involved leading to a reduction and focusing of subsidies
- Basically no quotas on road operators coming from EC member countries (Eco-point system abandoned)
- Further EC enlargement: quota-free transit of trucks from new Member States
- Qualitative restrictions on road transport, in particular in Austria and Switzerland (traffic control, inspection of weight and social standards)
- Increased road tolls on motorways and tunnels
- Focus on few but high frequency services to attract clients: generally we assume a frequency of one train every three hours both ways.
- Increased capacity load factor due to higher frequency and quality
- Accompanied CT services maintained which provide for an excellent bundling opportunity, acceptable rail operation cost, and value to truckers (Brenner by-pass, resting period on rail, weight limitations, or similar)

The results of the two scenarios are presented in Table 3.3. According to that the "beneficial framework" scenario estimates a total of 1,442,000 lorries resp. 27.4 million tonnes of goods. This would mean another increase compared to 2006 and a plus of 900,000 trucks compared to 2002 (+165%), corresponding to an average annual growth rate 2015/2002 of 7.7%.

In the "reduced framework" scenario we also foresee a certain modification of rolling highway services which, on the changed framework, we considered more reasonable. In total, this scenario results in a prognosis of 652,000 trucks resp. 12.4 million net tonnes. Even though this would mean a decline of 403,000 vehicles (-38%) against 2006, compared to 2002 the volume of accompanied CT would have grown by 19%. The average annual growth rate 2015/2002 would amount to 1.4%.

A preliminary result was presented to the Interunit Technical Committee which proposed to outline a more conservative scenario and an agreement with intermodal operators. The present final scenario result has been agreed upon and was assessed to be "realistic". Most recent (2003/04) developments on the RoLa through Austria seem to support the conservative assumptions. A graphical presentation of the results is shown in Figure 3.4

Figure 3.4 Prognoses of international accompanied CT by 2015

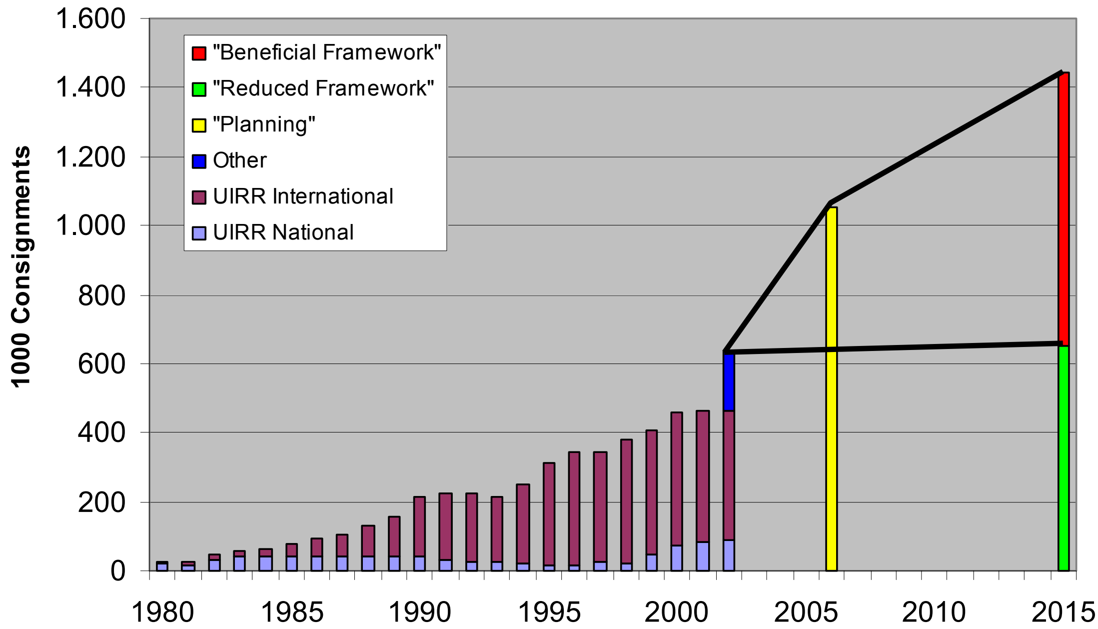


Table 3.3: Prognosis of International Accompanied Transport 2015

Rolling highway service (2002)	2002 - actual volumes				2015 - prognosis								Scenario 2: modified rolling highway services 2015
					Scenario 1: status quo/beneficial framework				Scenario 2: reduced framework conditions				
	cap/ dep	dep/ week	n° of trucks	net tonnage	cap/ dep	dep/ week	n° of trucks	net tonnage	cap/ dep	dep/ week	n° of trucks	net tonnage	
(a)	(b)	(c)	(d)	(e)=(d)x(3)	(k)	(l)	(m)=(k)x(l)x(1)x(2)	(n)=(m)x(3)	(o)	(p)	(q)=(o)x(p)x(1)x(2)	(r)=(q)x(3)	(s)
Aiton - Orbassano	--	0	0	0	18	434	300.000	5.700.000	18	112	82.000	1.558.000	Lyon - Torino
Sub-Total Modane			0	0			300.000	5.700.000			82.000	1.558.000	
Freiburg - Novara	19	84	44.536	846.000	25	176	180.000	3.420.000	25	112	114.000	2.166.000	Freiburg - Novara
Freiburg - Lugano	20	10	5.860	111.000	25	10	10.000	190.000			0	0	Freiburg - Lugano
Basel - Lugano	20	10	10.852	206.000	25	10	10.000	190.000			0	0	Basel - Lugano
Singen - Milano	20	10	9.122	173.000	25	16	16.000	304.000			0	0	Singen - Milano
Sub-Total Gotthard/Lötschberg			70.370	1.336.000			216.000	4.104.000			114.000	2.166.000	
Manching - Brenner	18	186	115.360	2.192.000	20	186	152.000	2.888.000	25	112	114.000	2.166.000	Manching - Bolzano
Wörgl - Verona	21	34	26.642	506.000	25	72	73.000	1.387.000			0	0	Wörgl - Verona
Wörgl - Bolzano	21	10	1.000	19.000	25	40	41.000	779.000			0	0	Wörgl - Bolzano
München - Bolzano	21	10	500	10.000	25	40	41.000	779.000			0	0	München - Bolzano
Wörgl - Trento	21	40	32.600	619.000	25	82	84.000	1.596.000	25	112	114.000	2.166.000	Wörgl - Trento
Sub-Total Brenner			176.102	3.346.000			391.000	7.429.000			228.000	4.332.000	
Salzburg - Palmanova	--	0	0	0	25	16	16.000	304.000		0	0	0	Salzburg - Palmanova
Salzburg - Ljubljana	16	34	20.015	380.000	25	36	37.000	703.000	25	112	114.000	2.166.000	Salzburg - Ljubljana/Villach
Wels - Maribor	17	50	23.013	437.000	25	116	118.000	2.242.000			0	0	Wels - Graz
Wels - Villach	18	96	77.070	1.464.000	25	122	124.000	2.356.000		0	0	0	Wels - Villach
Sub-Total Tauern/Phyrn			120.098	2.281.000			295.000	5.605.000			114.000	2.166.000	
Wels - Sopron	22	70	53.082	1.009.000	25	118	120.000	2.280.000			0	0	Wels - Sopron
Wels - Szeged/Arad	22	56	51.933	987.000	25	68	69.000	1.311.000	25	112	114.000	2.166.000	Wels - Arad
Wels - Budapest	--	0	0	0	25	38	39.000	741.000		0	0	0	Wels - Budapest
Sub-Total Donau			105.015	1.996.000			228.000	4.332.000			114.000	2.166.000	
Ljubljana - Szeged	18	6	2.756	52.000	25	12	12.000	228.000		0	0	0	Ljubljana - Szeged
Dresden - Lovosice	23	90	72.510	1.378.000	--	0	0	0	--	0	0	0	Dresden - Lovosice
TOTAL	**19**	**796**	**546.851**	**10.389.000**			**1.442.000**	**27.398.000**			**652.000**	**12.388.000**	

Assumptions

(1) Period of operations p.a: **48 weeks**

(2) Capacity load factor 2015: **85 %**

(3) Net-Tonnage per shipment (truck): **19 tonnes**

4. Infrastructure capacity needs

4.1 Conversion of goods flows 2002 into train flows

The result of the working phases described so far were matrices of goods flows in tonnes; differentiated by:

- International combined transports
- Rail transports (national combined and conventional)

The aim of this step is to convert goods flow matrices into train matrices via different model steps using different parameters described in tables 4.1 – 4.3 below. Scheme 4.1 describes the different model steps applied.

Figure 4.1: Model steps

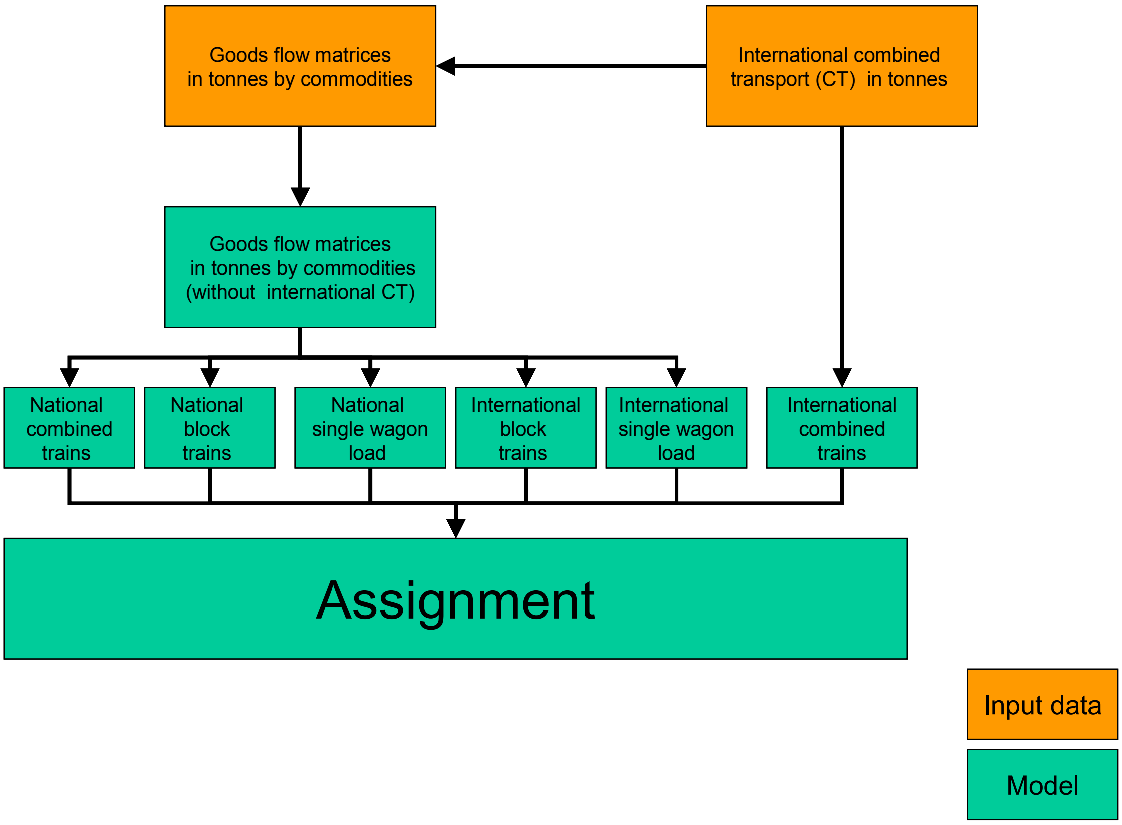


Table 4.1: Parameters for intermodal block trains (national and international)

Parameter	Value	Exceptions
Maximal train length	700 m	Italy: 550 m Domodossola – Novara 450 m Portugal: 400 m Spain: 550 m
Maximal train gross weight	1,500 tonnes	Italy 1,300 tonnes Portugal: 400 m Spain: 550 m
Length per wagon	20 m	
Average use of capacity in % of the total capacity per train	70 %	

Table 4.2: Parameters for conventional block trains

Parameter	Value	Exceptions
Maximal length per train	700 m	Italy: 550 m Domodossola – Novara 450 m Portugal: 400 m Spain: 550 m
Maximal gross weight per train	1,500 tonnes	Italy 1,300 tonnes Portugal: 400 m Spain: 550 m
Average use of capacity	400 – 1,000 net tonnes (Differentiated by commodities)	
Empty runs	50 %	

The transport volumes in the O/D matrice are only shipped in block trains, if the volume is high enough for at least one block train per day (280 days per year). Volumes less than this threshold value were transferred into the single wagon matrices.

Table 4.3: Parameters for single wagon load

Parameter	Value	Exceptions
Maximal length per train	700 m	Italy: 550 m Domodossola – Novara 450 m Portugal: 400 m Spain: 550 m
Maximal gross weight per train	1,500 tonnes	Italy 1,300 tonnes Portugal: 400 m Spain: 550 m
Average use of capacity per wagon	17 – 41 tones (Differentiated by commodities)	

In the case of single wagonload traffic, the share of empty wagons per train is dependent on the non-equilibrium of goods flows. Thus, the resulting share is an average of 42 % of empty wagons per train.

As a result table 4.4 presents the number of freight trains to be assigned on the European network in 2002.

Table 4.4: Number of trains in the year 2002 by type of train

Type of train	Trains 2002
International combined transport	58,500
National combined transport	38,000
International conventional trains	444,100
National conventional trains	3,754,600
Total	4,295,200

4.2 Conversion of goods flows 2015 into train flows

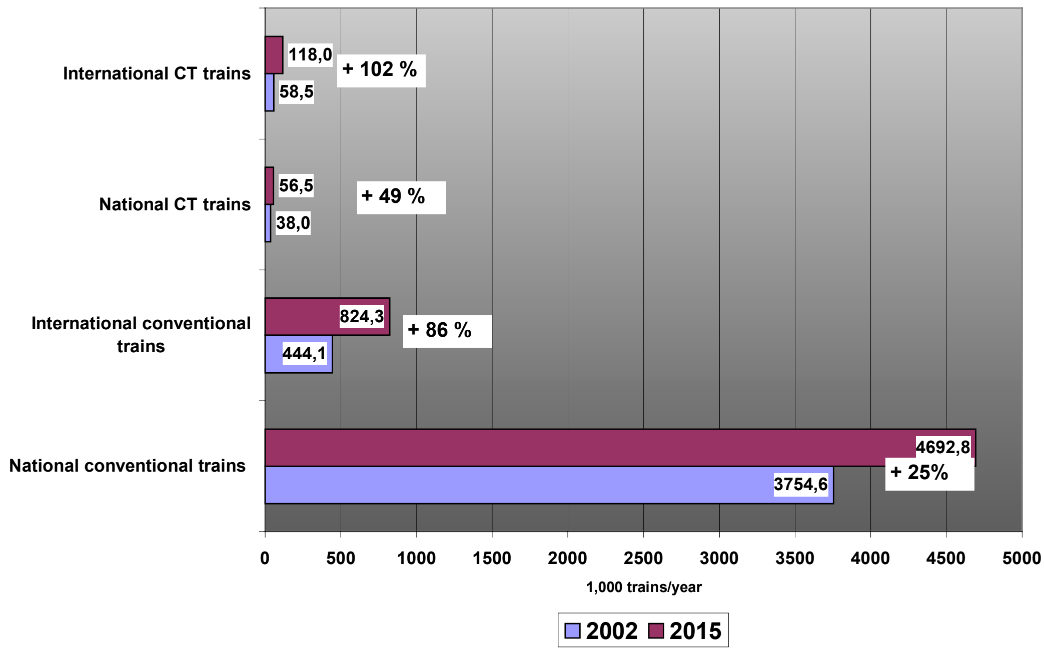
The same model was used to estimate the number of trains in 2015. Productivity gains of the railway system were integrated on the basis of the following assumptions:

- A general maximum length per train of 750 m in 2015
- A general maximum gross weight per train of 1,500 tonnes in 2015
- An average load factor on combined trains of 80 %.

It is obvious that these assumptions are relatively optimistic and that, to achieve this, strong efforts have to be made by all actors involved (infrastructure managers, railway undertakings, intermodal operators).

The prognosis of transport volumes for 2015 in combination with the assumptions mentioned above point to an expected increase in the number of trains as presented in figure 4.2.

Figure 4.2: Development of the number of trains per year 2002/2015 by type of train



The total number of trains per year is expected to rise by 33 % from 4,295,200 to 5,691,600. When investigating this global figure, it becomes obvious that

- international movements will witness a considerably higher growth than national traffic, which is due to a growing European integration and the resulting increase in international goods transports,
- international combined transport has the highest growth (+ 102 %),
- the growth of national combined transport is nearly double the national conventional traffic (+49 %/+25 %)

4.3 Methodologies of assignment on the networks 2002 and 2015

In the next working phase the train flows were assigned on the networks. In a first step the network model (see figure 1.1) had to be „pre-charged“ with passenger trains on each section.

Passenger trains

The number of long distance passenger trains per section was based on observed data of timetables. Concerning regional passenger trains, on some axis observed data were available, too. On other axis the number of movements was estimated based on the following assumptions:

- One regional passenger train per hour and per direction between 6:00 und 18:00 (= 12 trains per day and direction).
- Two regional passenger train per hour and per direction between 6:00 und 18:00 on main axis along densely populated areas (= 24 trains per day and direction).
- It is clear that on a European network model, it is not possible to model all passenger train movements in big conurbations, like for example Paris, Berlin, Rhine-Ruhr area, since services like “S-Bahn” or “RER” using mostly separate tracks.

Prognosis of passenger trains

- The number of long distance passenger trains in 2015 was estimated on the base of a UIC study.
- Following a “ceteris-paribus” assumption for the year 2015, the number of regional trains was assumed as constant.

Accompanied CT (rolling highway)

Rolling highway services were also treated as a “pre-charge” of the network sections. Table 3.3. in chapter 3 indicates the number of departures per week, which were converted in departures per day by dividing by 7 days per week.

4.4 Calibration of the assignment results

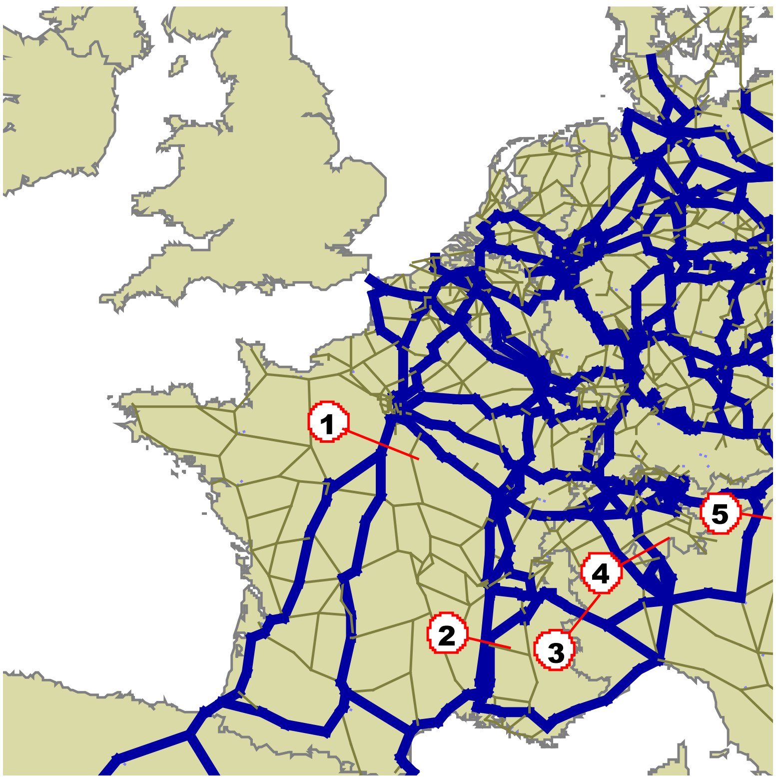
In a next step freight trains were assigned on the pre-charged network. Following that, the 2002 assignment was calibrated on the most important axes. The bases of these calibrations were countings of freight trains from different sources (operators, capacity studies on distinct axes). The following table 4.5 presents the results of the calibration step.

Table 4.5: Result of calibration

	Observed freight trains per day	Model Results
Cross section 1	87	89
Cross section 2	111	108
Cross section 3	80	78
Cross section 4	170	163
Cross section 5	95	100

Figure 4.3 below presents the cross sections referred to table 4.5

Figure 4.3: Cross sections for the calibration



To conclude, one can say that, given the normal model deviations, the calibration results are very good for these five cross sections. For the other cross-sections (6-12) no countings were available.

Another calibration step was the comparison with an independent prognosis published by the UIC Infrastructure Group. Figure 4.4 gives an overview of the results of this comparison.

Figure 4.4: Comparison of the results with the UIC Infra prognosis

	Scenario	2001 (billion tkm)	2020 (billion tkm)	Average annual growth rate (% per year)
UIC- Infra	Conservative	258,0	400,0	2,3
	Medium	258,0	500,0	3,5
	High	258,0	750,0	5,8
UIC- GTC		2002	2015	
		284,2	423,7	3,2

It becomes obvious that two independent prognosis comes to very coherent results and this in terms of absolute figures (tonnes-kilometres "tkm") and average annual growth rates.

To conclude, one can say that

- the actual network load with freight trains is represented very exactly by the model and
- that the prognosis for 2015 leads to very reasonable results, within the frame of other comparable prognosis.

4.5 Data base

The final result of these model works is a complete data base that provides for each of the nearly 3,000 sections of the European rail network model the following information (table 4.6) **for the base year 2002 and the forecast horizon 2015**:

Table 4.6: Structure of the data base

1. Network parameters	1.1	Name of start node of the section
	1.2	Name of end node of the section
	1.3	Number of tracks
	1.4	Electrification
2. Passenger trains	2.1	Number of long distance passenger trains per day and direction
	2.2	Number of regional passenger trains per day and direction
3. National freight trains	3.1	Number of national single wagon load trains per day and direction
	3.2	Number of national block trains per day and direction
	3.3	Number of national intermodal trains per day and direction
4. International freight trains	4.1	Number of international single wagon load trains per day and direction
	4.2	Number of international block trains per day and direction
	4.3	Number of international intermodal trains per day and direction
5. Capacity parameters	5.1	Theoretical capacity per direction
	5.2	Use of capacity (total of lines 2.1 to 4.3)
	5.3	Use of capacity in relative figures (5.2/5.1x100)
	5.4	Use of capacity in absolute figures (5.2 – 5.1)

The data base will be provided under excel format. For further use, this allows for more detailed analysis in the case if more precise or observed data (e.g. number of passenger trains, real capacity) is available for specific sections.

4.6 Methodology of capacity analysis

Capacity limits in 2002

From the beginning of the study it was clear that the determination of network capacities on a European level could only be done by using standardized capacity limits. From different studies (DBAG, RFF, SNCF), a capacity limit of

144 movements (passenger and freight) per day and direction
on a double tracked electrified line

seemed to be a reasonable base assumption. It has to be clearly said that this assumption is based on **movements** and not on (theoretical) **train paths**.

Based on this limit, which represents a 100 % use of capacity the following figure 4.5 gives different loading stages for different loads for the year 2002:

Figure 4.5: Capacity limits 2002 (movements per day and direction on a double tracked electrified line)

> 100%	2002: > 144 trains per day and direction
85% - 100%	122 - 144
70% - 84%	86 - 121

Capacity limits in 2015

For the forecast horizon 2015 a growth of the average network capacity of 20 % has been assumed for 2015. This is due to

- shorter block distances,
- improved operational/signalling systems,
- bi-directional traffic.

This assumption, which is again relatively optimistic, leads to the following capacity limits (cf. figure 4.6)

Figure 4.6: Capacity limits 2002 (movements per day and direction on a double tracked electrified line)

> 100%	2015: > 173 trains per day and direction
85% - 100%	147 - 173
70% - 84%	103 - 146

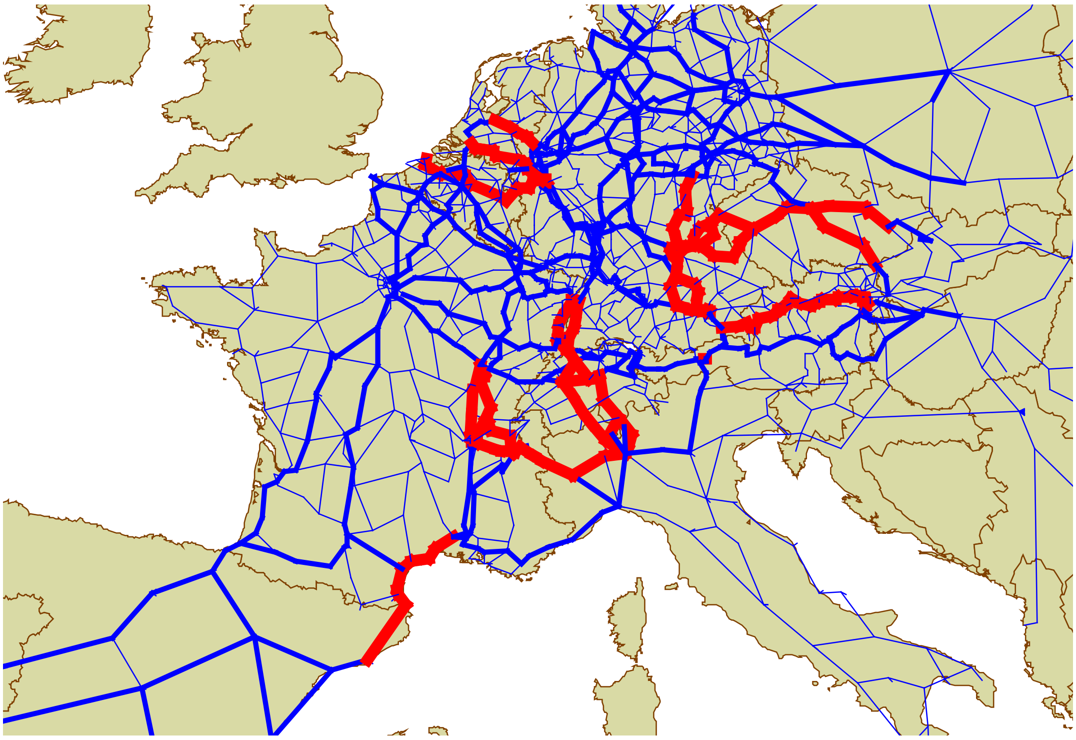
4.7 Infrastructure investments

For the determination of capacity shortcomings in the year 2015 a review of infrastructure investment plans had to be done. In principal the following investment plans were taken into account ("planned investments"):

- In Germany the actual "Bundesverkehrswegeplan"
- In Fran**ce**: Audit sur les grands projets d'infrastructures de transport
- In **Switzerland**: Bahn 2000 (Phase 2), NEAT

In **other countries** national investment programmes were taken into account. Figure 4.7 gives an overview of these "planned investments".

Figure 4.7: "Planned" investments until 2015 in the European rail network (links marked in red)



While collecting respective data on planned infrastructure investments, for the most of these investments it became obvious that they are more or less uncertain as regards their realisation until the forecast horizon 2015.

Consequently, we decided to analyse the infrastructure capacity **on three levels**

- **Level 1**
  The 2015 flows were assigned on the 2002 network („reference situation"). This **„theoretical" situation** shows the capacity lacks on the European network under the assumption that **no further investment in the rail network would be made**.

- **Level 2**
  In a next step the 2015 matrices (trains) were assigned on a 2015 network, where all "planed" investments (cf. figure 4.7) or under construction at present have been integrated.

- **Level 3**
  On this third level the remaining infrastructure capacity shortcomings were pointed out and respective measures are recommended.

In the following chapter 5 the results of this analysis are presented corridor by corridor.

5. Infrastructure needs by corridors

5.1 Determination of corridors

The starting point of this capacity analysis were the 18 European railway corridors defined in the terms of reference (cf. table 5.1).

Table 5.1 Corridors defined in the terms of reference

	Corridor	Via…
1	Benelux, Germany, Switzerland, Italy	
2	Benelux, France, Switzerland, Italy	Bettembourg/Athus, Metz, Basel
3	Benelux, France, Italy	Bettembourg/Athus, Metz Modane
4	Benelux, France, Italy	Paris, Modane
5	Scandinavia, Germany, Austria Italy	
6	Germany, Poland	
7	Benelux, Germany, Czech Republic, Slovakian Republic	
8	Benelux, France, Spain	Paris, Bordeaux, Hendaye
9	Benelux, France, Spain	Paris, Dijon, Lyon, Cerbère
10	Germany, France, Spain, Portugal	Cerbère and Hendaye
11	France, Germany, Austria, Hungary	Le Havre/Forbach or Paris/ Basel
12	France, Hungary	Switzerland
13	United Kingdom, France, Spain	Cerbère or Hendaye
14	United Kingdom, France, Germany, Austria, Hungary	Calais, Metz or Forbach
15	United Kingdom, France, Italy	Paris or Metz or Modane
16	United Kingdom, France, Switzerland, Italy	Metz, Strasbourg or Basel
17	United Kingdom, France, Belgium, Germany, Switzerland, Italy	
18	Italy, France, Spain	Modane or Vintimille /Cerbère or Hendaye

In a first working stage the 18 corridors above were concretised in the rail network model to the itineraries used by intermodal services. Since a considerable part of the corridors overlap, it was possible to aggregate these 18 corridors to 9 consolidated corridors as defined in table 5.2 below.

Table 5.2: Consolidated corridors

N°	Corridor
1	Benelux/Germany ⇔ Switzerland ⇔ Italy
2, 3, 4, 15, 16, 17	United Kingdom ⇔ Benelux ⇔ France/Germany/Switzerland ⇔ Italy
5	Scandinavia ⇔ Germany ⇔-Austria ⇔ Italy
6	Germany ⇔ Poland
7	Benelux ⇔ Germany ⇔ Czech Republic ⇔ Slovakian Republic
8, 9, 10, 13	Benelux/Germany ⇔ France ⇔ Spain/Portugal
11, 14	United Kingdom ⇔ France/Germany ⇔ Austria ⇔ Hungary
12	France ⇔ Switzerland ⇔ Austria ⇔ Hungary
18	Italy ⇔ France ⇔ Spain

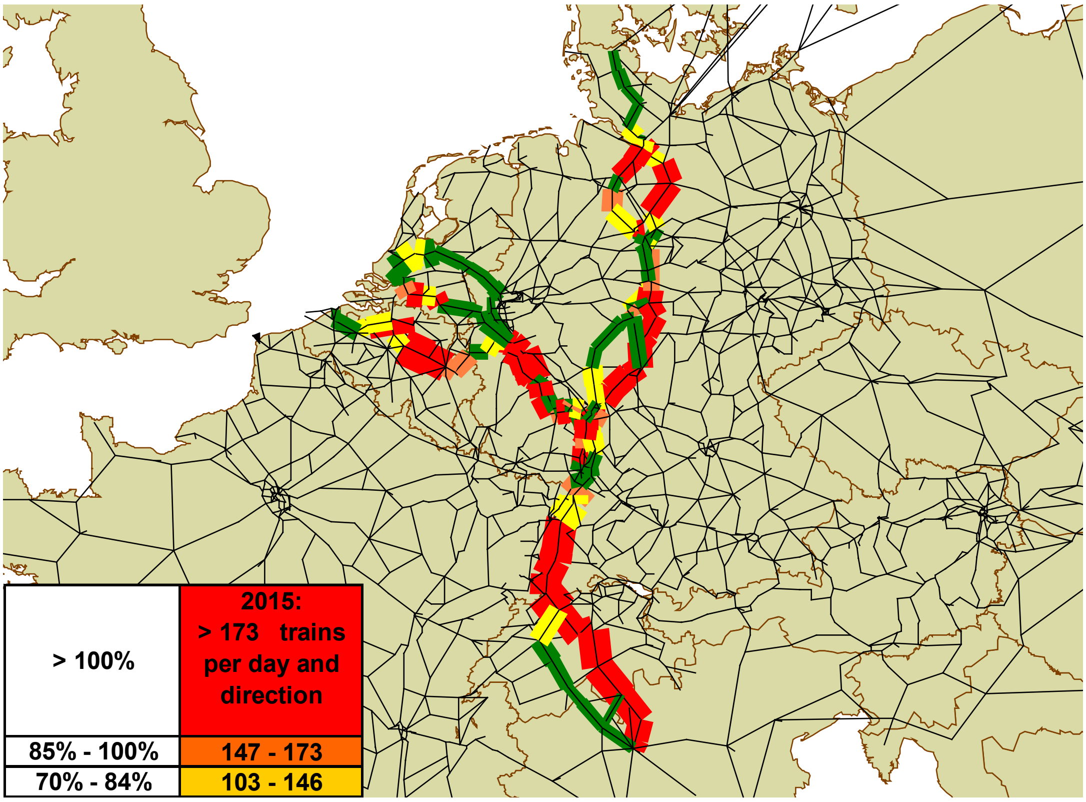
In the following chapters for each of the 9 consolidated corridors the following information are presented:

- The utilisation of capacity and capacity overloads in the year 2015 under the assumption that no further infrastructure investments were carried out. This reflects the situation "level 1" as described in chapter 4.7 above.
- The planned infrastructure investments on the corridor
- The utilisation of capacity and capacity overloads after the planned infrastructure investments were carried out ("level 2" in chapter 4.7).
- For the sections where capacity is still lacking ("level 3", the capacity overload is analysed in detail and remedies to overcome the capacity overloads are proposed.

5.2 Corridor n°1 Benelux/Germany – Switzerland – Italy

Figure 5.1 presents the results of the capacity analysis on level 1 (without infrastructure investments)

Figure 5.1: Utilisation of capacity 2015 without further infrastructure investments on corridor n°1 Benelux/Germany – Switzerland – Italy



It is obvious that for most sections of this corridor the capacity is not sufficient, i.e. Utilisation of capacity of more than 100% (red sections), between 85 and 100% (orange) or between 70 and 84% (yellow), which can be interpreted as “capacity overloads at certain periods of the day” and “instability” of train paths for the latter.

Table 5.3 gives an overview of planned investments on this corridor.

Table 5.3: Planned investments on corridor n° 1

Projects
Beetuwje line
Amsterdam - Arnhem
Köln - Bruxelles
Offenburg - Basel
NEAT

Figure 5.2: Utilisation of capacity 2015 with planned infrastructure investments on corridor n°1 Benelux/Germany – Switzerland – Italy

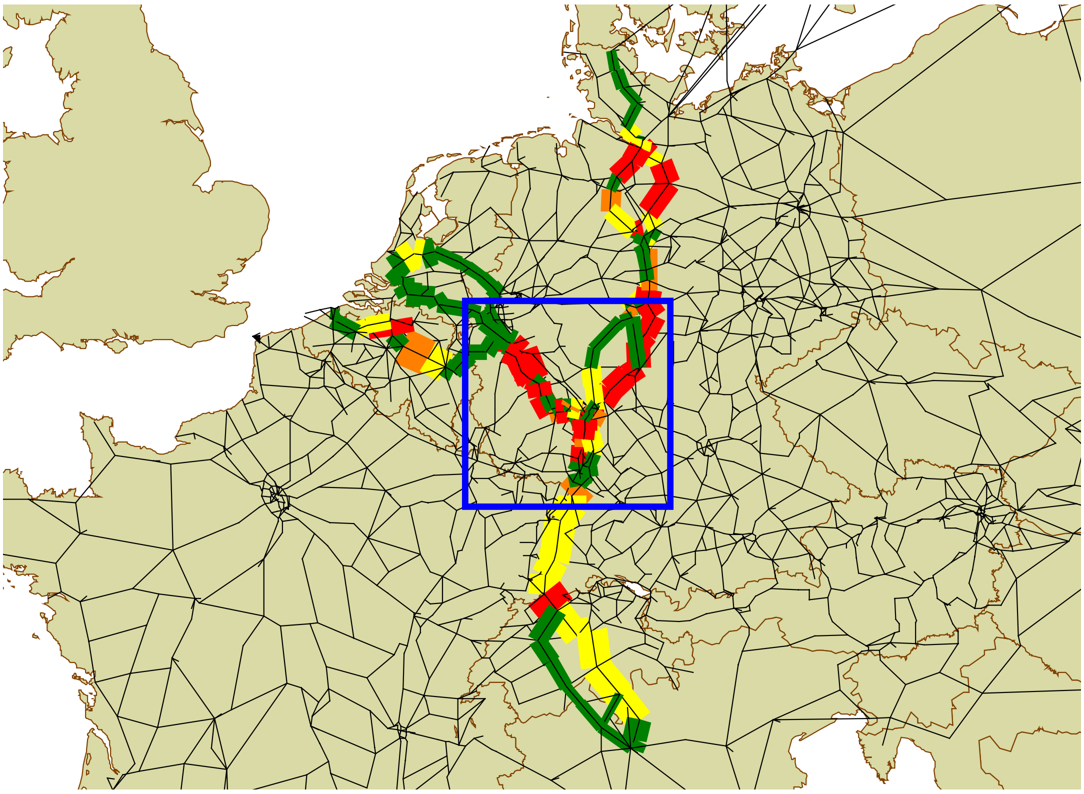


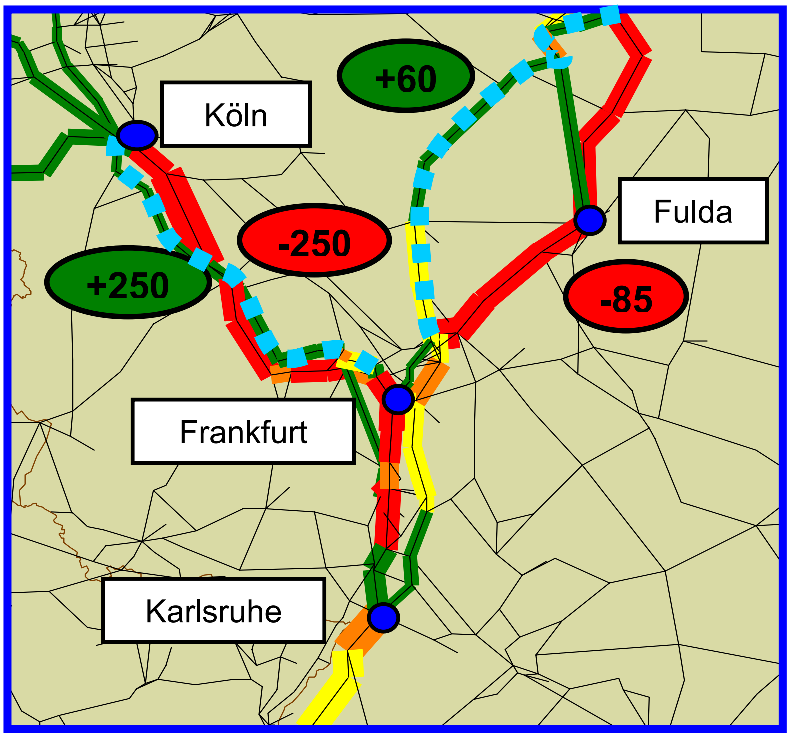
Figure 5.2 clearly shows that, even when the planned investments have been carried out, there is still a considerably high part of those sections where capacity is lacking. In particular, bottlenecks remain on the links between

- Hamburg – Hannover (in depth analysis in chapter 5.4)
- Göttingen – Karlsruhe,
- Bruxelles – Antwerpen, (in depth analysis in chapter 5.3)
- Köln – Frankfurt,
- and the Basel area (in depth analysis in chapter 5.3)

To analyse the capacity restriction and its remedies in more detail, the blue square in figure 5.2 represents a zoom on the Göttingen - Karlsruhe and Köln – Frankfurt axes (cf. figure 5.3).

After the results of the prognosis, between **Göttingen and Frankfurt** (via Bebra) occurs a lack of capacity of 85 trains/day (both direction) south of Fulda. On the parallel link via Kassel/Gießen (blue line) free capacity remains for 60 trains/day. It must be clearly pointed out that the deviation to the parallel line would mean that this would lead to a 100% Utilisation of capacity on this link. To remedy the capacity overload on these links, we propose an enforcement of the line between Göttingen and Frankfurt.

Figure 5.3: Utilisation of capacity 2015 on the Köln – Frankfurt and Göttingen – Frankfurt axis



Between **Köln and Frankfurt** (south of Köln) in the Rhine valley there are two parallel double tracked electrified lines. At present one line is dedicated more or less to passenger trains, the other one to freight trains and regional passenger train.

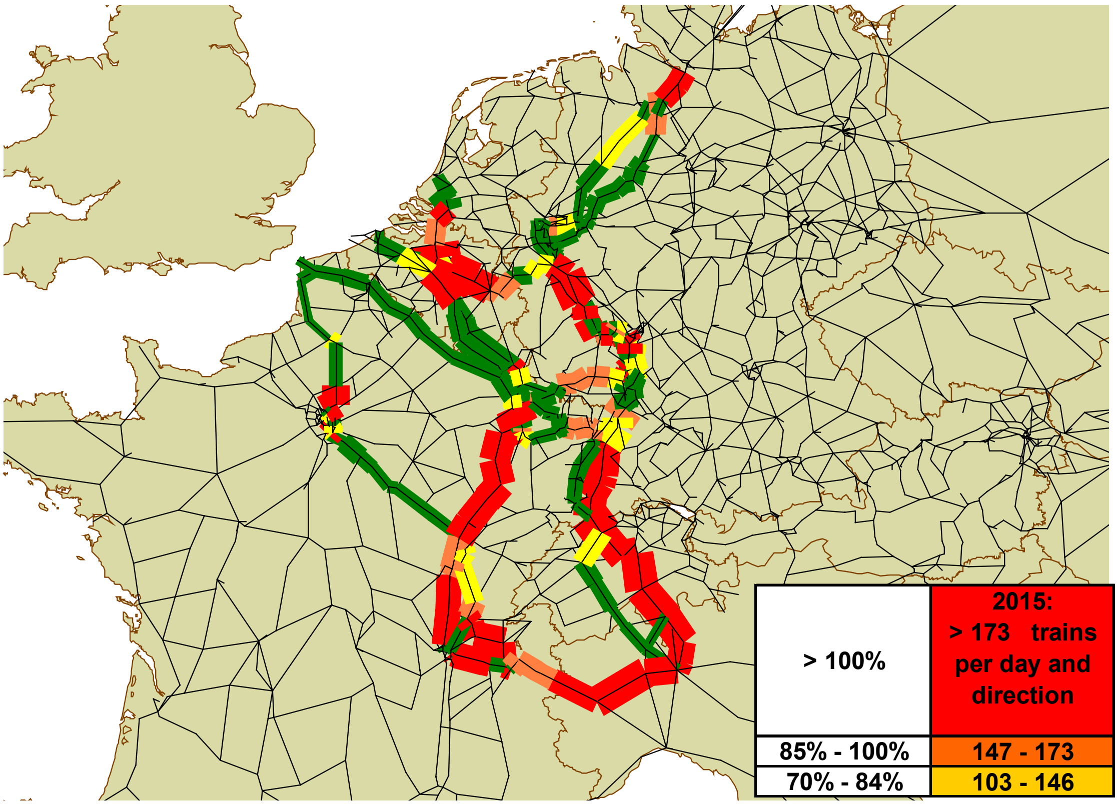
For the forecast horizon 2015 there will be, after this prognosis, a capacity overload of 250 trains/day (both directions). In theory, it would be possible to divert the trains to the line on the opposite side of the Rhine valley, where is free capacity of 250 trains/day. But regarding intermodal trains, this opportunity is limited, due to lauding gauge restrictions of less than P400 profile. Thus, to ensure a flexible use of both lines, the lauding gauge between Mainz and Köln has to be enforced.

The remaining capacity restrictions on this corridor (Hamburg – Hannover, Bruxelles – Antwerpen, the node of Basel) will be analysed in detail in section 5.3 and 5.4.

5.3 Corridors n° 2,3,15,16,17 UK ⬄ Benelux ⬄ France/Germany/ Switzerland ⬄ Italy

As a first step, figure 5.4 presents the results of the capacity analysis on level 1 assuming that no further infrastructure investment on this corridor would be carried out. Again, considerable parts of the network are overloaded. This is particularly true for the French, Italian and Belgium network, which proves the necessity of the investments which are partly only in the state of “projects” at present. Concerning the transalpine links in Switzerland, figure 5.4 represents of course a “theoretical” model situation, since the Lötschberg and Gotthard is under construction.

Figure 5.4: **Utilisation of capacity 2015 without further infrastructure investments on corridors n° 2,3,15,16,17 UK - Benelux - France/Germany/ Switzerland - Italy**



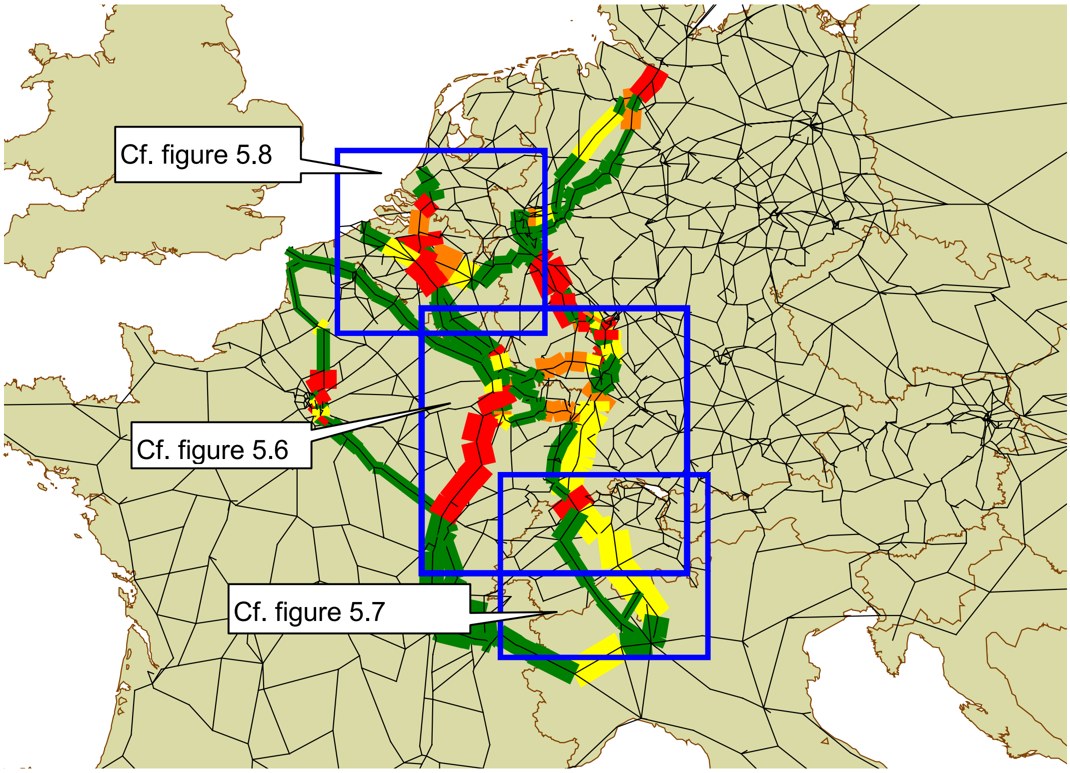
Again table 5.4 gives an overview of planned investments on this corridor.

Table 5.4: **Planned investments on corridors n° 2,3,4,15,16,17**

Projects
Amsterdam - Arnhem
Offenburg - Basel
NEAT
Rhin-Rhône (Sud)
Contournement de Lyon (Lyon bypass)
Lyon - Turino
Turino - Milano

Even under the relatively optimistic assumption that all investments mentioned in table 5.3 will be under operation in the year 2015, figure 5.5 presents again some considerable bottlenecks in the European rail network.

Figure 5.5: Utilisation of capacity 2015 with planned infrastructure investments on corridors n° 2,3,15,16,17 UK - Benelux - France/Germany/ Switzerland - Italy



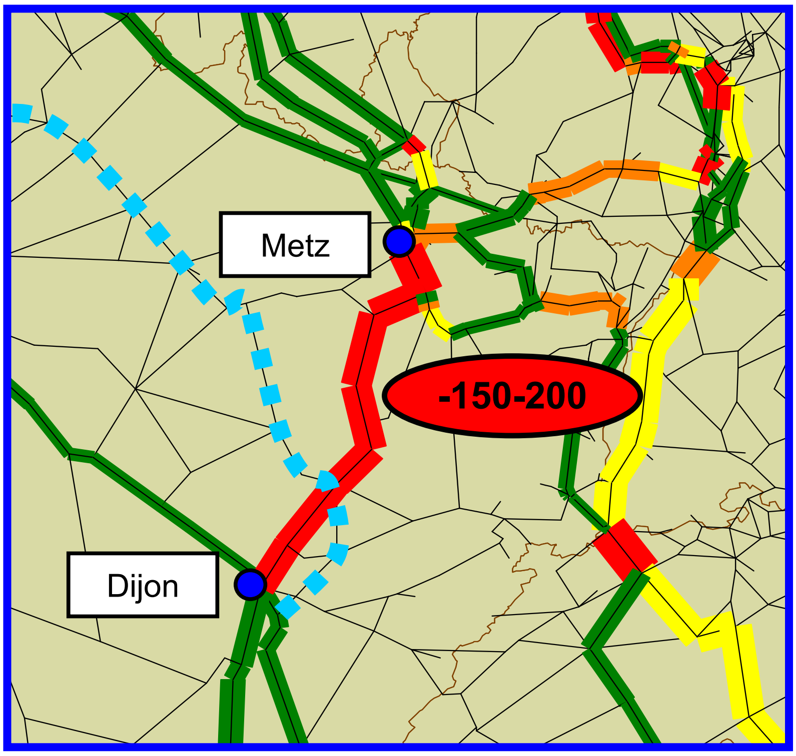
In particular,

- Hamburg – Bremen, (in-depth analysis in chapter 5.4)
- Antwerpen – Namur,
- Köln – Frankfurt (in-depth analysis in chapter 5.2),
- Metz – Dijon,
- and the Basel area

have to be mentioned.

The zoom in figure 5.6 shows in detail the link between Metz and Dijon in France. This line, which even today is one of the most loaded parts of the French railway network, will in the year 2015 be overloaded by 150 to 200 trains/day (sum of both directions).

Figure 5.6: Utilisation of capacity 2015 on the Metz – Dijon axis



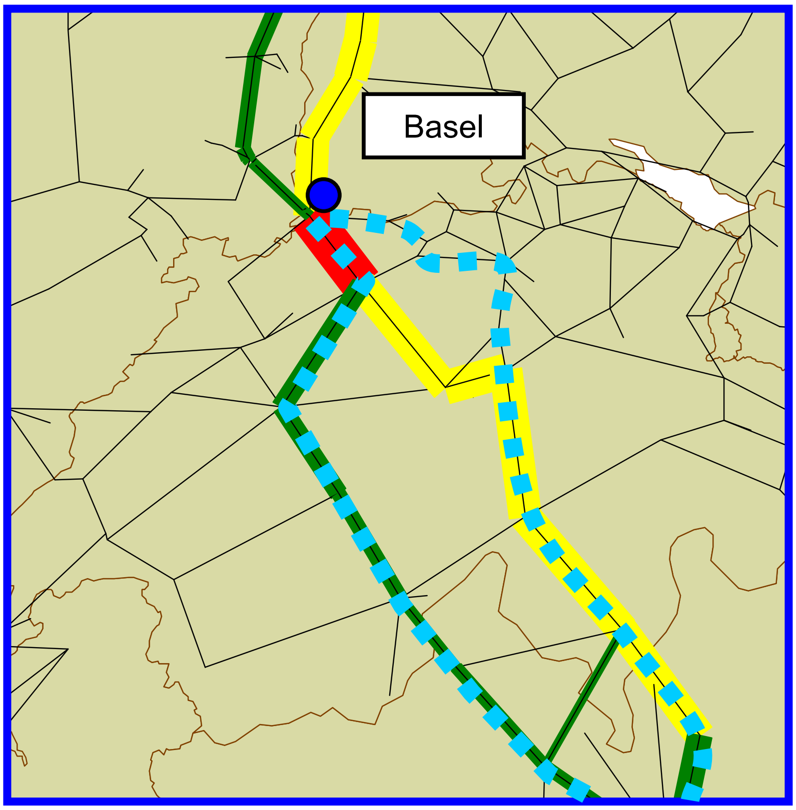
On this line is concentrated the international traffic, which is oriented to/from Belgium, the Netherlands, Luxemburg and Germany. These flows are superposed with national flows oriented to/from the Lorraine region and the French ports in the Normandy. For the latter a dedicated freight axis (blue dotted line) "Magistrale Eco Fret" connected with the Dijon bypass (Contournement de Dijon) could discharge the Metz – Dijon axis to a certain extent. But most of the traffic is still bound to this line. Thus, to expand capacity to a sufficient extent, infrastructure investments on this line seem to be inevitable.

The following zoom (figure 5.7) presents the utilisation of capacity 2015 in the node of Basel, a strategically important bottleneck in the European railway network since it bears the total of the alpine transit flows via Switzerland. In theory these 3 parallel axes could be used

- Basel – Bern – Thun – Lötschberg
- Basel – Olten – Luzern - Gotthard
- Basel – Brugg – Wahlen – Rothkreuz – Arth-Goldau – Gotthard

But a flexible use of these 3 itineraries requires the construction of the Liesthal base tunnel.

Figure 5.7: Utilisation of capacity 2015 in the Basel area

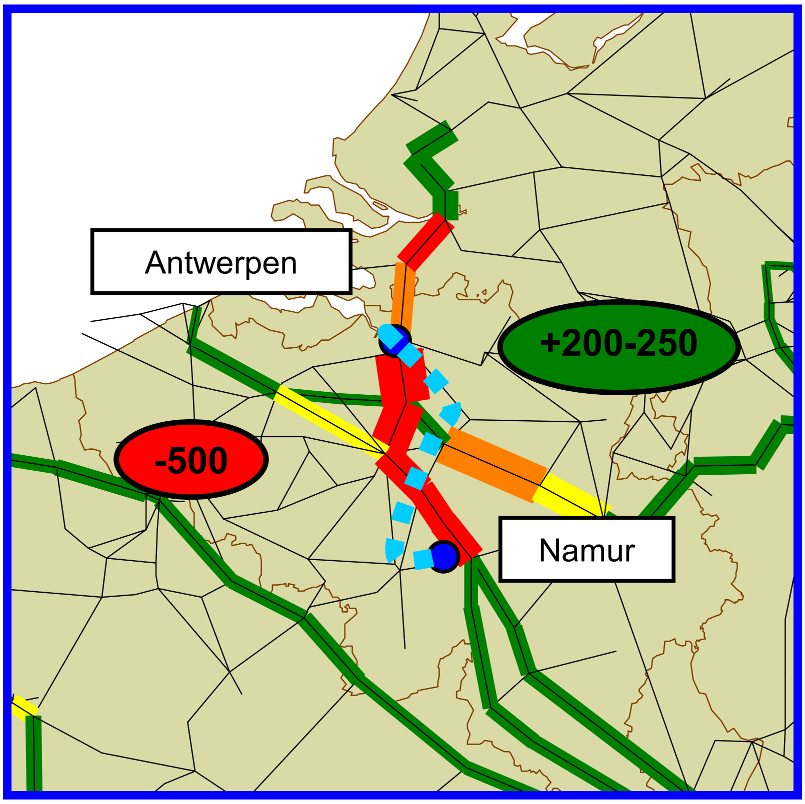


A further bottleneck on this corridor is located in the Antwerpen/Bruxelles area, as presented in figure 5.8 below.

After the prognosis a capacity overload of about 500 trains/day (both directions) will occur in the year 2015 between Antwerpen and Bruxelles. A deviation via the link Antwerpen-Leuven – Ottignies – Fleurus - Namur (blue line) could expand the capacity to an extend of 200-250 trains/day. This deviation could be linked in Namur with the “Athus-Meuse” line, a dedicated freight line, inaugurated in 2003.

The remaining capacity overload of 200 – 250 trains/day between Antwerpen and Bruxelles makes an enforcement of the existing link necessary.

Figure 5.8: Utilisation of capacity 2015 between Antwerpen and Namur



5.4 Corridor n°5 Scandinavia ⬄ Germany ⬄ Austria ⬄ Italy

Figure 5.9 presents the results of the capacity analysis on level 1 (without further investments).

Figure 5.9: Utilisation of capacity 2015 without further infrastructure investments on corridor n°5 Scandinavia - Germany - Austria – Italy

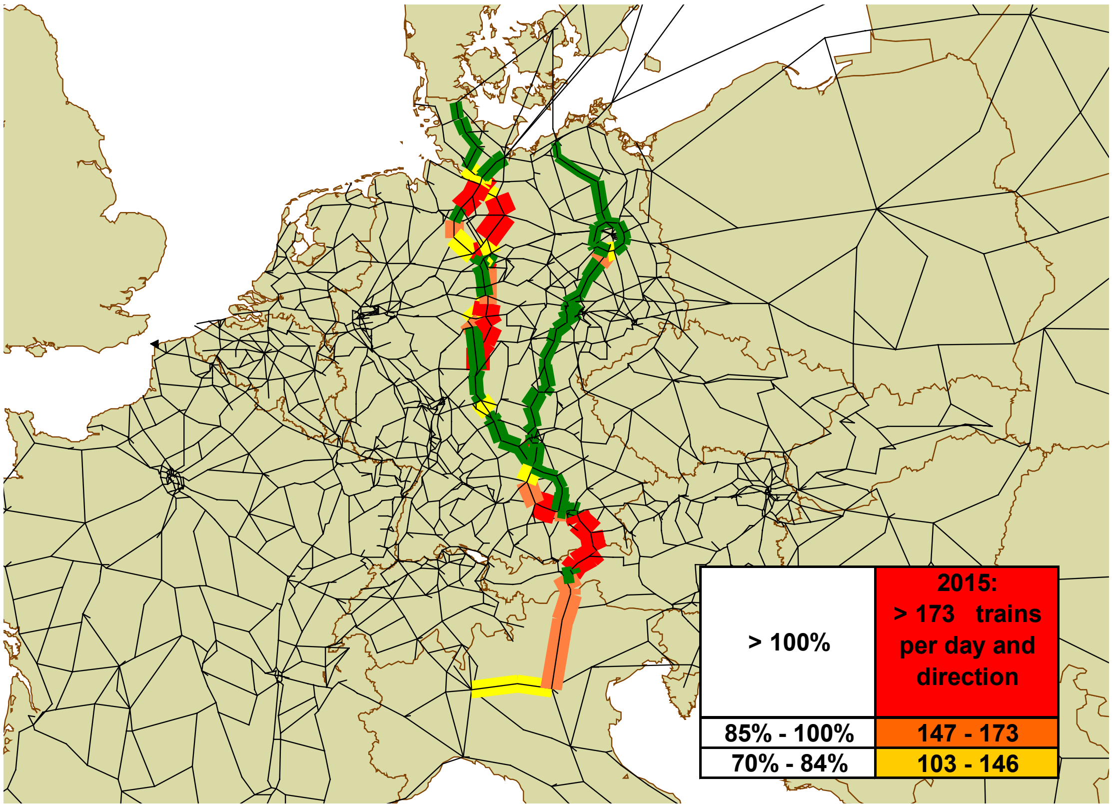


Table 5.5: Planned investments on corridor n° 5

Projects
Erfurt - Nürnberg
Nürnberg - München
Augsburg - München

Figure 5.10: Utilisation of capacity 2015 with planned infrastructure investments on corridor n°5 Scandinavia - Germany - Austria - Italy

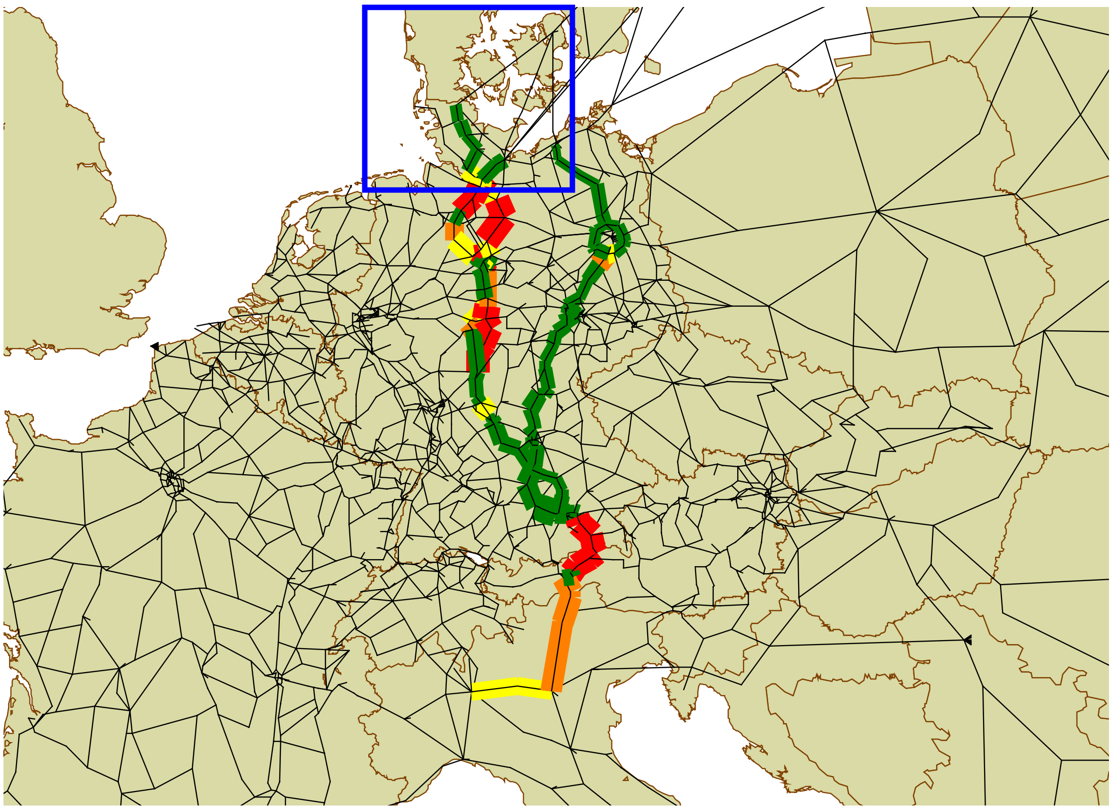


Figure 5.11: Utilisation of capacity 2015 between Hamburg and Fulda

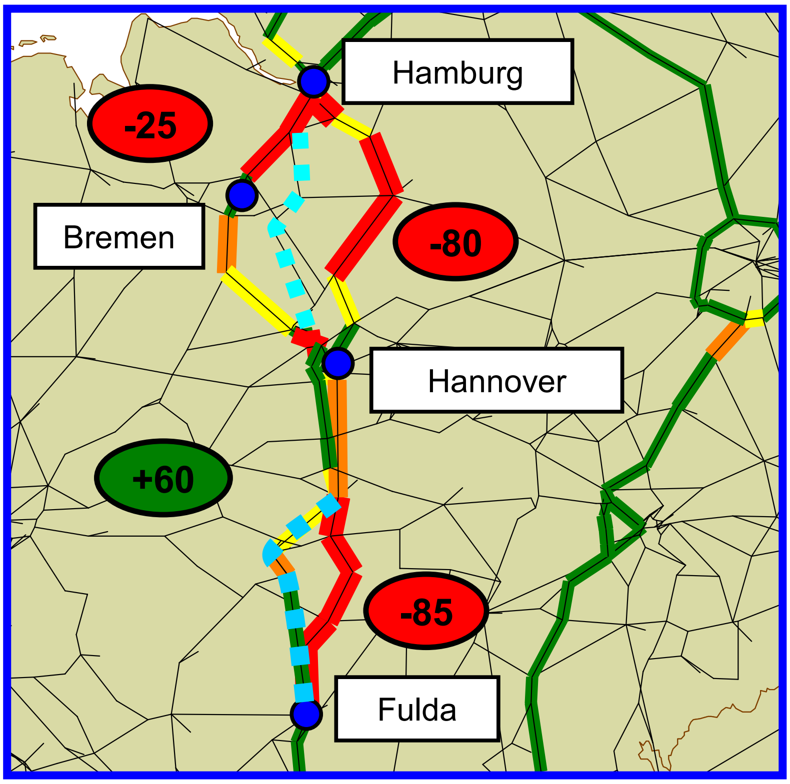


Figure 5.11 shows a zoom in the Hamburg – Göttingen area. (The Göttingen – Fulda area has already been analysed in chapter 4.2).

Between Hamburg and Hannover, where most of the overloads occur, two parallel double tracked electrified lines exist:

- Hamburg – Bremen – Hannover
- and Hamburg – Uelzen – Hannover.

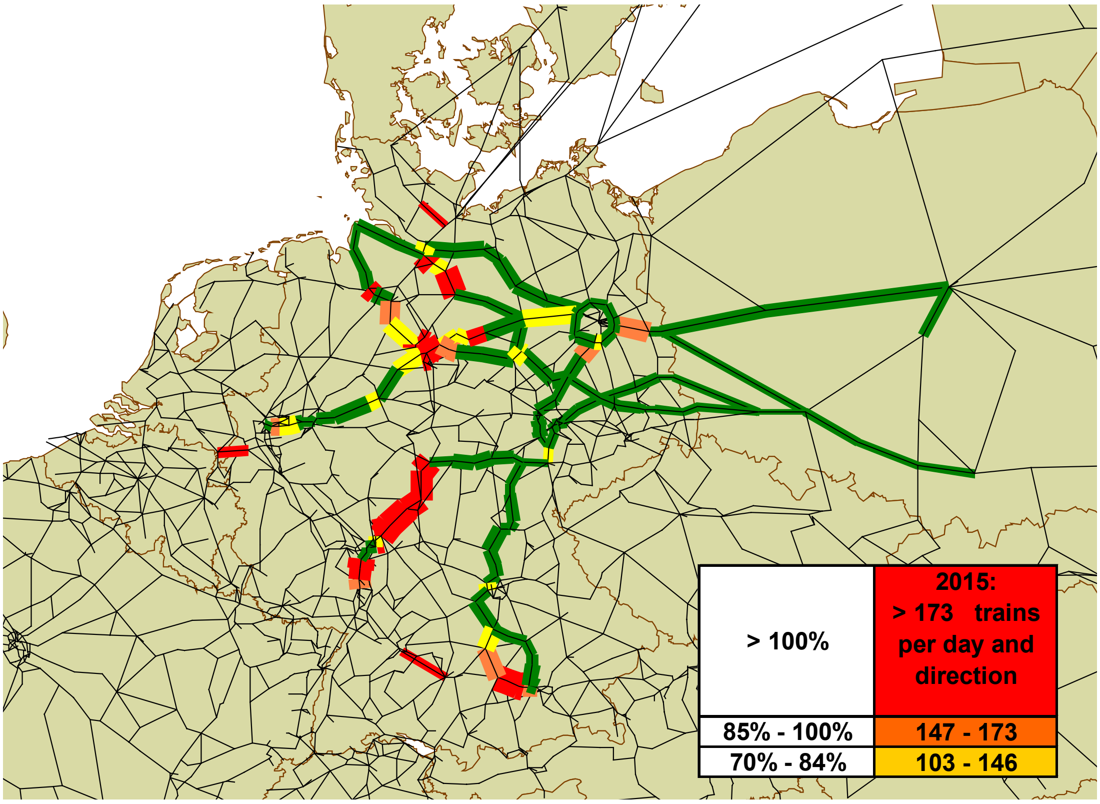
Our prognosis for 2015 shows that both lines lack capacity for 105 trains/day (sum of both directions). The overload on the Hamburg – Bremen link is due to the intermingling of train flows between Hamburg and the Ruhr area, between Hamburg and Bremerhaven and between Hamburg and Oldenburg/Wilhelmshaven/Emden. Since the capacity overload of 25 trains is comparatively small, we propose “soft measures” e.g. shorter block distances, longer trains etc. to overcome the capacity lack.

In regards to the Hamburg – Hannover section, where the capacity overload is up to 85 trains in the year 2015, further infrastructure investments seem to be necessary. A deviation for a small number of trains via Hamburg – Soltau – Hannover may be a short-term solution, since this is a single-track non-electrified line.

5.5 Corridor 6 Poland ⇔ Germany

Figure 5.12 shows that without infrastructure investments, capacity is lacking only on sections in the German network. These sections have already been analysed or will be analysed further down.

Figure 5.12: Utilisation of capacity 2015 without further infrastructure investments on corridor n°6 Poland - Germany



5.6 Corridor n°7 Benelux ⇔ Germany ⇔ Czech Republic ⇔ Slovakia

Figure 5.13 presents the results of the capacity analysis on level 1 (without investments)

Figure 5.13: Utilisation of capacity 2015 without further infrastructure investments on corridor n°7 Benelux - Germany - Czech Republic - Slovakia

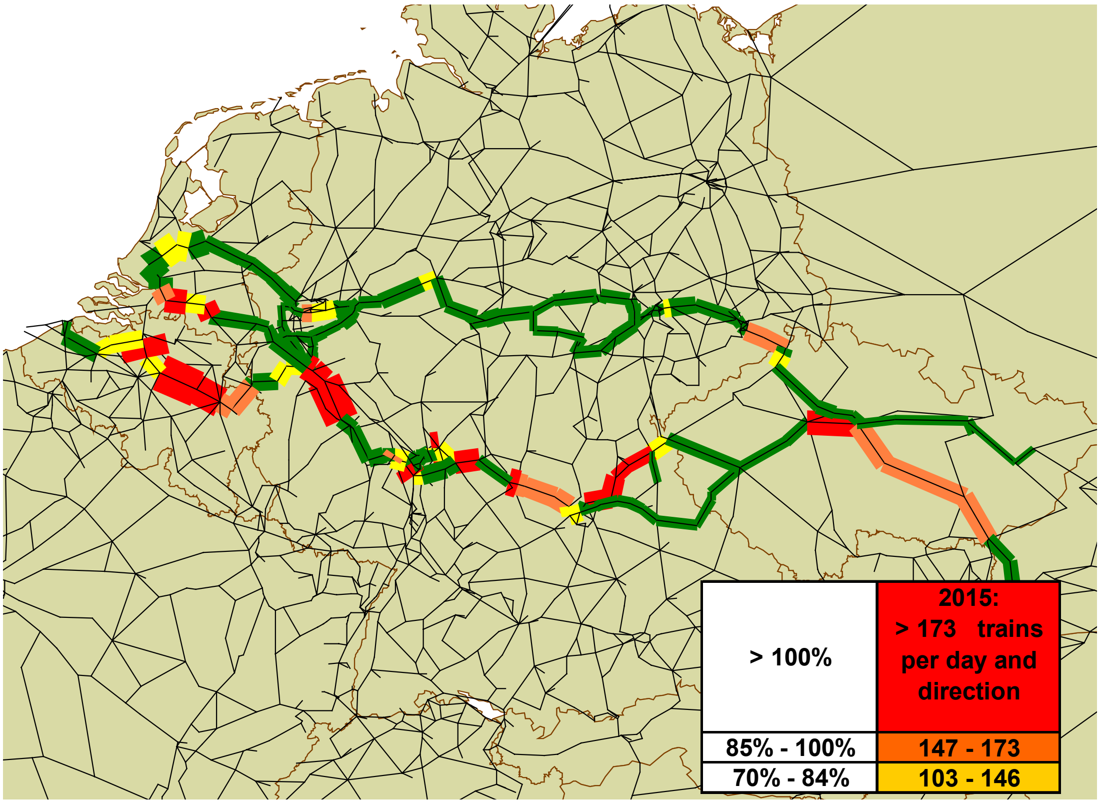
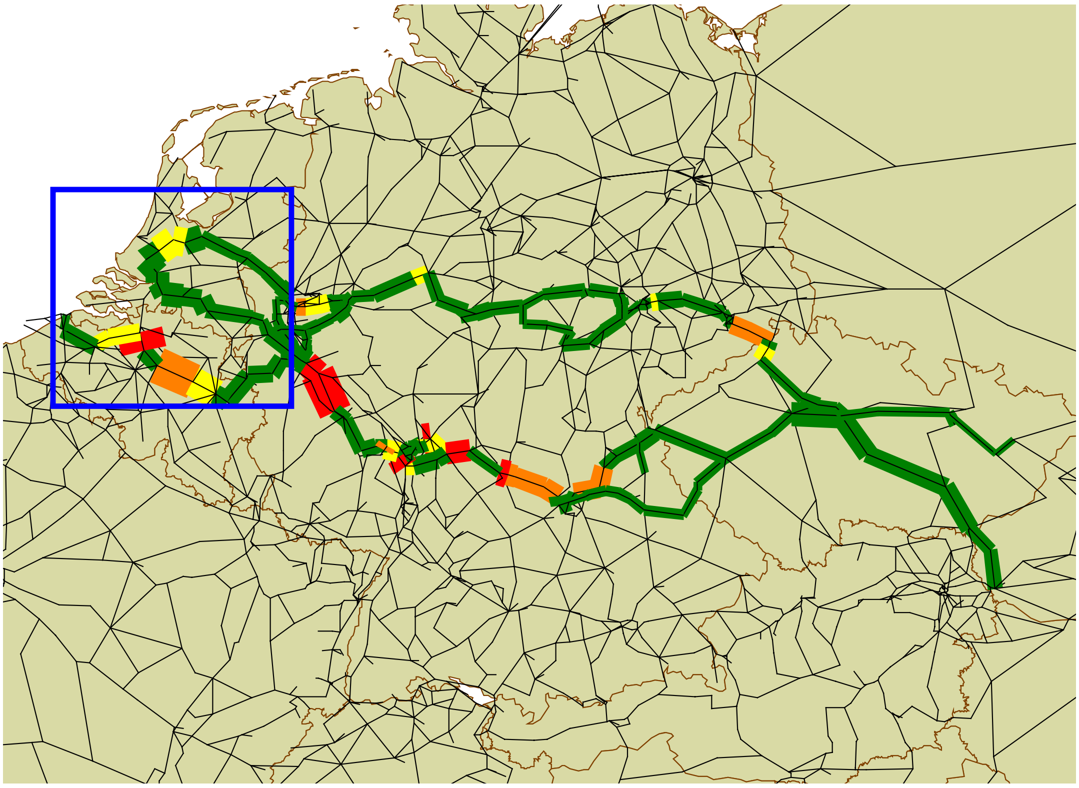


Table 5.6: Planned investments on corridor n° 7

Projects
Beetuwje Line
Amsterdam-Arnhem
Furth i.W. - Prag
Prag – Wien

Figure 5.14: Utilisation of capacity 2015 with planned infrastructure investments on corridor n°7 Benelux - Germany - Czech Republic - Slovakia

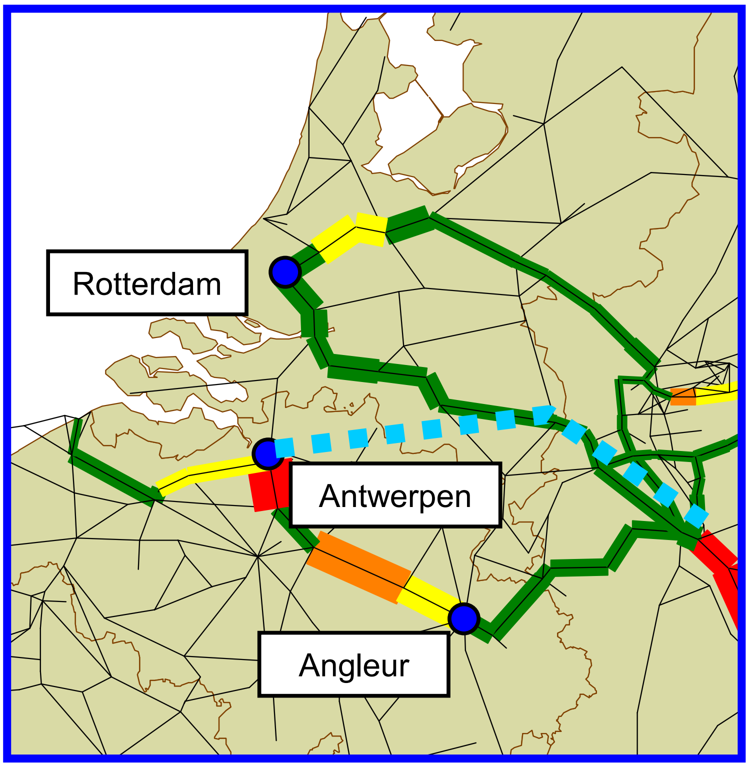


From figure 5.14 it is obvious that when all planned infrastructure investments (cf. table 5.6) are in operation in 2015, capacity is lacking in two sections:

- Antwerpen – Angleur
- Köln – Rhein – Main (cf. chapter 5.2)

The zoom in the Antwerpen – Angleur region in Figure 5.15 shows a lack of capacity of about 500 trains/day. In the context of this corridor the project of the “Iron Rhine” (blue dotted line) could remedy this capacity shortage.

Figure 5.15: Utilisation of capacity 2015 between Antwerpen and Angleur



5.7 Corridors n° 8, 9, 10, 13 Benelux/Germany ⇔ France ⇔ Spain/ Portugal

Without further infrastructure investments until 2015 the employment of capacity on the corridors n° 8,9,10,13 would be as presented in figure 5.16. In this case considerable parts of the French railway network are overloaded.

Figure 5.16: Utilisation of capacity 2015 without further infrastructure investments on corridors n° 8, 9, 10, 13 Benelux/Germany - France - Spain/ Portugal

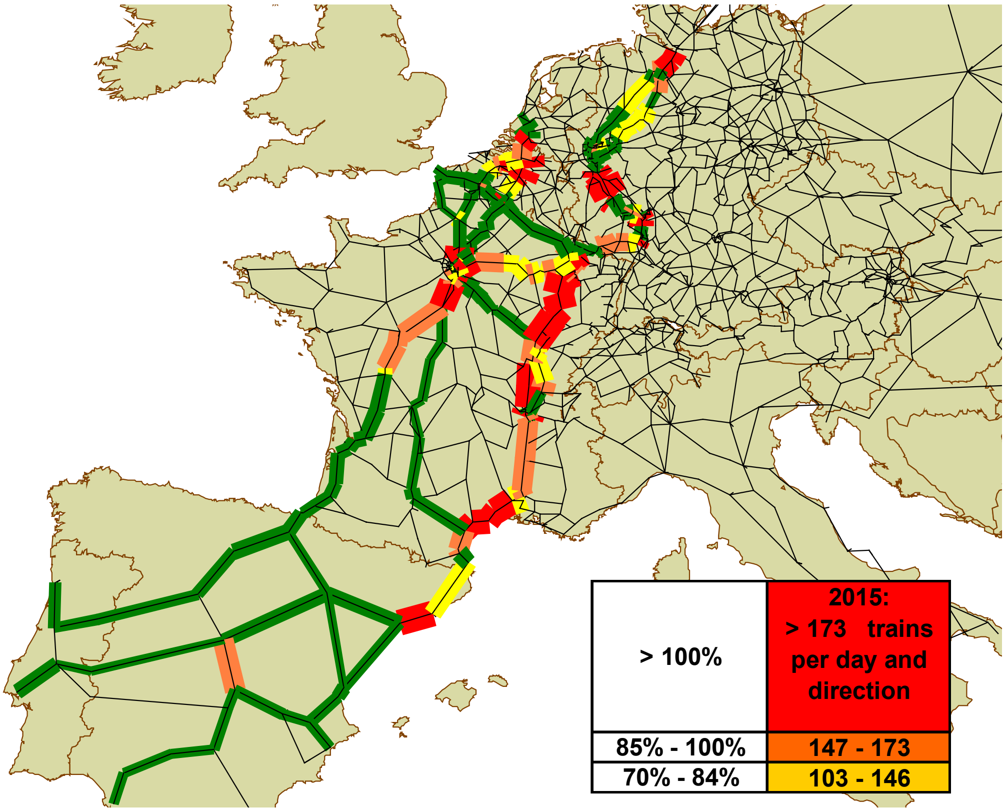
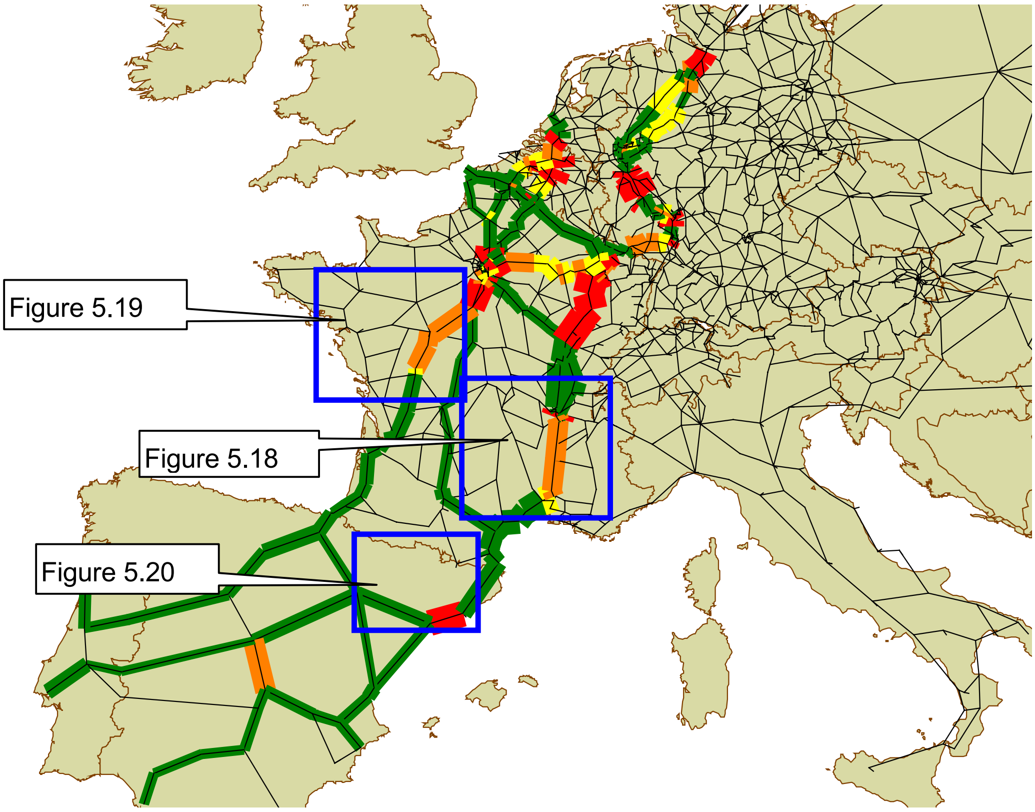


Table 5.7: Planned investments on corridors n° 8, 9, 10, 13

Projects
Rhin-Rhône (Sud)
Contournement Lyon
Nîmes – Montpellier
Perpignan – Figueras
Figueras - Barcelona

Figure 5.17: Utilisation of capacity 2015 with planned infrastructure investments on corridors n° 8, 9, 10, 13 Benelux/Germany - France - Spain/ Portugal



Even under the assumption that all planned investments (c. table 5.7) on this corridor are operating in the year 2015, the following axes still lack capacity:

- Paris – Poitiers
- Lyon – Avignon
- Barcelona – Tarragona

Further links with capacity shortages in France, Belgium and Germany were analysed in previous chapters.

Figure 5.18: Utilisation of capacity 2015 between Lyon and Montpellier

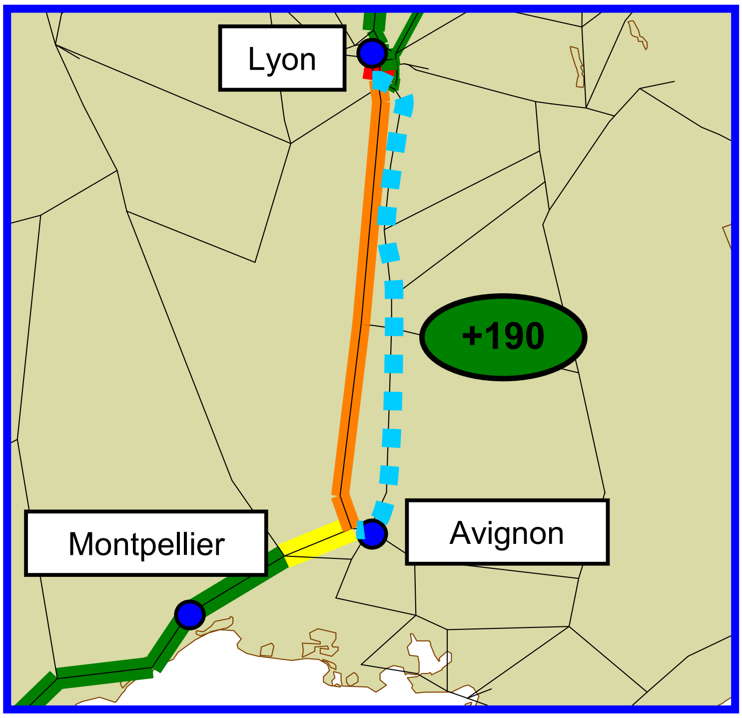
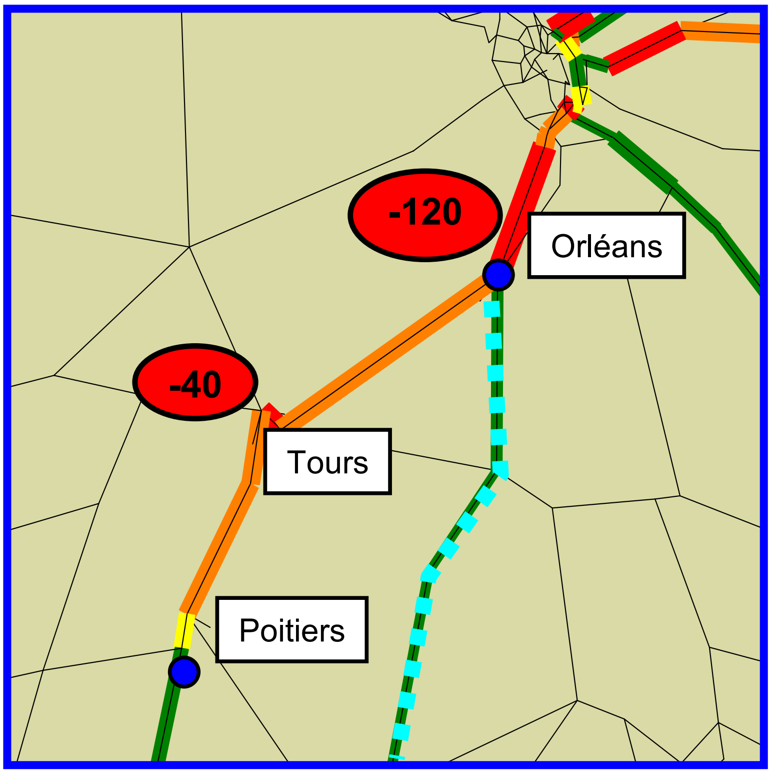


Figure 5.18 presents the situation in the year 2015 south of Lyon. The section on the right bank (west side) of the river Rhône, where the freight trains are concentrated, is close to the capacity limit (85 – 100% of maximum capacity). Using the line on the left river bank (blue dotted line) would free capacity for 190 trains/day (both directions). This would be possible, since most of the long distance passenger services are now diverted on the high-speed TGV line Lyon – Marseille.

However, it must be pointed out that the line on the left bank of the Rhône suffers under loading gauge restrictions, which are even more limited than on the French network in general. Thus, to enable a flexible use of both lines, the lauding gauge should be enhanced.

Figure 5.19: Utilisation of capacity 2015 between Paris and Poitiers



The capacity utilisation in 2015 on the sections Paris – Orléans – Tours – Poitiers is presented in figure 5.19. An overload of 120 trains per day (both directions) occurs between Orléans and Paris. Around Tours the capacity for 40 trains is missing.

A diversion of trains via Orléans – Vierzon – Limoges (blue dotted line) seems impossible for this corridor, since a performing link between Limoges, Angoulême and Bordeaux does not exist at present (only single, non-electrified track).

Figure 5.20: Utilisation of capacity 2015 between Barcelona and Tarragona

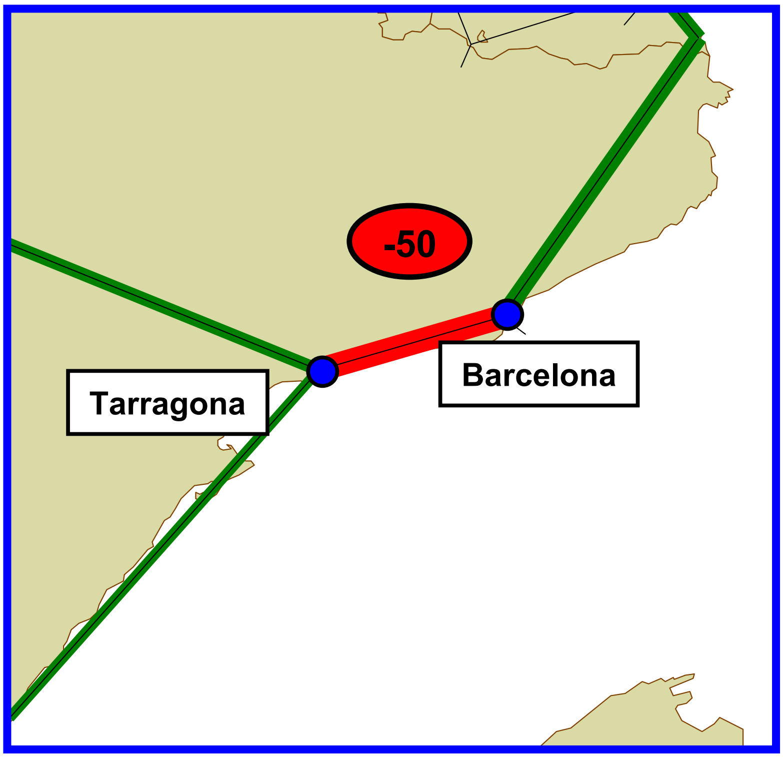


Figure 5.20 indicates a capacity shortage of 50 trains/day (both directions) between Barcelona and Tarragona. To overcome this shortage, we propose an enforcement of this link by the construction of a new line in UIC standard gauge between the French border and the ports of Barcelona and Tarragona. This project is presently discussed in Spain.

5.8 Corridors n° 11, 14 UK ⬄ France/Germany ⬄ Austria ⬄ Hungary

Figure 5.21 presents the results of the capacity analysis on level 1 (without infrastructure investments)

Figure 5.21: Utilisation of capacity 2015 without further infrastructure investments on corridors n° 11, 14 UK - France/Germany - Austria - Hungary

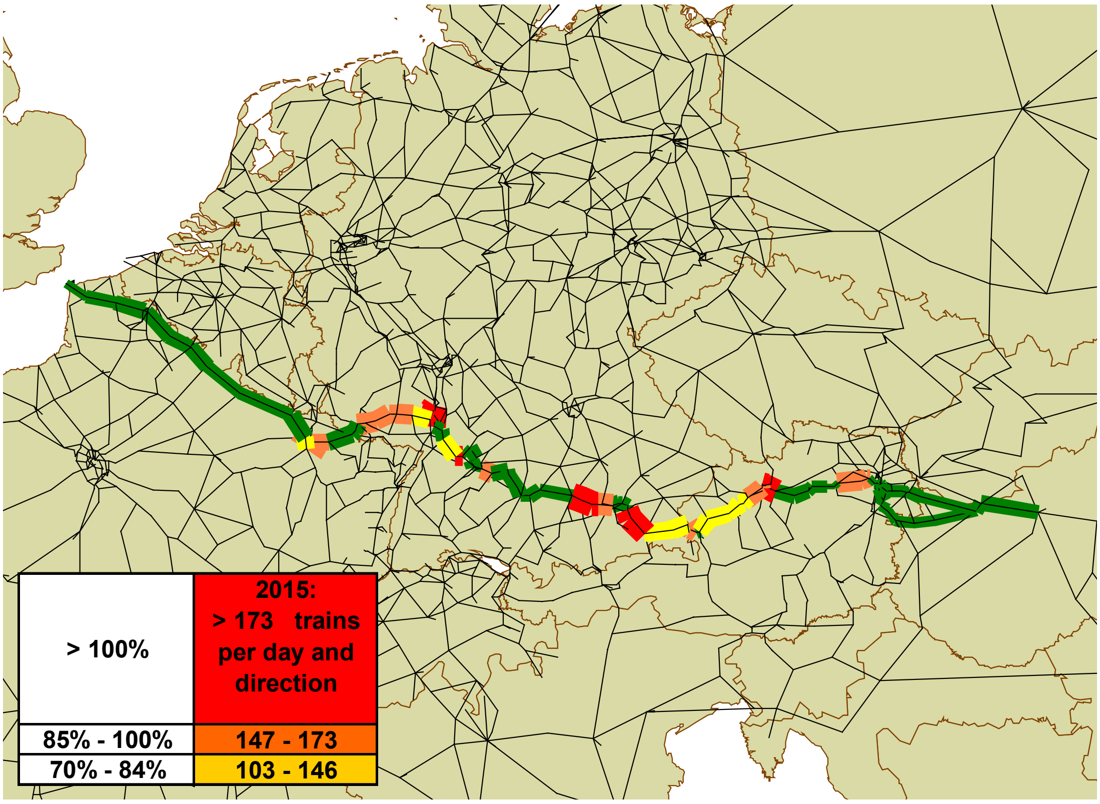


Table 5.8: Planned investments on corridors 11, 14

Projects
Augsburg – München
Salzburg – Wels – Wien

Figure 5.22: Utilisation of capacity 2015 with planned infrastructure investments on corridors n° 11, 14 UK - France/Germany - Austria - Hungary

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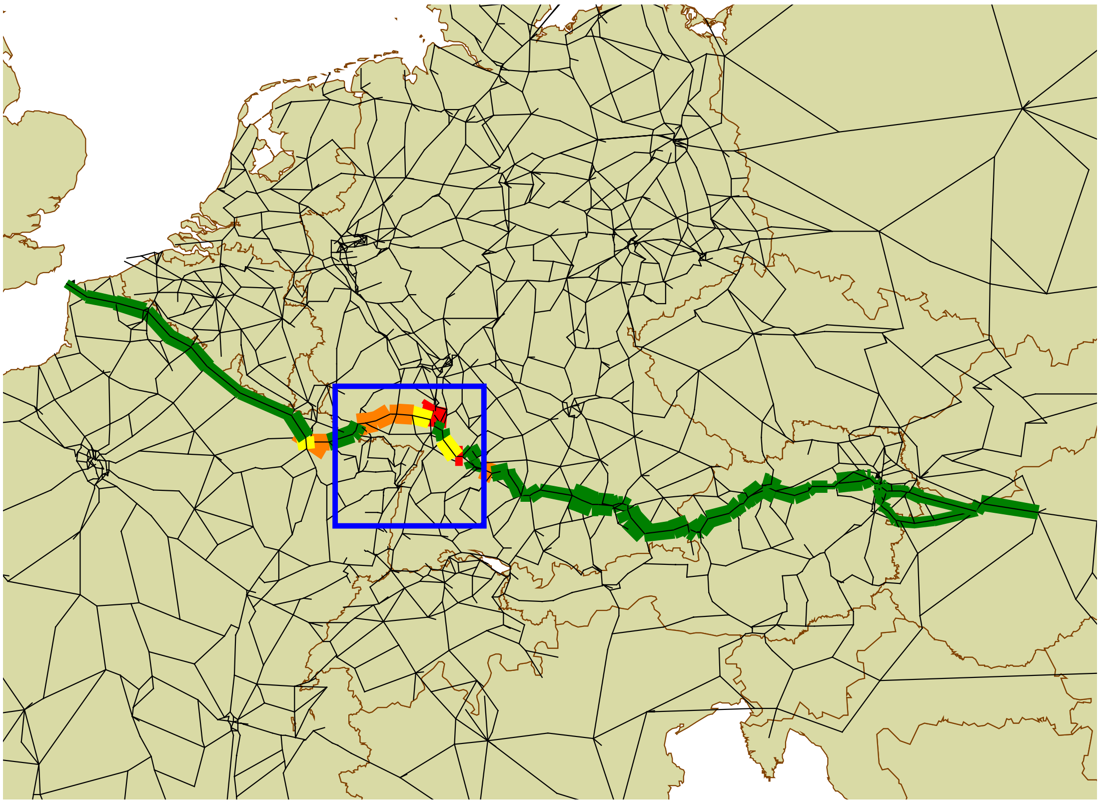
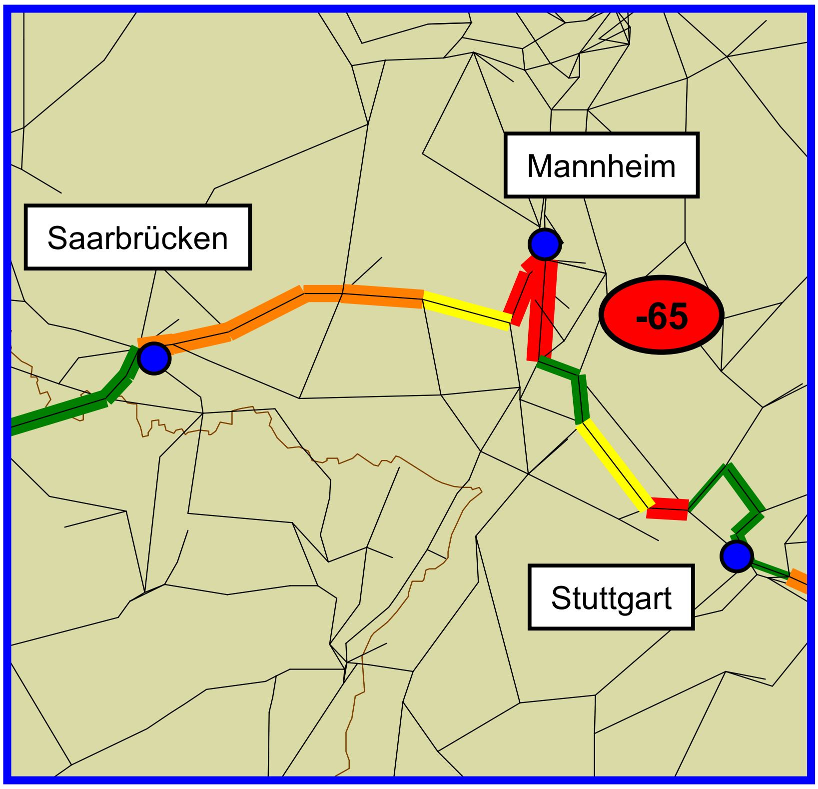


Provided that all infrastructure investments listed in table 5.8 are carried out before 2015, figure 5.22 indicates a capacity shortage on the link between Saarbrücken and Stuttgart in the German network. The zoom in figure 5.23 presents in detail these parts of the network.

Figure 5.23: Utilisation of capacity 2015 between Saarbrücken and Stuttgart



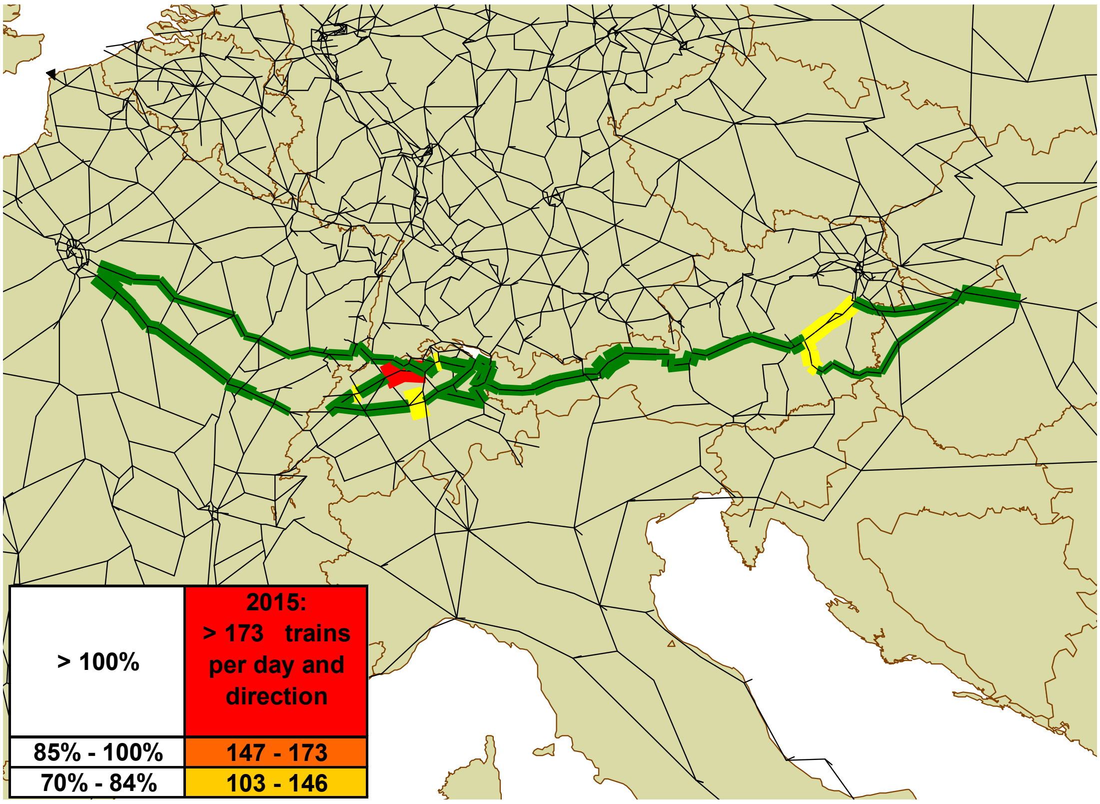
The POS project ("Paris – Ostfrankreich – Stuttgart"), under discussion since many years between France and Germany, could solve the capacity problems on this link.

Between Mannheim and Stuttgart, the capacity could be extended while using the high-speed railway link Mannheim – Stuttgart for freight trains, which is technically possible.

5.9 Corridor n° 12 France ⇔ Switzerland ⇔ Austria ⇔ Hungary

Figure 5.24 presents that even in the case with no infrastructure investments until 2015, the capacity on corridor n° 12 seem to be sufficient. Some minor bottlenecks in the Swiss network will be eliminated by the investments done within the frame of NEAT and Bahn 2000 (phase 2).

Figure 5.24: Utilisation of capacity 2015 without further infrastructure investments on corridor n° 12 France - Switzerland - Austria - Hungary



5.10 Corridor n° 18 Italy ⇔ France ⇔ Spain

The capacity shortcomings on this corridor have already been analysed in chapters 5.3 and 5.7. Consequently a separate analysis of this corridor is not necessary.

6. Analysis of selected intermodal terminals on the corridors

6.1 Objectives and approach

In the framework of this study, **phase 2** aims at

- elaborating the 2015 transhipment capacity need of representative intermodal terminals on the UIC corridors selected,
- investigating into capacity enlargement measures scheduled,
- and determining and analyzing possible capacity bottlenecks at those representative intermodal terminals, which are resulting from the difference between the 2015 estimated handling volume and the handling capacity planned so far. Thus the need for additional transhipment capacity can be derived.

The present report only refers to **terminals for unaccompanied intermodal transport**. The capacity requirements of terminals for accompanied intermodal services are closely related to the development of these services (cf. chapter 3.2).

The terminal analysis features two types of intermodal rail terminals. First of all, **inland terminals** located in rail yards, inland ports, or freight villages, providing for rail access and intermodal services are taken into account. Secondly, **port terminals** are included if they are operated separately as a sort of Rail Service Centre (RSC), but not if the transhipment between vessel and rail is taking place on the quay. RSCs can be located and operated in different forms. They can either focus on maritime containers if they are dedicated to one marine terminal or they can offer mixed handling of maritime and continental loading units. Private transhipment facilities e.g. at shippers' sites, which do not ensure a non-discriminatory access, are not taken account of by this study.

For the terminal analysis in phase 2 the following methodology and working steps have been applied:

- Identification of representative European intermodal terminals / terminal areas
- Analysis of 2002 handling capacity, volume and rate of employment
- Investigation into capacity extension and terminal investment scheduled
- Deduction of 2015 capacity need (target) of European terminal areas from prognosis
- Determination of additional terminal infrastructure investment needed to comply with the prognosis volume

6.2 Selection of representative intermodal terminals

Intermodal rail-road terminals generally speaking are facilities, which enable the transhipment of intermodal transport units (ITU) or intermodal loading units (LU) [2] between road and rail.

From the very beginnings of combined rail-road transport in Europe, a large variety of types of intermodal terminals as regards layout, handling systems, or process organization emerged. Terminals were not only differing from country to country but within each of the European countries as well. This "patchwork" appears to be a typical feature of a new, fast growing, and hardly structured industry. When, however, in the 1980s intermodal services could be stabilized, combined transport created separated rail production systems, and - in a word - combined transport grew more mature, it also was time to improve the terminals. Makeshift facilities, which were transformed from former rail sidings, were no longer able to properly respond to performance requirements. In a process of convergence the configuration of intermodal terminals throughout Europe became more and more standardized particularly as concerns larger facilities, which provide for central functions and/or are connected to international services. As a result a typical layout developed featuring the following components:

- Transhipment modules with 3 to 5 loading tracks under gantry cranes
- Loading tracks, which can accommodate a complete train set of wagons (train-long length)
- Loading and driving lanes for pick-up and delivery trucks
- Buffer and storage area both under cranes and at separated areas
- Check-in and check-out gates
- Live-lift transhipment organization.

Variants of the layout are resulting from the local availability of space, the share of maritime and continental flows, the share of stackable loading units, the behaviour of clients to pick-up and deliver units, the access to the main rail network, and the technical-operational concept to use rail-mounted gantry cranes or mobile cranes (reachstacker) for the transhipment.

The European Agreement on Important International Combined Transport Lines and Related Installation (AGTC) dated 1991 includes a long list of "terminals of importance for international combined transport on the territory of the contracting countries". Also the European Commission's "Trans-European Transport Network Outline Plan (2010 Horizon)" dated 1997 included a Map of transhipment areas in relation to the railway corridors. The impression of these two publications is that a dense network of terminals is of importance for international intermodal transport and thus likely to be developed.

[2] The terms Intermodal Transport Units (ITU) or loading units (LU) are used synonymously.

In contrast to these plans, international intermodal services and the volume of transport, in recent years, has been concentrating on a few large terminals, because the most effective rail product is a block or shuttle train which is moving between two terminals without further manipulation. A further experience is, that those terminals with good services grew faster than others. According to intermodal operators it was easier – both from the production planning and customer reaction point of view – to set up a 2nd or even 3rd train pair on a given route rather than creating a completely new link.

The study is concentrating on the development of **international intermodal transport** on selected trans-European transport corridors, and the prognosis of future volume has been agreed using global growth rates between countries.

We have therefore based the terminal analysis also on the **macro-economic, corridor and transport area approach** composing of the following general steps:

- Investigation of current (2002) international combined transport volume between different sites (origin and destination) aggregated to the level of transport area to transport area relation
- Different growth rates per country and UIC Corridor applied by the network model (phase 1)
- Deduction of future (2015) international CT volume per transport area

The model assumes a **persistence of the current international transport structures** which means that the transport areas and their relations remain the same but the volume per relation and thus the volume per area can grow differently. According to that the model can neither create new areas nor derive changes of the share of different terminals within an area, but provide a ranking of the areas by volume today and in the future.

For the terminals it means that the existing economic gravity centres (entry points for the rail network) will remain the same. It is therefore possible to concentrate the analysis on those transport areas with a significant market volume in 2015.

The following table 6.1 is presenting the top 25 transport areas in terms of international intermodal transport volume in 2015. The traffic volume (export and import) in Million tonnes was created by the network model (phase 1) and extracted on the basis of transport areas. Transport areas compose of important nodal centres such as Sopron or Metz, where intermodal train are consolidated and redirected and areas which represent a larger area such as Zürich for central Switzerland or Malmö for Sweden interms of the model. The **growth rate is a resultant** of the overall international intermodal transport forecast rather than a detailed local analysis (macro economic approach).

Table 6.1: Top 25 transport areas by 2015 for international CT

N°	Transport area	Export [1,000 t]		Import [1,000 t]		Growth rate	
		2002	2015	2002	2015	2015/2002	p.a.
1	Milano	4.402	11.477	4.908	12.566	158%	7,6%
2	Rotterdam	3.176	6.960	3.450	7.717	122%	6,3%
3	Köln	3.338	7.811	2.184	4.870	130%	6,6%
4	Verona	2.123	5.225	2.642	6.522	147%	7,2%
5	Antwerpen	2.574	6.355	2.283	4.934	132%	6,7%
6	Hamburg	2.384	6.335	2.241	4.585	136%	6,8%
7	Novara	1.677	4.382	2.238	5.862	162%	7,7%
8	Praha	1.141	2.277	1.288	2.580	100%	5,5%
9	Mannheim/Ludwigshaf	1.279	3.070	646	1.521	138%	6,9%
10	Zeebrügge	953	2.441	730	1.849	155%	7,5%
11	Paris	830	2.004	759	1.866	144%	7,1%
12	Basel	982	1.923	978	1.863	93%	5,2%
13	Barcelona	517	1.460	662	2.047	197%	8,7%
14	Valencia	558	1.328	587	1.714	166%	7,8%
15	Genk	663	1.769	449	1.217	169%	7,9%
16	Nürnberg	602	1.436	551	1.297	137%	6,9%
17	Neuss	710	1.500	529	1.084	109%	5,8%
18	Bremen/Bremerhaven	623	1.643	463	874	132%	6,7%
19	Roma	301	781	586	1.519	159%	7,6%
20	München	479	1.200	395	989	151%	7,3%
21	Duisburg	605	1.275	440	894	108%	5,8%
22	Wien	311	678	623	1.370	119%	6,2%
23	Wels	379	795	495	1.073	114%	6,0%
24	Budapest	408	749	553	1.051	87%	4,9%
25	Ljubljana	466	736	518	840	60%	3,7%
Subtotal 1.-25. (~72%)		31.480	75.609	31.196	72.706	137%	6,9%
Other transport areas		12.391	28.017	12.549	28.794	126%	6,5%
Total volume		43.870	103.626	43.744	101.499	134%	6,8%

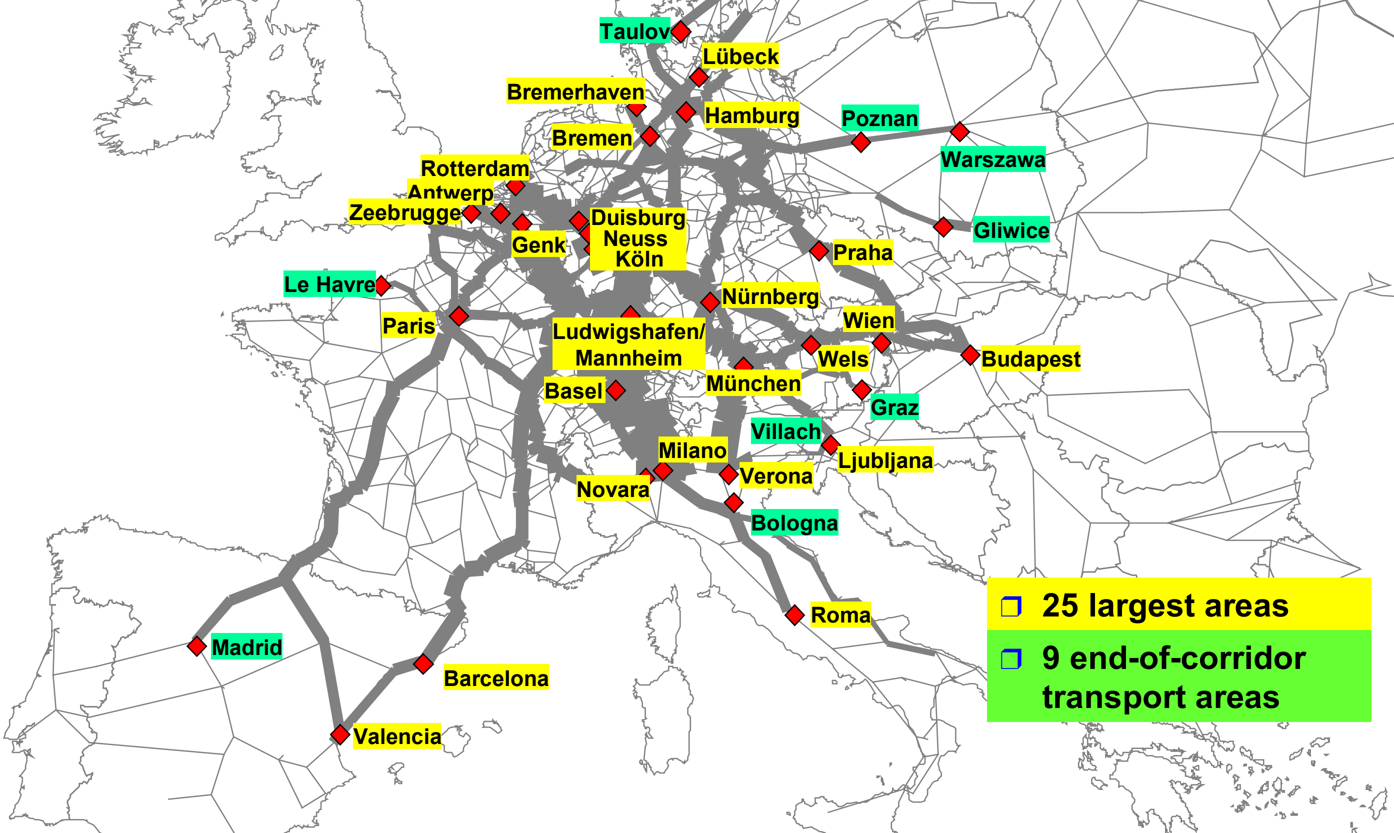
(Differences between exports and imports and total UCT owing to model).

Those transport areas which represent a larger share of transiting traffic flows in the network model (e.g. marshalling yards or entry points to the model) but no important own international transhipment volume of a terminal have been excluded from further analysis of the transhipment volume and capacity.

A further selection criterion is the location with respect to the UIC corridors and within the rail network and the availability of detailed data. Those terminals on the UIC corridors have been looked at with priority.

The terminal areas of significant international transport volume, transhipment capability and link to the UIC corridors are presented in the following figure 6.1.

Figure 6.1: Map of Transport areas of significant international volume and link to the UIC corridors



The current study is looking at intermodal transport from the macroscopic European dimension. It is therefore not possible to take into consideration every local development. Methodologically – already in the data gathering – different real terminals of a selected area have been assembled to a "transport area" and their international transport flows have been aggregated. For example the two rail – road terminals of Mannheim and Ludwigshafen make one terminal area "Mannheim/Ludwigshafen", but we have also situations such as for München where only one physical terminal is covering a whole "terminal area". For the in-depth analysis of such an area a database of terminals (based on the UIRR terminal database) has been elaborated and extended.

We'd like to emphasize that different **transport area concepts** were applied in the first and second phase of the study. In the first phase the traffic flows between different sources (origin / destination) of a transport area have been aggregated to international intermodal transport flows between transport areas. Such sources are rail-road and port terminals but railfreight stations (marshalling yards linking various smaller sites) and large shippers premises, too. In contrast to that, in the second phase the actual transhipment volume only of intermodal terminals has been aggregated. Intermodal terminals are public sites providing a non-discriminatory access for the transhipment of intermodal transport units.

6.3 Existing terminal capacity, volume, and employment

6.3.1 Definitions, data base approach

The **transhipment capacity** of an intermodal terminal is the technical-operational capability of handling intermodal transport units in a certain period of time. The total transshipment capacity of a transport area is composing of the individual capacity of the terminal sites in that area. A pure mathematical sum of the individual capacities will give the total handling capacity for the purpose of this study. In practice, however, a capacity limit of one terminal, in most cases, can't be compensated by spare capacity of another site due to operational reasons, customer patterns of behaviour, railway access, or intermodal operators' supply policy.

The **transhipment volume** is first of all determined by the transport volume of outbound and inbound loading units. But is also dependent on a couple of operational factors such as the behaviour of clients, e.g. pick-up and delivery time related to train schedule and opening hours.

The **rate of employment** of an intermodal terminal is defined as the ratio of the actual transhipment volume to the existing capacity of a terminal.

For all representative terminals, information on those figures or on technical-operational data, which would have allowed us to calculate the transshipment capacity ourselves, were neither existent in a data base nor available in comparable quality for all sites. The UIRR database on terminals includes many technical features (track length and equipment type) and customer-related information (opening hours, additional services offered, contacts) for about 150 terminals served by UIRR companies. However, neither can it cover terminals served by non-UIRR companies nor does it always include topical developments, e.g. replacement of terminal *Josefvaros* by BILK-terminal in Budapest, nor does it include annual transhipment volume and capacity data. This bit of information often is deemed to be confidential, and a terminal operator may be using it strategically.[3].

In order to obtain a detailed and comparable data base on the representative terminals we enforced a comprehensive investigation with all relevant terminal operators in the countries affected by this study, over and beyond the information we had acquired before. For this purpose we designed a one-page form, which facilitated the operators to supply the data.

Against our worries that terminal operators might hesitate to provide us with information the survey proved to be pretty successful. Apart of a few terminals we obtained valid and usable data. Even for them we were able to transform the accessible technical features (e.g. from the extended UIRR-database) by means of our own expertise or other expert

[3] A terminal operator will announce sufficient free capacity towards a potential client while – in order to receive funding for the enlargement – he might emphasize the shortcomings towards potential investors and funding agencies

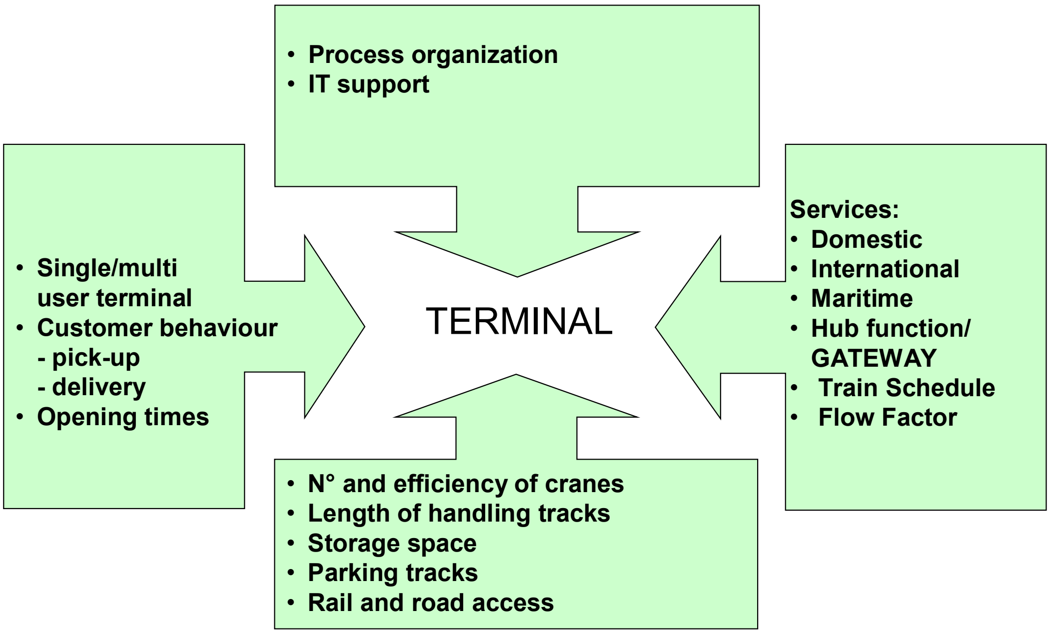
evaluation into terminal capacity. Thus the objectives of phase 2 could absolutely be achieved.

6.3.2 Existing transhipment capacity of intermodal terminals

The **transhipment capacity** of an intermodal terminal in particular is determined by the following influences (see also Fig. 6.2):

- Infrastructure and superstructure: number and length of transhipment tracks, number and type of handling devices
- Terminal process organisation: road and rail access, railway operational processes incl. flow factor, internal organisation and IT support
- Type of intermodal services: block train services, maritime/continental loads
- Type and share of intermodal transport units, e.g. share of stackable units and semi-trailers
- Customer behaviour and opening times

Figure 6.2: Capacity Determinants for Intermodal Terminals



In addition we have to distinguish between rail-road transhipments and other handlings, which are not counted in the transport statistics though binding transhipment capacity like:

- Rail-rail handlings in hub or Gateway terminals,
- Operational handlings of units, which were not transshipped live-lifted between truck and wagon,
- Depot handlings to treat storage and empty containers.

Technically the transhipment capacity of an intermodal terminal is primarily determined by two limiting components: the total length of the handling tracks, and the number and efficiency of the handling equipment. The smaller fo the two results has to be considered as the technical transhipment capacity. The capacity calculation formulae, which we applied, are widely acknowledged. They are as follows:

(1) Capacity depending on the **length of the transhipment tracks**:

$$C_{Rail} = \frac{L_{Track}}{L_{Wagon}} \ x \ LF \ x \ FF \ x \ 2 \ x \ N_{TD}$$

$$\begin{aligned} C_{Rail} &= Capacity \ related \ to \ the \ railtracks \ in \ units \ per \ day \\ L_{Track} &= Lenghth \ of \ the \ Transshipment \ Tracks \ in \ m \\ L_{Wagon} &= Length \ of \ an \ average \ wagon \ in \ m \\ LF &= Load \ Factor \ in \ LU / Wagon \\ FF &= Flow \ Factor, the \ use \ of \ a \ track \ during \ the \ day \\ N_{TD} &= Number \ of \ Traffic \ Days \ per \ year \end{aligned}$$

(2) Capacity depending on the available **handling equipment**:

$$C_{Equipment} = C_{Gantry} + C_{Mobile} \ x \ U_{Mobile}$$

$$\begin{aligned} C_{Equipment} &= Capacity \ of \ the \ Handling \ Equipment \\ C_{Gantry} &= Capacity \ of \ the \ Gantry \ Crane(s) \\ C_{Mobile} &= Capacity \ of \ the \ Mobile \ Crane(s) \\ U_{Mobile} &= Utilisation \ Factor \ of \ Mobile \ Cranes \\ & \quad for \ Rail \ Road \ Transshipment \end{aligned}$$

(2a) Capacity depending on the available **Gantry Cranes (RMG)**:

$$C_{Gantry} = N_{Gantry} \ x \ \frac{P_{Gantry}}{MH_{Gantry}} \ x \ T_{Open} \ x \ TD$$

$$\begin{aligned} C_{Gantry} &= Capacity \ of \ the \ Gantry \ Crane(s) \ in \ LU / Year \\ N_{Gantry} &= Number \ of \ Gantry \ Cranes \\ P_{Gantry} &= Performance \ of \ Gantry \ Cranes \ in \ LU \ per \ Hour \\ MH_{Gantry} &= Factor \ for \ Managament \ Handlings \\ T_{Open} &= Opening \ Hours \ of \ the \ Ter\min al \ per \ Day \\ TD &= Number \ of \ Transport \ Days \ per \ Year \end{aligned}$$

(2b) Capacity depending on the available **Mobile equipment (e.g. Reach Stackers)**:

$$C_{Mobile} = N_{Mobile} \ x \ \frac{P_{Mobile}}{MH_{Mobile}} \ x \ T_{Op\ en} \ x \ TD$$

Analogue definition to (2a)

(3) Overall **limiting Terminal Capacity** depending on the smaller of the two values resulting from equation (1) and (2):

$$C_{Ter\min al} = C_{Rail} \ \ for \ C_{Rail} \leq \ C_{Equipment}$$
$$= C_{Equipment} \ \ for \ C_{Rail} \geq C_{Equipment}$$

In the following figure 6.3 a calculation of the transhipment capacity is made using the example of the terminal area Mannheim/Ludwigshafen. This areas composes of two public rail road terminals namely KTL in Ludwigshafen and DUSS in Mannheim. The recent total capacity is 254 000 loading units per year.

Figure 6.3: Calculation of Transhipment Capacity (example of Mannheim/Ludwigshafen)

KTL_{Rail}	= 2.256/20 x 1,6 x 1,5 x 2 x 250	= 135.360
$KTL_{Equipment}$	= (2 x 30/1,5 + 0) x 19 x 250	= 185.000
$KTL_{Terminal}$	= 135.360 LU p.a.	
$KTL_{Operator}$	= „140-150.000“	
□ KTL	**= 150.000 LU p.a.**	

$DUSS_{Rail}$	= 134.000
$DUSS_{Equipment}$	= 140.000
$DUSS_{Terminal}$	= 134.000 LU p.a.
$DUSS_{Operator}$	= „104.000“
□ DUSS	**= 104.000 LU p.a.**

Ludwigshafen/ Mannheim	**= 254.000 LU p.a.**

6.3.3 Existing transhipment volume and rate of employment of intermodal terminals

With our market survey we were also requesting for the topical **transhipment volume** of each terminal site broken down by international and national transport. In most cases we obtained 2003 data, only rarely we had to refer to 2002 figures. On the level of terminals it was much more convenient to ask for actual transhipment volume rather than using the disaggregated information from the global traffic model of phase 1.

The calculated capacity was compared to the value provided by the operators, and a resulting figure is mediated from the two sources and by means of our own expertise considering the specific situation of the terminal in question.

By means of this approach a comprehensive picture of the transhipment capacity and rate of employment could be achieved.

After performing the same approach for all selected terminals in the terminal areas the following resulting table 6.2 could be derived. It is showing only those terminals with significant rail-road and rail-rail transhipment, while pure rail-rail shunting hubs (e.g. Metz) have been excluded here.

Table 6.2: Current Transhipment Volume and Capacity [in LU] and Rate of Employment [in %] by Selected Terminal Area

Country	Transport area	N° of terminals	Transshipment volume 2002			2002 handling capacity	Rate of employment
			Total	National	International		
AT	Graz	1	50.000	9.000	41.000	130.000	38%
	Villach	1	51.289	6.668	44.621	70.000	73%
	Wels	1	102.815	33.929	68.886	132.000	78%
	Wien	2	152.115	42.394	109.721	175.000	87%
BE	Antwerpen	4	356.700	161.700	195.000	610.000	58%
	Genk	2	57.842	2.889	54.953	69.000	84%
	Zeebrugge	1	126.693		120.000	365.000	35%
CH	Basel	2	155.274	67.527	87.746	195.000	80%
CZ	Praha	2	148.600	9.600	139.000	250.000	59%
DE	Bremen/Bremerhaven	2	542.000	337.200	204.800	760.000	71%
	Duisburg	2	107.500	53.500	54.000	208.000	52%
	Hamburg	5	969.231	582.066	271.165	1.200.000	81%
	Koeln	1	265.745	72.466	193.279	237.000	112%
	Luebeck	1	42.500	0	42.500	140.000	30%
	Muenchen	1	200.000	144.000	56.000	320.000	63%
	Neuss	1	75.092	9.847	65.245	140.000	54%
	Nürnberg	2	118.800	63.800	55.000	150.000	79%
	Mannheim/Ludwigshafen	2	260.752	129.910	130.842	254.000	103%
DK	Taulov	1	75.000	25.000	50.000	80.000	94%
ES	Barcelona	3	163.000	87.000	76.000	314.000	52%
	Madrid	1	100.000	80.000	20.000	192.000	52%
	Valencia	2	105.000	43.000	92.000	240.000	44%
FR	Le Havre	2	108.946	95.500	13.446	34.000	(a)
	Paris	6	176.282	110.837	65.445	658.000	27%
HU	Budapest	2	140.000		140.000	210.000	67%
IT	Bologna	1	93.585	49.600	44.000	220.000	43%
	Milano	9	488.002	81.462	406.540	801.000	61%
	Novara	3	182.625	750	181.875	315.000	58%
	Verona	2	223.796	1.043	222.753	329.000	68%
NL	Rotterdam	2	516.000	125.000	391.000	600.000	86%
PL	Gliwice	1	30.000		30.000	30.000	100%
	Poznan	1	27.000		27.000	25.000	108%
	Warszawa	1	40.000		40.000	60.000	67%
SI	Ljubljana	1	58.300	11.100	47.200	100.000	58%
All transport areas			6.310.484	2.436.787	3.781.018	9.613.000	66%

Rate of employment calculated on 100% nominal capacity & full substitution between terminals of an area.

(a) No valid calculation since capacity only regards terminal, volume includes quayside, too

6.4 Terminal investment schedules

In order to gather the terminal investment which is already planned and scheduled to be realised by 2015 the respective transport master plans (if available) and plans of the terminal operators have been analysed. The first do normally not provide details such as the investment volume and improvement measures per terminal but only a long list of terminal areas and a lump annual or multi annual figure of state funding, whereas the latter are very much too detailed or confidential to be used in the framework of this study.

In order to overcome this unfavourable situation additional data gathering has been performed by desk research, e-mail inquiries and telephone interviews. The following country specific information could be made available for respective countries:

6.4.1 Austria

In Austria we can find a couple of rail-road terminals both in railyards and inland ports. The largest intermodal terminals in Austria in 2002 were Wien Nordwest CCT, Wels CCT, Linz Stadthafen CCT, Villach Sued CCT and Wien Freudenau Hafen CCT. A new terminal Graz Süd CCT has been inaugurated in June 2003 and is said to replace the facility in Messendorf and Kalsdorf. Their joint volume would lead to a large terminal, too and the capacity is 130 000 LU p.a.

For the future the following expansions are foreseen:

- Wien Freudenau Hafen CCT planned for 2006/7; total expected capacity will be 140 000 LU p.a. (only rail-road);
- Villach Sued CCT planned for 2006 (110 000 LU p.a.);
- Wien Inzersdorf planned for 2007/08 in order to replace Wien Nordwest with an aimed at total capacity of 160 000 LU p.a.

The detailed technical-infrastructural measures could not be derived, but the envisaged future capacity was agreed upon with ÖBB.

6.4.2 Belgium

Information on Belgium has been provided by B-Cargo. According to that, short term extension of terminal capacity is foreseen in terminals:

- Antwerp Terminal Zomerweg by end of 2004;
- Genk Haven: plus 30 000 m² space and 1 000 m track. The total expected capacity will be 42 000 LU p.a;
- Genk-Euroterminal: plus 42.000 m² space, 1.200 m track and 2 cranes. The total expected capacity will then be 80 000 LU p.a.

A long term investment was reported by Interferryboats (IFB), the terminal owner and intermodal operator. IFB argued that Antwerp Main-Hub capacity will be doubled after the relevant section of the high-speed line Brussels-Amsterdam has been completed and the potential expansion site has been made available (approx. 2012). The expected capacity will then be 460 000 load units p.a.

6.4.3 Czech Republic

The intermodal terminals in the Czech Republic (Praha) are operated by private operators Metrans (Uhrineves), Intrans (Ziskov) and Maersk (Melnik). The terminal Praha-Ziskov is due to be closed within the next two years. The largest site (Uhrineves) is used as a hub for all Metrans traffic. Extension plans have not been communicated.

6.4.4 Denmark

Information regarding the intermodal terminals in Denmark was provided by Kombidan and Railion Denmark. Extension measures are planned for the terminal at Taulov for the near and medium future. The stage of the planning is to decide to either invest on the existing (inappropriate) site or to move the whole terminal to a new location. Both options would result into an increased capacity of up to 120 000 LU p.a.

6.4.5 Germany

In Germany the terminals are owned by either German railways (DB Netz AG) or by private companies. The DB terminals are operated by DUSS, a joint venture of DB and Kombiverkehr for this purpose. The private terminals can be found in sea- and inland ports, freight villages and in other sites. They are operated by different local companies with multiple shareholders (municipalities, port authorities, shippers and forwarders, railways and intermodal operators). The information from the private operators was made available through contacts to these firms while the information concerning DB sites was finally made available by DUSS. A country wide extension planning for the next decade does not exist anymore. DB and private operators have separate plans, which are not public domain and separate funding regulations. The extension plans which have been made public concern the following sites:

- Basel-Weil am Rhein by 2003/4
- Bremerhaven by 2007
- Duisburg by 2010
- Hannover ("Mega Hub") by 2006/7
- Herne by 2010
- Ludwigshafen by 2005
- Nürnberg by 2006/7 (1^{st} phase) and 2010 (2^{nd} phase)

The Terminal **Bremerhaven** is to be extended by building up of CT IV (large vessel container terminal number 4) until 2006/2008 and parallel construction of new (rail) transhipment yard of 6 x 1 000 m for either Van Carrier or Transtainer service. The new yard will add 300 000 LU to the then overall expected capacity of 900 000 LU p.a.

The Terminal **Duisburg** DIT is planned to be extended by 2nd RMG, 1 additional transhipment track and more parking tracks in railway station. The total expected capacity will be then be 150 000 LU p.a.

The Terminal **Hannover**-Lehrte will be a completely new terminal which will be serving local volume but mainly serve as a hub for rail-rail transhipments. It shall be completed by 2007 and offer a total capacity of 200 000 LU p.a.

For the Terminal **Köln**-Eifeltor a DUSS planning foresees to add one more module (4 tracks, 2 RMG) by 2008. The total expected capacity will be: 300 000 LU p.a.

The Terminal **Ludwigshafen** KTL is to be extended by 3 tracks and 2 RMG by 2005. The total expected capacity will be: 242 000 LU p.a.

In the inland port of **Nürnberg** next to the existing transhipment facility a completely new terminal, Nürnberg-Roth (Hafen), composing of 2 modules (1. step: 4x710 m track, 2 RMG and separate Depot by 2005; 2. step: 3x700 m track, 2 RMG) will be built by 2007. The total expected capacity will be 300 000 LU p.a. The Terminal Nürnberg Hgbf will be closed after opening of the new site in Roth by 2007.

6.4.6 France

In December 2003 the General Planning Office (*Commissariat General du Plan*) published a report on the evaluation of public supporting measures for intermodal transport rail road *("Evaluation des politiques publiques en faveur du transport combine rail-route")*.With respect to intermodal terminals this report refers to the infrastructural aid for the development (creation, relocation and extension) of terminals according to the state/region plan 2002-2006. Significant measures (according to the state aid reserved) are foreseen at the following rail – road sites: Valenton, Avignon, Marseille-Le Canet, Lyon Vénissieux, Perpignan, Lomme II, Cavaillon Dourges and Dijon are in the realisation or planning phase. The evaluation concludes that in particular the numerous smaller terminals are not profitable without public subventions. On the other hand the long planning phase (e.g. 10 years for the Paris region) is lamented. In the port terminals in particular in Le Havre and Marseille further increase of (seaside) capacity is foreseen and should also incorporate the hinterland services. Generally, like for the finance of terminals the railway and intermodal operators shall play a larger role.

The terminals in France are operated by the intermodal operators CNC and Novatrans and Port Authorities. Both operators handed over information on the current business situation of their respective terminals of significant international importance. According to that replacement of equipment will take place in Noisy-Le-Sec while the terminal at Perpignan will be extended by 2007. All other improvement and infrastructure extension projects have been frozen for the time being. The French railway sector is currently undergoing a significant restructuring and the impact on intermodal transport and in particular the future of intermodal terminals is not yet visible.

6.4.7 Hungary

In the capital of Hungary, Budapest, two older terminals have been closed recently and they have been replaced by the new installation which is part of the BILK (*Budapesti*

Intermodalis Logisztikai Központ, Budapset Logistic Centre) and started operation in November 2003. International transport is concentrated on this nodal point while the plans for developing an own domestic intermodal transport systems (hub-system) have been postponed. In the area of BILK further space for expansion has been reserved, so that one module of 3 x 750 m tracks and 2 RMG can be built. The total expected capacity will then be 300.000 LU p.a. MAV and Gysev (Raaber-Bahn) are jointly developing another gateway at Sopron, mainly to serve international trains.

6.4.8 Italy

In Italy a dense network of intermodal terminals exists throughout the country. The terminals of significant international importance are those in the commercial and industrial centres in the north of Italy in the Milano area, Novara, and Verona. Further important sites are Bologna, Roma, Napoli, and Bari. Those terminal areas in the north such as Novara and in particular Milano compose of a couple of terminals which are used by separate operators to organise Gateway transports. Although the national transport plan (*Piano Generale dei Trasporti e della Logistica*) compose a chapter in favour of intermodal transport and intermodal terminals the investment has to be done by either RFI (the Italian Infrastructure Manager), local investors or the intermodal operators. Such plans are hardly to receive, but the following extensions measures could be investigated:

- Bologna Interporto (freight village) in 2008
- Busto Arsizio II and III/Gallarate by HUPAC for 2005
- Bari, new freight village in 2007
- Segrate from 2004 onwards
- Verona Quadrante Europa after 2004
- Isola della Scala (Verona) by 2007
- Melzo by 2006

The Terminal **Bologna** Interporto is to be extended by 5 tracks and 1 RMG (not yet specified) to be completed by 2008. The total expected capacity will be: 235 000 LU p.a.

The Terminal **Busto Arsizio II** is to be enlarged by 120 000 m² by 06/2005, while a completely new terminal is under construction at GALLARATE. It composes of 5 RMG (40t), 6 transhipment tracks (4 500m), 5 holding tracks (2 800m) and offer a total capacity of Busto II and Gallarate of 400 000 LU p.a.

The Terminal **Melzo** is to be extended by enlargement of area, reorganisation of the loading cycle, expension of tracks and new RMG by 2006. The total expected capacity will be 215 300 LU p.a.

The capacity of terminal Milano **Rogoredo** is reduced at least by 40% due to building of new high speed infrastructure line from 2004 on.

The Terminal **Segrate** is to be extended by the following measures: start operation in 2004 with two train pairs. The total expected capacity is: 200 000 LU p.a.

The Terminal **Novara** CIM is to be extended by 2 RMG, new entry switches for 6 tracks and offer a capacity of 250.000 LU p.a. by 2006. By the year 2015 2nd terminal CIM East made of 12x750 m track + 8x750 parking track and offering a total expected capacity of 700 000 will be planned.

The Terminal **Verona Quadrante Europa** is to be extended by 3 transhipment tracks, 5 parking tracks and 2 gantry cranes. The total expected capacity will be 380’000 LU p.a.

A completely new terminal is scheduled to be built at **Isola della Scala**, which is some 12 kms south of Verona. The operation of the facility was planned to be commenced not before 2007.

6.4.9 The Netherlands

In the Netherlands a couple of terminals are operational, both inside and outside of ports. The terminals in Rotterdam are by far dominating the intermodal volume to and from The Netherlands. Two installations, the Rail Service Centres (RSC) **Waalhaven** and **Maasvlakte** are handling the majority of transports. In 2002, about 500 000 units have been transhipped to or from rail in these terminals.

For the RSC Waalhaven only minor completion of works such as expansion of craneway by 150 m, double-sided access to remaining 4 tracks and extension of depot area) are due to be completed in 2004. The RSC Maasvlakte was completed in 2000 and supplements the existing ECT terminal, so that above all a capacity of about 500 000 units is in operation out there. A further expansion is planned in line with the port development concept named “Maasvlakte II” by the year 2012/15. Than 3 further rail-road modules (each composing of 7 tracks and 2 RMG) providing a handling capacity of altogether about 1 Mill. Units shall be installed.

While Waalhaven terminal incorporates both maritime and continental load the traffic of Maasvlakte terminals is maritime, only.

Besides minor modernisation and expansion measures in existing terminals still the planning of the “hub” at **Valburg** on the Betuwelijn close to Arnhem/Nijmegen has to be mentioned. Although the local citizens and authorities are opposing the installation due to the (stated bad) environmental impact, the transport industry still wants the new terminal. The terminal should serve as a nodal point for trains passing by on the new Betuwelijn between the port of Rotterdam and the European hinterland and other national destinations. Since it will be a “green site” installation the investment volume is large including rail and road access infrastructures, terminal infra- and superstructure. The terminal would replace the installation at Ede.

6.4.10 Poland

Generally speaking the terminal infrastructure in Poland is due to be modernized. The old portal cranes are initially designed for container handling, only. Thus semi-trailers could not be handled then. Transhipment tracks are not train-long and not equipped with stationary braking inspection installations. The on-site expansion possibilities are limited.

Terminals that are operated by PKP (e.g. Gliwice) are characterised by extensive operational processes and long pick-up and delivery times for the clients.

Terminals which are operated by Polzug e.g. Pruszkow (Warszawa), Gadki (Poznan) and Wroclaw) have undergone an investment programme (modernisation of equipment) and are due to be extended (surface, new rails, new layout).

After the 1st of May 2004 hopefully the legal problems (ownership of land, purchase of land by foreign investors) should be solved so that investment can be done in preparation of transport volumes.

6.4.11 Slovenia

Until now the international intermodal transport to and from Slovenia (SI) is concentrating in the rail road terminal in Ljubljana operated by Slovenian railways and the Port of Koper. According to information provided by Slovenian Railways it is foreseen to modernize both terminals in the next two years by installing new Gantry Cranes.

6.4.12 Spain

Until recently[4] the terminals in Spain belong to the freight section of Spanish railways (RENFE *Cargas*) while they are operated by section *Transporte Combinato* (TECO), which subcontracts the real transhipment operation from local companies. The terminals are generally grown according to the development of volume rather than according to a scheduled plan. The majority of them composes of older equipment and provisional process organisation which is limiting the capacity. In particular in the area of Barcelona the terminal capacity is loaded, the space does not allow further expansion and only a modernisation or operational optimisation may lead to further transhipment capacities. In Spain we have to distinguish between the border stations at Cérbère/Port Bou and Irun and inland terminals. At the border terminals either intermodal transport units are transhipped between trains or axles of complete wagon are changed to shift between normal and the Spanish broad-gauge line. Both border terminals are working at their respective capacity limits. A couple of Project have described the situation and proposed measures to overcome the situation, but a decision on a clear road-map and financial plan has not been taken, yet. With respect to inland terminals apart from Barcelona also Zaragoza, Tarragona and Valencia play a dominant role with respect to international intermodal transport. Expansion plans are known for Tarragona Constanti for the near

[4] RENFE is undergoing a restructuring and the situation with respect to the ownership and organisation of intermodal is going to be changed by 18.05.2004. RENFE will be separated into an infrastructure (ADIF) and a freight (Cargas) company. The terminals will belong to ADIF while the intermodal section will become part of Cargas. In this time of changing responsibilities it is hardly impossible to obtain recent data on terminals.

future. In this terminal 3 transhipment tracks of total 1 650 m and 1 holding track (700 m) are to be built so that the total capacity will become 80 000 LU p.a.

The province of Catalunya is eager to push a new terminal project in the area of Figueras which would enable to relieve the congested Barcelona terminals. Too, there are concepts to connect this new site with UIC tracks from Port Bou/Cérbère.

6.4.13 Switzerland

In Switzerland a couple of intermodal terminals are existing and served by either (international) block trains or wagon load traffic. Extension plans have been transmitted by SBB and Hupac for terminals:

- Basel for the year 2007/8 (4-5 x 700 m track and 2 RMG, total capacity for 2nd phase: 200 000 LU p.a.)
- Zürich for the year 2010/11

While the site at Basel-Nord shall replace Basel-Wolf and serve as a nodal point for international services it is intended to use the new site at Zürich as a Gateway where international block trains are transferred into domestic services.

6.4.14 Other

Information regarding **Slovak Republic** has not been collected since Slovak Republic is out of the selected UIC Corridors.

Information regarding **Sweden** has not been collected since Sweden is out of the selected UIC Corridors. The international intermodal transport between the Western and Central Europe and Sweden is partly using the “land bridge” and partly operated through the RoRo-Ferries in which case the terminal infrastructures in Lübeck and Rostock in Germany and their corresponding port terminals in Malmoe, Helsingborg and Trelleborg are used. From these ports Rail Combi AB, the Swedish subsidiary of CargoNet AS is organising domestic transport to Swedish destinations.

Information regarding **United Kingdom** has not been collected since UK is out of the selected UIC Corridors. Nevertheless, the international intermodal traffic to and from UK has had been integrated in the network model (phase 1).

The information obtained from these sources (4.1-4.14) has been assessed and finally transferred into the terminal database as a quantified figure for the planned transshipment capacity for the year 2015.

For all those terminals where no information about the closing of the site was received we assume a stability of capacity by either ongoing utilisation of the same equipment or replacement of used equipment and worn out infrastructures.

By cumulating the existing and planned capacity, finally, the total future capacity of a terminal and/or terminal area could be given (see also chapter 6).

6.5 Deduction of 2015 Capacity Requirement (target) on European Terminal Areas from Prognosis

Based on the database of international intermodal transport flows between terminal areas (access points) 2002 and assumptions on the country-to-country or corridor specific growth rates a prognosis matrix of intermodal transport in the year 2015 was elaborated and put on the model rail network (phase 1).

By re-transforming the prognosis data into terminal area related figures an indication on the future potential and growth rate of a terminal area could be given. By applying the area related growth rate to all terminals of an area the total prognosis transshipment volume of these terminals and thus the capacity requirement (target) on European terminal areas can be deduced (see Fig. 6.4). The result is presented in the following table 6.3.

Table 6.3: Determination of Transhipment Volume [in LU] by 2015

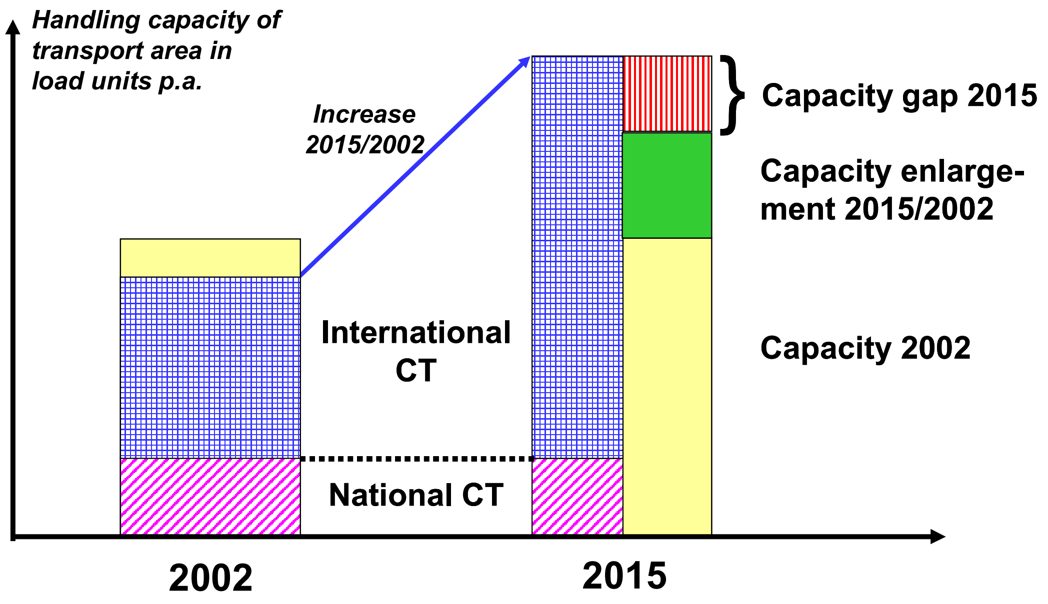
Country	Transport area	Transshipment volume 2002		2015/2002 internat. traffic	2015 total volume
		National	International		
AT	Graz	9.000	41.000	212%	137.000
	Villach	6.668	44.621	157%	121.000
	Wels	33.929	68.886	114%	181.000
	Wien	42.394	109.721	119%	282.000
BE	Antwerpen	161.700	195.000	132%	614.000
	Genk	2.889	54.953	168%	150.000
	Zeebrugge		120.000	155%	306.000
CH	Basel	67.527	87.746	94%	238.000
CZ	Praha	9.600	139.000	100%	288.000
DE	Bremen/Bremerhaven	337.200	204.800	139%	813.000
	Duisburg	53.500	54.000	108%	166.000
	Hamburg	582.066	271.165	136%	1.222.000
	Koeln	72.466	193.279	130%	517.000
	Luebeck	0	42.500	138%	101.000
	Muenchen	144.000	56.000	149%	283.000
	Neuss	9.847	65.245	109%	146.000
	Nürnberg	63.800	55.000	138%	195.000
	Mannheim/Ludwigshafen	129.910	130.842	139%	443.000
DK	Taulov	25.000	50.000	109%	130.000
ES	Barcelona	87.000	76.000	189%	307.000
	Madrid	80.000	20.000	200%	140.000
	Valencia	43.000	92.000	166%	288.000
FR	Le Havre	95.500	13.446	132%	127.000
	Paris	110.837	65.445	144%	270.000
HU	Budapest		140.000	88%	263.000
IT	Bologna	49.600	44.000	140%	155.000
	Milano	81.462	406.540	158%	1.130.000
	Novara	750	181.875	162%	478.000
	Verona	1.043	222.753	147%	551.000
NL	Rotterdam	125.000	391.000	122%	993.000
PL	Gliwice		30.000	90%	57.000
	Poznan		27.000	98%	53.000
	Warszawa		40.000	97%	79.000
SI	Ljubljana	11.100	47.200	60%	87.000
All transport areas		2.499.787	3.850.711	138%	11.540.000

6.6 Determination of additional terminal infrastructure investment

The additional terminal infrastructure needed to comply with the prognosis volume 2015 is a resultant which can be derived from the existing 2002/3 transshipment capacity and volume on the one hand and the future (2015) capacity and prognosis volume on the other.

The following figure 6.4 is presenting the way of calculation in a graphical form:

Figure 6.4: Graphical Presentation on Determination of Capacity Need



The future (2015) transshipment **capacity** of terminal (terminal area) is the existing capacity plus the planned extension measures.

The future (2015) transshipment **volume** (prognosis) of a terminal (terminal area) is the existing volume (separated into domestic and international traffic) in which only the international part is multiplied by the growth factor (of the appropriate terminal area).

We refrain from assuming a separate growth rate (which may be positive or negative) for transshipment resulting from **national transports**, for two reasons:

1. the UIC-Study is concentrating on the **impact of international intermodal transport**. After thorough analysis of multiple studies, expert interviews and validation process this type of traffic was subject to particular analysis and forecasting on the respective UIC-corridors (see phase 1), while the national intermodal transport is included in the network model as base load of the railfreight network, only. A validation of the modeled volumes on the level of loading units per terminal can not be performed in the framework of this study.

2. national intermodal transport is dependent on **national framework conditions**, behavior of the infrastructure managers and strategies of the railway undertakings to offer competitive train prices between terminals. A wide-spread of scenarios is under discussion in Europe. In The Netherlands practically no domestic intermodal transport takes place, in Norway CargoNet is concentrating on shuttle trains and has abandoned wagon load traffic, while in Switzerland and Austria mixed systems are used to serve sidings and national terminals. A detailed consideration of all these developments and strategies and assessment of their impact on national intermodal transport can only be executed in a separated much more detailed study.

We therefore opted to maintain the existing 2003 national transshipment volume as a constant for the future terminal volume as well.

The future additional capacity **"need"** of a terminal (terminal area) is than calculated as the difference or **"gap"** between the future capacity and the prognosis volume. We have decided to display two alternative calculations of the "need".

- In the first "Maximum Need" Scenario the need is calculated on the basis that
  - the practical capacity limitation of a terminal is already reached at 80% of its nominal capacity and that
  - the individual terminal "needs" are added rather than assuming a collective capacity within the region.
- In the second "Minimum Need" Scenario the need is calculated on the basis that
  - 100% of the nominal capacity are the threshold for expansion and
  - the collective capacity of a region is confronted with the collective demand.

This calculation is taking into account that some terminals are able to provide a good quality of service even beyond their nominal capacity, while other terminal seem to be "overloaded" at volume less than their capacity. According to experience the punctuality of trains, not favourable historic layouts and extreme intermediate storage as well as not optimal organisation can reduce the capacity dramatically and thus require an expansion need below the nominal capacity.

The data is calculated on the capacity and volume of individual terminal of a region while it is displayed on the basis of terminal areas. This implicates that the "free" capacity and services are interchangeable between terminals of a region. This is practically not easy to organize since terminals may have different operators, catchment areas and trains offered. The two scenarios take into account that such capacity sharing takes place (scenario 2) or not (scenario 1).

The "need" is the additional capacity needed to comply with the future volume. Additional investment to replace used equipment and worn out infrastructures (**replacement**) has not been taken into account. In order to do that carefully a detailed analysis of the age and wear of infra- and superstructures which could not be performed in the framework of this study, but is highly recommended since it can be expected that the historically built terminals are aging and tend to operate at their lifetime limits.

As a result of the analysis the following table 6.4 was elaborated. It shows a mediation between the two scenario assumptions namely the most **probable** additional capacity need, calculated on the basis, that

- capacity is saturated at 80% rate of employment and
- full substitution between terminals of an area is possible.

Table 6.4: Determination of expected "Need" by Terminal Area by 2015

Country	Transport area	Capacity 2015	Total volume 2015	Rate of employment	Probable capacity gap 2015
AT	Graz	130.000	137.000	105%	33.000
	Villach	110.000	121.000	110%	33.000
	Wels	132.000	181.000	137%	75.400
	Wien	300.000	282.000	94%	42.000
BE	Antwerpen	940.000	614.000	65%	
	Genk	122.000	150.000	123%	52.400
	Zeebrugge	365.000	306.000	84%	14.000
CH	Basel	390.000	238.000	61%	
CZ	Praha	200.000	288.000	144%	128.000
DE	Bremen/Bremerhaven	1.060.000	813.000	77%	
	Duisburg	318.000	166.000	52%	
	Hamburg	1.200.000	1.222.000	102%	262.000
	Koeln	300.000	517.000	172%	277.000
	Luebeck	140.000	101.000	72%	
	Muenchen	320.000	283.000	88%	27.000
	Neuss	140.000	146.000	104%	34.000
	Nürnberg	320.000	195.000	61%	
	Mannheim/Ludwigshafen	346.000	443.000	128%	166.200
DK	Taulov	120.000	130.000	108%	34.000
ES	Barcelona	348.000	307.000	88%	28.600
	Madrid	192.000	140.000	73%	
	Valencia	236.000	288.000	122%	99.200
FR	Le Havre	39.000	127.000	(a)	(a)
	Paris	658.000	270.000	41%	
HU	Budapest	300.000	263.000	88%	23.000
IT	Bologna	235.000	155.000	66%	
	Milano	1.057.925	1.130.000	107%	283.660
	Novara	805.000	478.000	59%	
	Verona	780.000	551.000	71%	
NL	Rotterdam	1.400.000	993.000	71%	
PL	Gliwice	32.000	57.000	178%	31.400
	Poznan	65.000	53.000	82%	1.000
	Warszawa	60.000	79.000	132%	31.000
SI	Ljubljana	150.000	87.000	58%	
Total terminals		13.271.925	11.184.000	84%	1.675.860

The terminal areas in which according to the assumptions and considerations of our analysis a need to offer **additional transshipment terminal capacity** to comply with the increasing international unaccompanied intermodal transport are shown in Table 6.5.

Table 6.5: Terminal areas with additional capacity need

Country	Terminal areas with additional capacity need
Austria	Graz Villach Wien Wels
Belgium	Genk Zeebrugge
Czech Republic	Praha
Denmark	Taulov
Germany	Hamburg Köln München Neuss Ludwigshafen/Mannheim
Italy	Milano
Poland	Gliwice Poznan Warszawa
Spain	Barcelona Valencia

Moreover, further capacity enlargement is required at almost all terminal areas under the condition that a utilization of 80% is already requiring an increase and that the spare capacity of one terminal can not be shared with another terminal of the same area (scenario 1).

It has to be underlined that additional impact on the terminals originates from positive development of national intermodal transport and from the inauguration of sophisticated train operation forms, e.g. shuttle trains with short staying times in the terminals or Gateway systems with the need of rail-rail transshipment in demanding time windows. In addition particular local developments may call for specific extension measures that could not be shown by the macroscopic approach.

Nevertheless, the step approach chosen to identify the additional terminal infrastructure investment need resulting from the increasing international intermodal transport in selected European terminals on the UIC corridors is showing valid results.

Their interpretation with respect to conclusions and recommendation has been carried out in phase 3 of the study (cf. chapter 7).

7. Conclusions and recommendations

Phase 3 of the study addresses the conclusions and recommendations drawn from the results of the previous phases 1 and 2. Thus this chapter deals with

- conclusions regarding the rail network capacity (cf. chapter 7.1) and the intermodal terminal capacity (chapter 7.2) in terms of infrastructural measures;
- recommendations with respect to additional (operational) measures, which could be taken by intermodal actors (chapter 7.3).

7.1 Conclusions regarding the Rail Network

7.1.1 Model assumptions and their effects on the capacity analysis

The results of the capacity analysis of the rail network per consolidated corridor are presented in detail in chapter 5 of this report. These results have to be considered in the light and the limitations of the model assumptions discussed in chapter 4.

From the beginning it was clear that a capacity analysis covering the entire rail network in Europe could only be completed on the basis of simplifying model assumptions, and that the work so far carried out, however comprehensive and differentiated, does not render extensive and detailed capacity analyses superfluous. However, the data basis worked out in connection with this study provides an excellent basis for these in-depth analyses. The following pages summarise the most important model assumptions and their effects on the capacity analysis.

Theoretical maximum capacity per corridor

The capacity of a corridor depends on a number of quite different factors such as the characteristics of the tracks, the combination of fast and slow train movements and the flow factor of the junctions. Naturally these data are not available for the entire European rail network.

As described in chapter 4.6, our calculations for the base year 2002 are therefore based on a theoretical maximum capacity (= 100%) of 144 train movements per day and direction on 2-track electrified corridors. This marginal value has proved very worthwhile in various investigations for network and railway operators and was judged to be a realistic average estimate.

The forecast horizon for 2015 is based on a 20 % higher maximum capacity of 173 train movements. This value reflects progress in productivity and the signalling systems. This estimate was also verified in a number of investigations, in particular in Germany and France.

A transfer of this maximum value for 2015 to the entire European rail network can definitely be regarded as a relatively optimistic assumption of the then available capacity.

Base load in passenger transport

As explained in chapter 4.3, our calculations for the long-distance passenger transport were founded on train figures observed per corridor in 2002 and then projected for 2015 by means of a UIC study.

With regard to the regional passenger transport it was also possible to employ observed values for certain axes. For the majority of the corridors a hypothetical hourly interval between 6.00 and 18.00, i.e. 12 trains per day and direction, served as a basis for our calculations. On corridors along densely populated areas and in countries with dense passenger transport (such as the Netherlands and Belgium) half-hourly intervals in the same period, i.e. 24 trains per day and directions, were calculated. In the sense of a „ceteris paribus“ assumption we have not assumed an increase in the number of trains in regional transport for 2015.

This can also be considered relatively optimistic in view of the available remaining capacity for freight transport.

Capacity load parameter for freight trains

Calculations for 2015 are based on relatively optimistic capacity load parameters for freight trains (cf. chapter 4.1). The maximum train length Europe-wide was estimated to be 750 m with a maximum weight of 1,500 tonnes. The average utilization of loading length of intermodal trains was raised from the current 70% to 80% in 2015.

As these assumptions are very near the upper limit, they must also be considered as optimistic with respect to the additional infrastructure needed.

Enlargement or reconstruction measures in the European rail network

In view of the limited means of investment, assumptions regarding a capacity increase through enlargement or reconstruction measures within the European rail network are also based on a relatively progressive enlargement standard for 2015.

Scenario of the transport development

As is evident from chapter 3 of this report, our estimates are founded on the assumption of a rather conservative transport development until 2015. In this case there would be an increase in the number of trains in international combined transport („CT“) of 102%, the international conventional transport is expected to increase by approx. 86 % whereas the national CT is expected to grow by about 50%. The trains of the national conventional transport, which in absolute terms has the largest volume, will only increase by 25% until 2015 (cf. figure 4.2).

In conclusion it can be said that all major model assumptions tend to aim at eliminating bottlenecks and that the individual analyses of the corridors carried out in chapter 5 are to be seen as altogether optimistic with respect to the additional capacity needed. As a consequence neglecting the identified needs would cause a significant impediment for the further increase of international rail freight services.

7.1.2 Capacity bottlenecks by 2015

Despite the optimistic assumptions regarding the available capacity, the corridor specific capacity analysis for 2015 in chapter 5 still reveals a large number of bottlenecks which call for enlargement measures on the section itself or on parallel alternative routes.

The most important bottlenecks are found on the following axes:

Country	Axes with bottlenecks
Germany	Hamburg – Fulda - Rhein/Main
	Köln – Rhein/Main
	Saarbrücken – Stuttgart
France	Metz – Dijon
	Lyon – Avignon
	Paris – Orléans – Tours
Belgium	Freight corridors from/to Antwerp
Switzerland	Greater Basel area
Spain	Barcelonan - Tarragona

The table above very clearly shows that these bottlenecks are located on the major European freight corridors and that, consequently, the elimination of these obstacles is of great strategic significance.

Together with the enlargement programme, as assumed in the capacity analysis, the results of the investigation have proved very conclusively that considerable efforts will be required up until 2015 to cope with the increased volume of transports even if the transport development remains moderate.

In addition to the individual measures in the rail network, which are described in detail in chapter 5, a number of other measures have to be mentioned in connection with the entire rail network.

- Enlargement of a dedicated freight network such as carried out by for instance B-Cargo on the route Athus-Meuse or as envisaged in the projects NEW OPERA or Magistrale Eco Fret.
- Priority networks for rail freight transport on existing corridors with rationalization investment (DB – Project „Netz 21“)
- An overall loading gauge enlargement to allow for P400 codification in the mayor European rail lines (in particular in one or two lines in France)
- Avoiding the closing down of fly-overs or the establishment of alternative sidings to maintain the operational flexibility on the loaded corridors.

The implementation and advantages of these measures have to be examined and analysed in depth individually. The data base elaborated for this study (cf. table 4.6) supplies the relevant information for priority works.

7.2 Conclusions regarding Intermodal Terminals

7.2.1 Results of the capacity analysis of representative intermodal terminals

In the framework of the capacity study an analysis of the existing capacity, the employment, and the 2015 capacity requirements of terminals for unaccompanied intermodal transport on selected UIC freight corridors have been carried out. This part of the investigation was composed of study consisted of six sequential steps:

1. Identification of representative CT terminals based on the global international CT prognosis (phase 1) and the following three criteria:
    - Significant handling volume in 2015;
    - Only CT terminals disregarding shipper's sidings, rail hubs like Metz, on quay loading in container ports;
    - Transport areas at the end of UIC corridors, which function as access points for the forecast model.

    Finally the 25 largest CT transport areas and 9 end-of-corridor transport areas were selected for further detailed investigation.
2. Analysis of the handling capacity of 71 CT terminals in these 34 selected areas by exploiting the terminal managers' expertise and, if not provided, application of acknowledged calculation schemes. These schemes take into consideration technical and operational data of the terminal such as the number and length of tracks and the available transshipment equipment. As a result a current handling capacity could be determined for all terminals. The total annual capacity installed in these terminals was about 9.3 mill loading units (2002).
3. Investigation of handling volume of 71 CT terminals in 2002/3 by collecting transshipment volume disregarding operational handling, broken down by national

and international transport, consolidation of terminal-related handling volumes to transport area related figures, if applicable, and calculation of a current rate of employment per terminal area. The rate of employment is calculated on the basis of 100% of the nominal capacity and full substitution between the terminals of an area. The total volume handled in these 71 terminals was 6.3 mill loading units (2002) and thus the overall calculated employment rate was 66%.

4. Capacity requirement (volume) of CT terminals in 2015 calculated by maintaining the current 2002 domestic transport volume and applying the terminal area specific growth rates from the transport prognosis to the respective current international transport volume of each terminal of the respective transport area, and aggregation of data by area. The capacity requirement of all 71 terminals will be 11.5 million handlings of intermodal load units p.a.

5. Capacity enlargement investment 2015/202 by investigation into enlargement investment schemes of terminal owners or operators in 13 European countries, own database and expertise and transformation of the information into distinct figures for the planned capacity in 2015. It has been assumed that the existing capacity will be maintained apart from those terminals which have reported a de-investment. The total transhipment capacity of the 71 terminals in the year 2015 will be 13.3 million load units, provided that all scheduled investments will be realised.

6. Additional need for investments by 2015 has been derived on the basis of the results of the previous steps. A capacity gap will appear if the forecasted volume exceeds the current and planned capacity. In order to calculate the probable gap we have assumed that the operational capacity limitation is already reached at a threshold of 80% of the nominal capacity and that all terminals of a transport area provide their collective capacity (substitution between terminal sites within a transport area is possible) to the market.

As a **result** of this approach, 34 representative transport areas covering 71 terminal sites, which make up some 85% of the total international CT volume by 2015, were analysed. The total estimated transhipment volume (national and international CT) of these sites amounts to 11.4 million loading units. This implies an increase of 80% compared to the 2002 volume (6.3 million loading units).

Plans to enlarge CT transshipment capacity by 2015, both the extending of existing or the building of new terminals, are envisaged in representative transport areas. The total transshipment capacity is expected to be 13.3 million loading units by 2015. This means an increase by 39% compared to the 2002 figure (9.6 million loading units).

A comparison of the total volume to the total nominal capacity would lead to an overall 86% utilization of the capacity in 2015.

7.2.2 Additional Capacity Needs in 2015

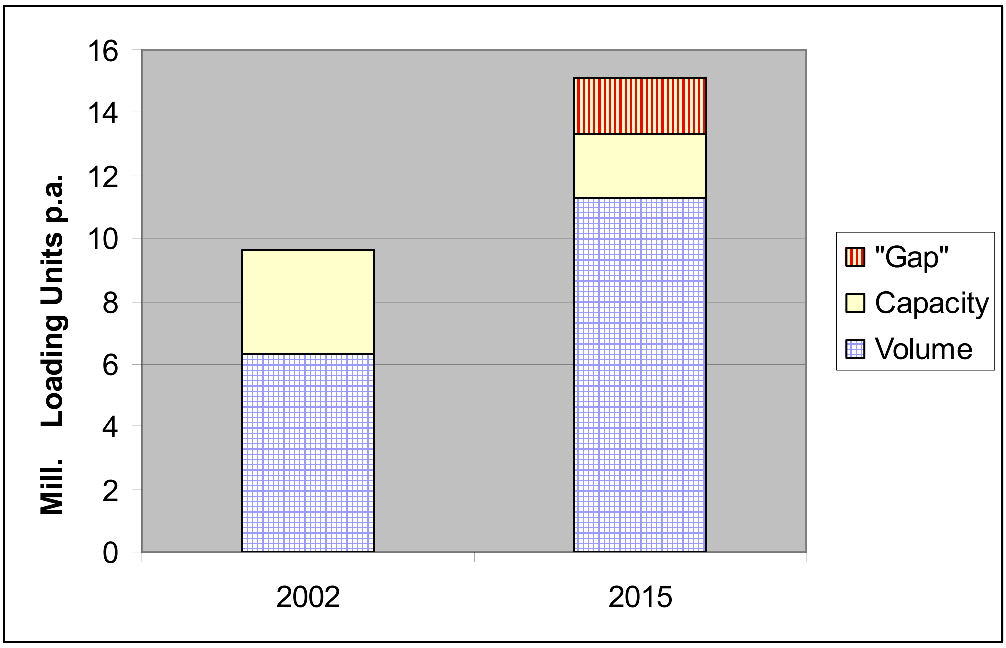
Despite this calculated global utilization rate, transshipment capacity "gaps" are likely to arise in 20 out of representative 34 transport areas.

The list comprises the "usual suspects", CT areas with large facilities, and the "surprisers", more peripheral and medium-sized CT areas. Particularly high capacity "gaps" have been identified for the following areas:

Country	**Transport areas with additional capacity need**
Austria	Graz Villach Wien Wels
Belgium	Genk Zeebrugge
Czech Republic	Praha
Denmark	Taulov
Germany	Hamburg Köln München Neuss Ludwigshafen/Mannheim
Italy	Milano
Poland	Gliwice Poznan Warszawa
Spain	Barcelona Valencia

On top of all already scheduled investments, another 13 % of transshipment capacity for 1.7 million loading units p.a. are likely to be required in order to meet CT demand with respect to prognosis, and maintain service quality in these transshipment areas.

Figure 7.1: Visualisation of the total capacity, volume and accumulated "gap" of 34 selected areas in 2002 and 2015



Additional capacity would be needed in single terminals, if the assumption of "substitution of capacity" cannot be realized to that degree (100%) either because the operators do not agree or because other operational constraints prevent a shifting of volume. Such constraints could be:

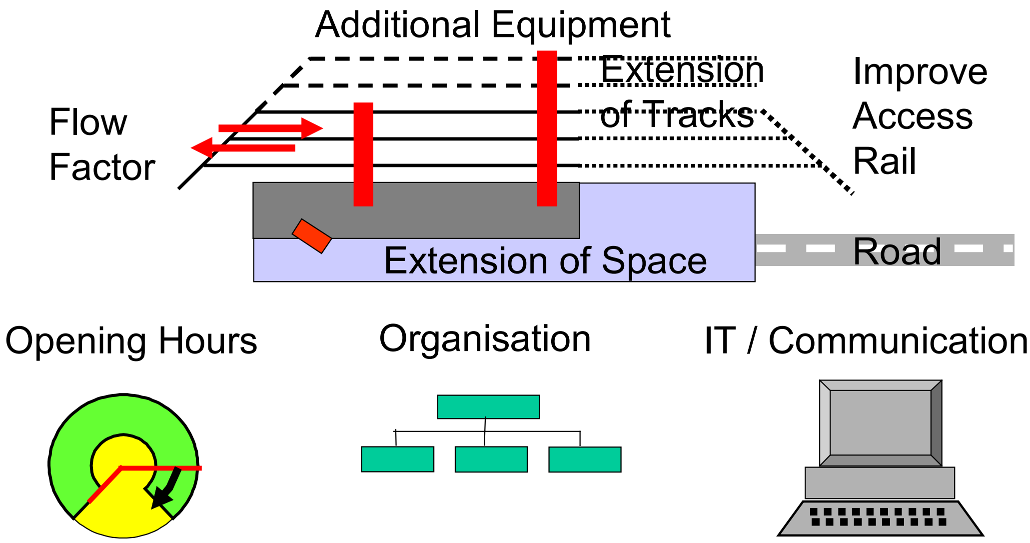
- Location in relation to gravity of customers
- Accessibility by rail and road (infrastructural and operational)
- Discrimination of free access (commercially)
- Length of transhipment and parking tracks
- Involvement of GATEWAY transhipments to corresponding trains in the same terminal.

7.2.3 Actions to increase transshipment capacity

The extension measures foreseen in the respective terminals normally foresee infrastructural measures such as the adding or extension of transshipment tracks or the replacement or adding of handling equipment, both railbound and mobile, or the extension of buffer and depot space. These measures are in the hands of the terminal owners. Further improvement plans related to e.g. the road-side and rail-side access or the capacity and operation of the railway (garage) sidings have not been mentioned, although they may be needed in addition to the improvement of the entire terminal.

Above all “soft” measures such as the improvement of the organization, the application of terminal management and control tools and the extension of the opening hours can lead to an increased capacity of the terminal.

Figure 7.2: Variety of Extension Measures



=> infrastructural, operational and „soft“ measures

Typical **infrastructural measures** currently being applied in the respective enlargement projects throughout Europe are:

- Building of completely new “greenfield” terminals e.g. Isola della Scala consisting of one or more transshipment modules and the necessary access infrastructure (rail and road);
- Extended loading tracks to accommodate full train length (the length can vary from country to country depending on the maximum train length accepted on the rail network);
- Enlarged area (buffer, storage space, value added services);
- Installation of additional loading and parking tracks of which the loading or transshipment track are inside of the terminal (reachable by rail-mounted gantry cranes or reach stackers); the parking tracks can be placed in a rail yard outside but in the vicinity of the terminal;
- Supplementary handling equipment/modernized handling equipment able to serve a larger area (larger span or outreach of gantry cranes), higher stacking capacity of mobile equipment or increased performance (e.g. traveling, hoisting and thus transshipment speed);
- Rail and Road Access (Access Roads, Gate, Electrification, double-sided access, sufficient sidings).

7.3 Recommendation with respect to Services and Products

The measures listed in detail in chapter 5 and amplified in chapter 7.1 are initially aimed at more or less extensive reconstruction and enlargement actions. In addition, a number of innovative „soft measures“ can to some extent result in a considerable increase in capacity if an appropriate infrastructure capacity cannot be provided.

7.3.1 Railway Operation

When the prognosis was carried out, a series of measures aimed at raising the capacity were included (extension of the maximum train length to 750 m, extension of the maximum train weight to 1,500 tonnes, increase of the net capacity load factor to 80%). Other possible measures such as shorter block distances, improved operational/signalling systems would result in a capacity increase of +20% on the rail net.

The measures listed below focus on an application of intelligent or innovative measures to increase the train path capacity over and beyond those measures already considered. The applicability of these measures will also have to be examined on the different axes and the individual markets. The available data base is suitable for this purpose.

Train Path Capacity

In order to increase the train path capacity, the following approaches can be made:

- Homogenization of train path scheduling
- “Bypass” of congested lines by using parallel or alternative routes
- High service quality reduces time-buffers in train path construction

Mixed Trains

Examining the application of mixed trains consisting of intermodal and wagon-load traffic to raise the bundling effect, and thus decrease the slot requirement.

Improved Wagon Technology

- reduced tare weight to raise payload factor
- increased net loading length (Flexi-Wagon)

7.3.2 Intermodal Operators

Apart from the railway infrastructure managers and railway undertakings, the intermodal operators, too, have a various opportunities to improve the utilisation of rail infrastructure capacities. Amongst others the following measures are important to be considered:

- Coming closer to the origin/destination of cargo flows and enlarging intermodal service network by substituting the original/final road leg by rail (Verona to Bologna etc.): shift of volumes from international key terminals to other locations and extending the rail service network.
- Enforcement of capacity management system (CMS) of intermodal operators aimed at increasing the capacity load factor of trains. A CMS is able to provide real-time information on the availability of empty places on trains and can thus assist to fill them by either disposition of already available loading units to earlier departures, alternative routings, last-minute shipments etc., so that above all the utilisation of the maximum train capacity is increased.
- Substitution of less efficient rail products for international CT services e.g. accompanied by unaccompanied CT services. Accompanied CT is a bypass measure on selected relations with demanding political framework conditions, but the net-tonnage of goods transported on the rail network compared to the tare load is significantly worse compared to other form of CT. In order to achieve a higher transportation of goods both in terms of volume (tonnes) and performance (tonne-km) unaccompanied CT services provide a better utilisation of the given limited rail infrastructure capacity.
- Efficient production systems to bundle volumes, like GATEWAY or other hub services
- Raising customer satisfaction to catch shippers' base volumes currently carried by trucks to achieve more regular volumes and reduce volatility of capacity load factor and thus reduce the difference between road and rail.

7.3.3 Terminal Operation

According to the findings of the study, the transshipment capacity does not become a major bottleneck provided that the enlargement schedules are realized. However, it is questionable whether these enlargement investments will come into operation on time to avoid temporary capacity shortages and quality deficiencies.

- It is therefore highly recommendable to calculate sufficient time for planning, approval procedures and financing, construction and opening of the enlarged terminals and their access infrastructure.
- As the interface between road and rail the terminal is the most crucial part of the CT supply chain, sufficient handling capacity is a prerequisite for ensuring high-level performance.
- It is therefore advisable to allow capacity reserves to prevent the terminal from becoming a bottleneck, both in terms of nominal capacity and quality of services.

In addition to these measures linked to the proper implementation of infrastructure enlargement, a number of "soft" tools to overcome infrastructure capacity limitations can be recommended for intermodal terminals.

- The first and decisive factor is qualified terminal management and staff working inside a terminal.
- The second most important factor are actions to optimize the capacity employment of intermodal terminals, e.g. by
  - ► Enhancement of process organization, and operations (clear definition of roles and interfaces) supported by an IT terminal management system
  - ► Eliminate redundant processes
  - ► Extended opening and working times
  - ► Increased flow factor to improve use of rail tracks
  - ► Bonus-malus-system applied to interim storage, and collection/delivery of intermodal units
- A 3rd factor is the creation of “public” terminals operated by “neutral” companies permitting non-discriminatory access to any intermodal operator; this will create a bundling effect with respect to intermodal volume and thus a better utilization of the installed capacity.

7.3.4 “UIC Master Plan”

The results of this (global) study create a perfect basis for the establishment of a more detailed European development programme on CT terminals (UIC Master Plan). This would require

- validating of model assumptions like the persistence of industrial and logistical structures
- investigating into the development of national CT
- considering local customer behaviour patterns
- taking into account replacement investment needs depending on age structure of infrastructure and superstructure
- considering the impact of rail production schemes like the GATEWAY system on capacity requirement (rail-rail handlings)

The development of CT terminals appears to be poorly co-ordinated:

- No co-ordinated investment schemes on national levels except for France and, to some extent, Italy
- No cross-country co-ordination of terminal investments
- Lack of co-ordination may jeopardize CT development: e.g. an enlargement of Verona would bring no alleviation if München was jammed.

This study recommends to considering the possibility of a co-ordinated CT terminal development, which could be undertaken on two levels:

- Piloting on a bilateral basis or on a major European freight corridor

- EU-wide plan (Master Plan)

It should also be investigated if such an innovative approach is eligible for being funded as “Common learning Action” under the Commission’s Marco-Polo Programme.