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# Towards a " *Primary European Rail Freight Network*" (PERFN) (Version 5.5) *Contribution of the Industry based on six Corridor Business Cases*

CONTRIBUTION

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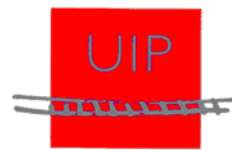


## ACKNOWLEDGEMENTS

This paper summarises the results of the six corridor business cases carried out by CER between October 2006 and July 2007 and proposes a vision for a Primary European Rail Freight Network (PERFN). It has been developed based on research done with the assistance of:

- McKinsey & Company
- the ERTMS Deployment Project coordinated by the European ERTMS Coordinator, Karel Vinck
- UIC, the International Union of Railways
- the CER members, i.e. both CER's infrastructure manager members and railway undertaking members. Within the railway undertakings group, both the freight side and the passenger side have been involved. In this way, a common position could be achieved of the rail sector (in all its components).

This paper has also been discussed with and its general principles are supported by the following customer organisations:



CER would like to thank all the parties involved for their invaluable input.

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## Executive Summary

The Lisbon Strategy sets ambitious targets for European GDP growth that cannot be considered without a performing and sustainable transport sector. In this context, economic and environmental reality indicates that the expected significant growth in transport demand has to be absorbed, in the first place, by the European railway system. Europe therefore needs a well-functioning rail system, based on a modern and, above all, sufficient rail infrastructure.

Based on concrete business cases, CER with the support of UIC and McKinsey, has developed a picture of what such freight network could look like on six major trans-European freight corridors. In order to support economic growth and to guarantee a high level of service quality, European rail freight policy has to provide 1) an infrastructure, without, as today, more and more bottlenecks; 2) an infrastructure capable of accommodating longer trains; 3) an adequate network of freight terminals. By removing bottlenecks, additional capacity will be created and service quality will improve. By upgrading the infrastructure to, notably, allow accommodating longer trains, unit costs will go down and productivity will increase, attracting more freight to rail.

The CER picture is based on a maximum increase of freight demand of 72% until 2020 accompanied by a modest increase of rail modal share. However, while consulting customer organisations, CER has received strong messages that a more ambitious vision should be considered, based on a willful increase of rail share to 30%-35%. Two customer driven projects supported by the European Commission, NEW OPERA and FERRMED, will present such a vision, based on full track dedication to freight, in the second half of 2008. In the meantime, as a first step towards a dedicated freight network, the CER vision, based on six business cases carried out with the support of McKinsey, is as follows:

1. A core rail network of freight-dedicated and mixed-traffic trans-European lines can be defined as the backbone of a wider network catering for rail freight needs. This core network is called **PERFN (Primary European Rail Freight Network)** and originates in the six ERTMS corridors. The six corridors for which business cases were carried out by CER and McKinsey would form an essential part of the PERFN.
2. The PERFN, as defined in this paper, should provide enough capacity to absorb a growth of up to 72% of rail freight until 2020. In the context of an expected general transport growth of 30% to 43% during the same period, this would mean an increase of the rail modal share from 17% in 2006 to potentially 21% - 23% in 2020.

3. These 72% of extra capacity would be obtained as follows:
  - 20% through the productivity gains of the railway system itself (future technological advances, optimisation of the use of existing capacity);
  - 41% through investments in relieving infrastructure bottlenecks;
  - 11% through infrastructure upgrades, notably, to accommodate trains of 750m and longer.
  
4. For this, up to 145.4 billion Euros would be needed **over the next 15 years** on the six corridors considered, of which 35.5 billions are already committed in existing budgets. Therefore, **an actual amount of 109.9 billion Euros would still need to be found over the next 14 years**. Also, it is likely that more funds will be needed to adapt the rest of the freight-relevant network.
  
5. Of this amount of 145.4 billion Euros,
  - a. Around 3.5% (5.1 billion Euros) would be spent on infrastructure upgrades, mostly to allow longer trains on the PERFN.
  - b. Around 84.5% (122.9 billion Euros) would be spent on relieving bottlenecks (congested nodes and lines) and expanding existing freight terminals and marshalling yards.
  - c. 12% (about 17.4 billion Euros) would be spent on ERTMS fitting (including adaptations of “interlockings” in relevant countries and on-board equipment)<sup>1</sup>.
  
6. In the years to come, ERTMS will play a major role as the common European signaling and train control system. As the European ERTMS coordinator Karel Vinck stated, the benefits of implementing ERTMS can however only be reached if capacity is simultaneously increased.

**Recommendation:** These facts and figures concerning investments needs on six key European rail freight corridors will allow the European Commission to **organise ministerial conferences** for each corridor in 2007. The objective should be to get clear commitments from all the key players - European Commission, National Governments, Rail Infrastructure Managers and Railway Freight Undertakings - for the development of each one of these corridors up to 2020.

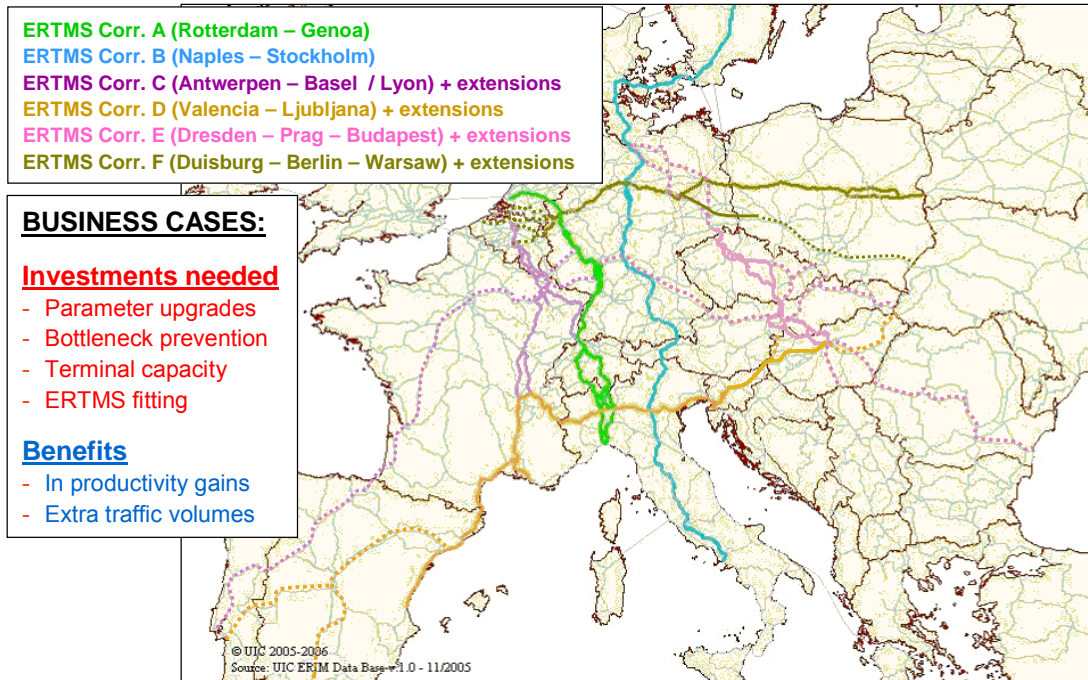
Only common simultaneous commitments can open up a timely and reliable perspective for the European rail infrastructure (including ERTMS adaptations). Otherwise, there will be the risk that insufficient capacity on the most important rail freight corridors could become a limiting factor to growth and employment in Europe, i.e. to the successful implementation of the Lisbon Strategy.

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<sup>1</sup> ERTMS investment data taken from the 2006 ERTMS corridor reports of the European Commission..

## Six business cases for a Primary Freight Network...

- Original **ERTMS corridors** are marked in **continuous lines**
- **Extensions** to the original ERTMS corridors are marked in **dotted lines**



### Cost/benefits of the actions needed on six corridors investigated (Summary).

SUMMARY FOR ALL 6 CORRIDORS	Infrastructure upgrades	Bottleneck alleviation	Terminal capacity enhancements	ERTMS fitting
Cost, of which:	5.1 bil. €	120.5 bil. €	2.4 bil. €	17.4 bil. €
- Committed	(0.8 bil. €)	(34.0 bil. €)	(0.7 bil. €)	(0.0 bil. €)
- Not committed yet	(4.3 bil. €)	(86.5 bil. €)	(1.7 bil. €)	(17.4 bil. €)
Productivity gains	+2-4%	Not assessed	Not assessed	None
Benefits (in traffic growth)	+72%			

\* including 5.5 billion Euro interlocking costs.

## 1. The case for a Primary European Rail Freight Network (PERFN)

This paper promotes the concept of a Primary European Rail Freight Network (PERFN).

### 1.1 What is a primary freight network compared to a dedicated one?

*Dedicated freight lines* are rail lines whose planned use is restricted to freight trains only. A *dedicated rail freight network* would consist of an integral network of such lines, either newly constructed lines or existing lines converted to dedicated freight use, with adaptation where necessary.

A *Primary Freight Network (or Semi-Dedicated Rail Freight Network)* consists of dedicated lines combined with mixed passenger and freight lines, with enough capacity to accommodate the **whole of the demand for rail freight services** at any given time and taking into account the different service requirements (punctuality, speed, timetable...) of various customer segments.

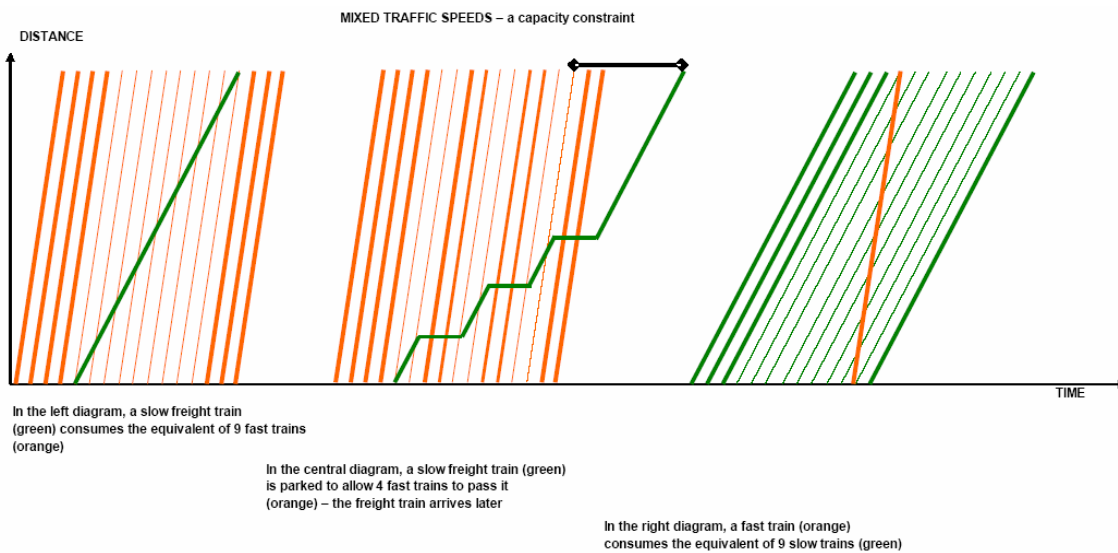
A *Primary Freight Network* or a *Dedicated Freight Network* does not have to include all the lines carrying freight. It is rather a "grid" made of the most significant international lines/corridors carrying freight (taking into account current and prospective transport flows). It may include some important feeder lines (for example some of those linking harbours or other important freight terminals). It is also important to remain aware of the fact that the creation of a *Primary Freight Network* or of a *Dedicated Freight Network* may affect other lines which are not part of it. For example, if the Primary Freight Network or Dedicated Freight Network is required to accept heavy and long trains, feeder lines which are not part of the grid may need to be adapted too.

In any case, such a network should be defined at a European level on the basis of business cases and cost/benefits analyses.

### 1.2 Why does the present rail network need to change?

Most of the railway lines in use today were designed and built at least 100 years ago, with capacity reductions following the historic development of road freight transport. Conventional (i.e. not high-speed) lines largely operate on a mixed traffic basis, i.e. with passenger trains and freight trains sharing the same

infrastructure with different speeds and priorities. Mixed traffic handicaps freight trains in two ways: 1) in case of conflict, whether at planning or at operating level, priority is usually given to passenger trains; 2) Capacity is being reduced because freight and passenger trains usually run at different speeds (due to their different weights). The chart below illustrates this phenomenon:

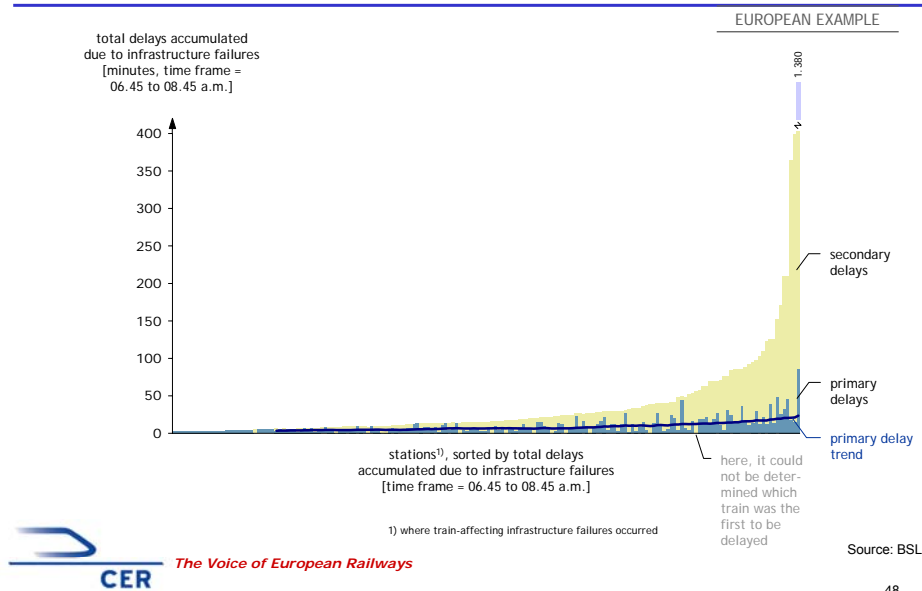


With the growth in international freight transport in the EU single market (especially in combined transport services), and increases in passenger rail service demand, the network is now congested on an increasing number of nodes and sections (with knock-on effects on the whole network).

In this situation, priority rules have to be used more and more often when planning freight and passenger services: these rules frequently lead to the exclusion of freight traffic from key routes at busy periods. **Priority rules, although necessary in all systems to handle “conflict situations”, should in principle not be used too often when planning operations.** The frequent use of priority rules at planning stage is indeed a symptom that the system itself is inadequate. The creation of a Primary (or Dedicated) Freight Network should allow to limit the use of priority rules to a minimum hence diminishing frustration among network users.

System congestion is also the source of aggravated traffic perturbations and lack of punctuality. Perturbations (like delays) happen in all systems. However, in congested systems, one perturbation is often at the origin of several secondary perturbations, by a chain reaction effect. A recent study carried out by the BSL Management Consultants in Germany shows that secondary delays increase as an exponential function of train frequency (see chart below).

## Secondary delays indeed appear to increase faster than primary delays



The creation of a Primary (or Dedicated) Freight Network with enough capacity to accommodate all traffic flows will diminish system failures and increase customer confidence in the rail mode.

System productivity improvement is one of the most important challenges which rail freight has to face today. Many existing routes have train-length and/or weight restrictions. Longer (and sometimes heavier) trains are, together with the better use of infrastructure, one of the most promising elements for a quantum leap in rail freight productivity.

### 1.3 How can the concept be developed?

The dedication or increase in capacity of existing lines will to some extent be facilitated by public policies regarding passenger services (e.g. development of high-speed lines and development of regional passenger traffic).

It would make little sense to develop dedicated or primary freight lines without having a strategy for the nodes at which these lines converge. The benefits of dedicated and primary freight lines can only be realised once the saturation at nodes is resolved. If not planned carefully, dedicated and primary freight lines can worsen saturation at nodes and therefore negate the very benefits of line dedication. In some other cases, a dedicated or primary freight line can have

unexpected and undesired effects on other (mixed traffic) lines, as well as on the nodes: e.g. the Betuwe route in the Netherlands is generating more freight trains on those parts of the mixed-traffic network which link it to the actual origins and destination of freight trains. In the development of a dedicated (or primary) freight network, this kind of side-effect has to be taken into account. **The process of dedication (or of upgrading existing mixed line) will therefore have to be “evolutionary”, concentrating investments first and foremost on relieving saturated “nodes” and “links”.**

Beyond the urgent issue of relieving bottlenecks, there is also the issue of improving rail freight productivity in general. This can be done by increasing significantly at least some basic infrastructure parameters (like train length, axle load, loading gauge, speed, etc.). Although the process of dedication or mixed-line upgrading should ideally be made in a consistent and coordinated manner all over Europe (in order to insure maximum interoperability), it is also true that characteristics may have to differ from one corridor to another or from one geographic area to another in order to take into account specific market conditions. For example, on a corridor mostly used for transporting heavy goods, the parameter which may be most appropriate to increase in a significant way may be axle load. Conversely, on a corridor mostly used by (light) intermodal services, there may be more of a business case for increasing significantly train length. In general, only a corridor- or an area- specific business case<sup>2</sup> allows determining the infrastructure characteristics best suited for each corridor or geographical area.

In any case, in the short/medium term, the design of new dedicated or primary freight links (whether brand-new or upgrades of existing lines) should right away take into account the characteristics targeted in the long term. Either these characteristics should be integrated in the construction right from the start (e.g. loading gauge, axle gauge...) or be taken into account at concept level in such a way they can be easily implemented at a later stage (e.g. train length, train weight...). This may imply that, in a starting phase, some characteristics imposed on new projects will only be used to their full potential at a later stage. However, this has to be weighed against the cost of having to build them in at a later stage (through the process of “upgrading”).

Business and management aspects must be part of the concept of a dedicated or primary freight network. Freight railway undertakings expect more and more

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<sup>2</sup> In this respect, a similar approach as the one used by the European Corridor Coordinator, Karel Vinck (in charge of developing corridor improvement programmes in the perspective of the implementation of ERTMS) may be applied. In this approach, the first step is to set realistic but ambitious objectives for rail freight, the second to identify the needs to realise these ambitions, the third to build a business case for future investments and the last to seek political support whenever infrastructure investments gaps are identified.

traffic fluidity, punctuality and speed from infrastructure managers. The gradual building towards a primary freight network must be accompanied by stronger quality and performance commitments from infrastructure managers towards railway undertakings (and vice versa).

The concepts of international paths construction, One-Stop-Shops and tracking & tracing could also be part of the “Primary European Rail Freight Network” concept (as supporting tools).

In the future, the emerging Primary European Rail Freight Network, PERFN, will also have to ensure administrative interoperability.

Between October 2006 and July 2007, CER realised business cases for infrastructure investments on six major trans-European corridors. These business cases provide concrete proposals of necessary investment programmes to improve both the infrastructure capacity for freight services and the productivity of rail freight on each corridor. Results of these corridor businesses cases will provide material evidence all along this paper.

## 2. Current and future demand for a Primary European Rail Freight Network

### 2.1 Freight volumes to be covered by a Primary Freight Network

According to the most recent yearly statistics from Eurostat, rail freight volumes in EU 25 (the European Union at 25 members before Bulgaria and Rumania joined) amounted to 384 billion ton.kilometres in 2006. This accounted for a share of 17% of the overall freight volumes carried by land transport modes<sup>3</sup>.

A study carried out by UIC in 2006, the ERIM study<sup>4</sup>, forecasts that, under ceteris paribus conditions, rail freight demand is likely to grow by 60% between 2006 and 2020<sup>5</sup> in Europe. This is consistent with an earlier study carried out by the European Commission, the TEN-STAC study<sup>6</sup>, which anticipated a growth of rail freight demand ranging from 72% to 104% between 2000 and 2020 (i.e. from 46% to 65% between 2006 and 2020), while overall freight demand would grow between 46% and 66% over the same 20-year period (i.e. between 30 and 43% over the period 2006-2020) . All this would happen in the context of an overall economic growth of 64%<sup>7</sup> between 2000 and 2020 (i.e. 41% over the period 2006-2020).

The table below summarises this findings.

Growth Estimates (EU 27 + Switzerland and Norway)	GDP growth	Overall freight demand growth	Rail freight demand growth
<i>ASSESS (2000 - 2020)</i>	+64%	+46%	-
<b>ASSESS (2006 - 2020)</b>	<b>+41%</b>	<b>+30%</b>	-
<i>TEN-STAC (2000 - 2020)</i>	-	+66%	+72% to 104%
<b>TEN-STAC (2006 - 2020)</b>	-	<b>+43%</b>	<b>+46% to 65%</b>
<i>UIC (2005 - 2020)</i>	-	+66% (as TEN-STAC)	+65%
<b>UIC (2006 - 2020)</b>	-	<b>+43%</b> (as TEN-STAC)	<b>+60%</b>

<sup>3</sup> Land transport includes rail, road and inland waterways

<sup>4</sup> ERIM study: European Rail Infrastructure Masterplan (ERIM) – 2006 Report – Facts and Figures (published in February 2007)

<sup>5</sup> i.e. 65% on the period 2005-2020, mentioned in the ERIM report

<sup>6</sup> TEN-STAC: Scenarios, Traffic Forecasts and Analyses of Corridors on the Trans-European Transport Network

<sup>7</sup> According to the ASSESS study (Assessment of the contribution of the TEN and other transport policy measures to the mid-term implementation of the White Paper on the European Transport Policy for 2010), European Commission, 2005

Today, the existing rail network is not able to absorb an increase of 60% in rail freight demand until 2020. The primary purpose of progressively establishing a “Primary European Rail Freight Network” should therefore be to help face the “2020” challenge of a potential 60% increase in rail freight demand in Europe.

This growth will particularly concern the six corridors investigated by CER (which account altogether to no less than 35% of all rail ton.kilometres in Europe). The objective is therefore to make sure that these corridors are in a position to absorb at least the expected growth in rail freight demand. In this respect, customer organisations and other stakeholders consider that road itself will not be able to absorb its expected own demand growth. They therefore support the objective that rail should not simply accompany general transport growth, but also increase its share of land transport from 17% today to 35% in a not too far future. Taking the assumption that overall transport demand would grow between 30% and 43% until 2020, this would mean that rail would have to absorb between 262% and 288% more volume than is currently the case.

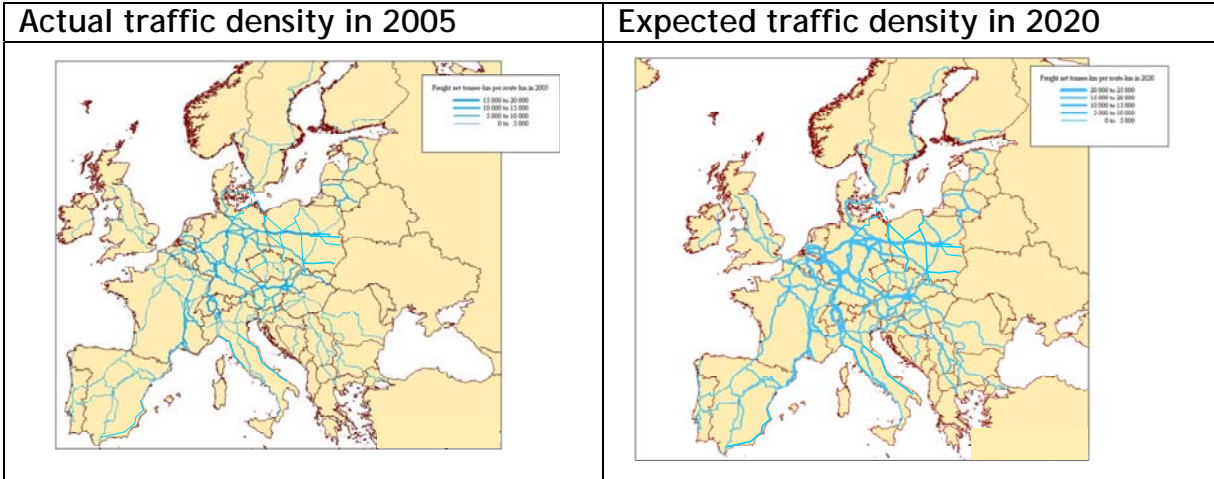
Obviously, the kind of traffic growth implied by this scenario could only be taken care by rail provided that a very ambitious policy is carried out at European level motivated by a real vision of a primary, and even dedicated, rail freight network. This vision of a Dedicated Freight Network is promoted and developed by two projects supported by the European Commission, FERRMED and NEW OPERA. The results of these two initiatives will be available in the second half of 2008. CER supports both the NEW OPERA and the FERRMED projects. In the meantime, based on the six corridor business cases carried out between October 2006 and July 2007, CER promotes a vision of a Primary European Rail Freight Network based on an intermediate growth scenario (see below).

## 2.2 Freight business flows to be covered by a Primary Freight Network

As seen before, the freight flows in the future Primary European Rail Freight Network should not simply cover today’s rail freight business flows. The network should be able to accompany overall economic and traffic growth and possibly attract many flows which are also relevant to road.

The UIC ERIM study mentioned above shows where rail freight flows are concentrating today and where they are likely to concentrate in 2020 (based on the analysis of overall freight flows forecasts). The maps below show the main routes taken by these flows today and in 2020. They also illustrate the actual

traffic density<sup>8</sup> in 2005 and the expected traffic density in 2020 on the main parts of the European network.



NOTE: The maps above are mainly based on the UIC ERIM study results, completed and validated through consultation of CER Members.

From these two maps, it is possible to see that the intensity of rail freight demand would strongly increase along almost all the main rail freight routes between 2005 and 2020.

### 2.3 Nature of the goods to be transported on the Primary Freight Network

Beyond the absolute volume numbers and overall configuration of flows expected in the future, a qualitative analysis of the evolution of the nature of goods transported is necessary to help define the future technical characteristics of a Primary European Rail Freight Network accurately.

For example, to accurately define characteristics of a Primary Freight Network, it is necessary to know whether the freight business of tomorrow will consist more of light goods or of heavy goods. This depends partly on individual freight companies' strategies but also on overall market trends.

Empirical evidence shows that the general trend is:

- towards a strong and continuous increase of the transport of light manufactured goods (with combined transport having the highest growth potential)
- and towards a much weaker, but still not negligible, increase of the transport of heavy bulk goods (notably on the East-West routes).

<sup>8</sup> Traffic density (measured in tonne.kilometres per route.kilometre) gives a common indicator of the distributed utilisation along each route kilometre.

Knowing that rail is particularly suited for the transport of heavy bulk goods, this means that the demand for heavy bulk transport by rail will carry on increasing at a moderate pace. However, the highest growth potential will come from light goods (in containers and swap-bodies or in single wagons), **provided that rail offers the right conditions** (in terms of price, quality and flexibility).

The business cases carried out by CER, with the help of UIC and McKinsey shows that this pattern applies to all six corridors investigated.

## 2.4 Consequences for the Primary Freight Network vision

The UIC ERIM study assumes that, due to technological advances and progress in traffic management techniques, the rail system will naturally make productivity gains, which will allow it to absorb up to 20% more freight until 2020. Assuming a growth demand of 60% (according to ERIM forecasts) from 2006 to 2020, this means that 40% (60% minus 20%) would have to be absorbed by the European rail network in other ways (i.e. more infrastructure).

The CER business cases on 6 major European corridors show that, apart from productivity gains internal to the system, there are two other ways to absorb more volume:

1. Increase the capacity of trains (by allowing them to be heavier, larger or longer);
2. Provide supplementary infrastructure (notably by relieving bottlenecks or by constructing dedicated new lines)

As far as increasing train capacity is concerned, all six business cases show that adapting the infrastructure to accept heavier trains would neither have the best return on investments (it indeed requires to renew the tracks and strengthen bridges) neither be market-adapted (indeed the best growth potential are in light goods and not in heavy goods). Conversely, adapting the infrastructure to accommodate longer trains seems to make sense both from a cost-benefit point of view (it mainly necessitates to create more passing loops) and from a market point of view (trains can take more light goods while not increasing significantly the train weight).

From the corridor business cases carried out, up to 11% more volume could on average be absorbed through investments aiming at increasing train length. But the main benefit of increasing train length would be to increase the productivity of trains, hence attracting more rail-accessible demand to rail.

In conclusion, the European Railways have both:

- an ambitious vision of what rail freight volumes and flows could be beyond 2020 if most the rail-accessible freight was indeed attracted to rail.
- and a more conservative view of where the sector might be in 2020 in the current political context (i.e. a 60% increase in demand compared to today).

Based on the six corridor business cases carried out between October 2006 and July 2007, they propose an intermediate scenario of a network with a capacity

- to absorb up to 72% more volume until 2020
- to bring the market share of rail from 17% to 21-23% (based on general transport growth hypotheses of 30 to 43%)
- and to maximise the cost/benefit ratio of required investments.

After having looked at some macro-economic parameters which should condition the development of the future "Primary European Rail Freight Network" (and before going into the detail of the characteristics of such a network), it is however necessary to also look at the micro-economic parameters to be fulfilled.

### 3. Quality, performance and cost criteria for a primary freight network

Regardless of the uncertainties on what the political ambitions for rail freight will be, it is CER’s position that the policy objective of a “Primary European Rail Freight Network” must be to significantly increase rail freight volumes against a background of continually increasing freight transport volume in Europe.

As seen earlier, this can be achieved by increasing the capacity of the rail network to allow more freight volume on rail and by increasing productivity. But the purpose of the Primary European Rail Freight Network should also be to improve the competitiveness of rail versus road through improved system quality, performance and cost...

Quality means delivering what is promised to the customer, in terms notably of punctuality, speed and information. The quality levels which a primary rail freight network should allow on end-to-end transport (i.e. beyond itself, including feeder lines which are not part of it) should be set taking road as a benchmark:

Parameter	<i>Average road quality level, TODAY (2005)</i>	Quality levels <u>TARGETED</u> for a primary freight network
Commercial punctuality of block trains <sup>9</sup>	<i>95% (with 60 minutes tolerance)</i>	Target: 97% (with 60 minutes tolerance), slightly above road 2005 performance.
Commercial punctuality of single wagons	<i>95% (with 60 minutes tolerance)</i>	Target: 95% (with 60 minutes tolerance)
Commercial speed <sup>10</sup> for block trains	<i>50km/hr</i>	Target: 60km/hr (i.e. 10km/hr more than trucks achieved in 2005)
Commercial speed for single wagons	<i>50km/hr</i>	Target: 50km/hr (i.e. the same as what truck achieved in 2005)

<sup>9</sup> The “COMMERCIAL PUNCTUALITY” target is the punctuality effectively observed by the customer, whether departure points and arrival points are situated within or outside the so-called “Primary European Rail Freight Network”. This therefore includes the whole journey taking into account feeder lines (which may not themselves be officially part of the Primary Network).

<sup>10</sup> The “COMMERCIAL SPEED” is the speed effectively observed by the customer when all stops and slowdowns have been taken into account.

Parameter	<i>Average road quality level, TODAY (2005)</i>	Quality levels <u>TARGETED</u> for a primary freight network
Information	<i>No quantitative data on how accurate Estimated Times of Arrival for trucks are.</i>	Target: 90% of Estimated Times of Arrival provided (in case of disrupted service) turn out to be right

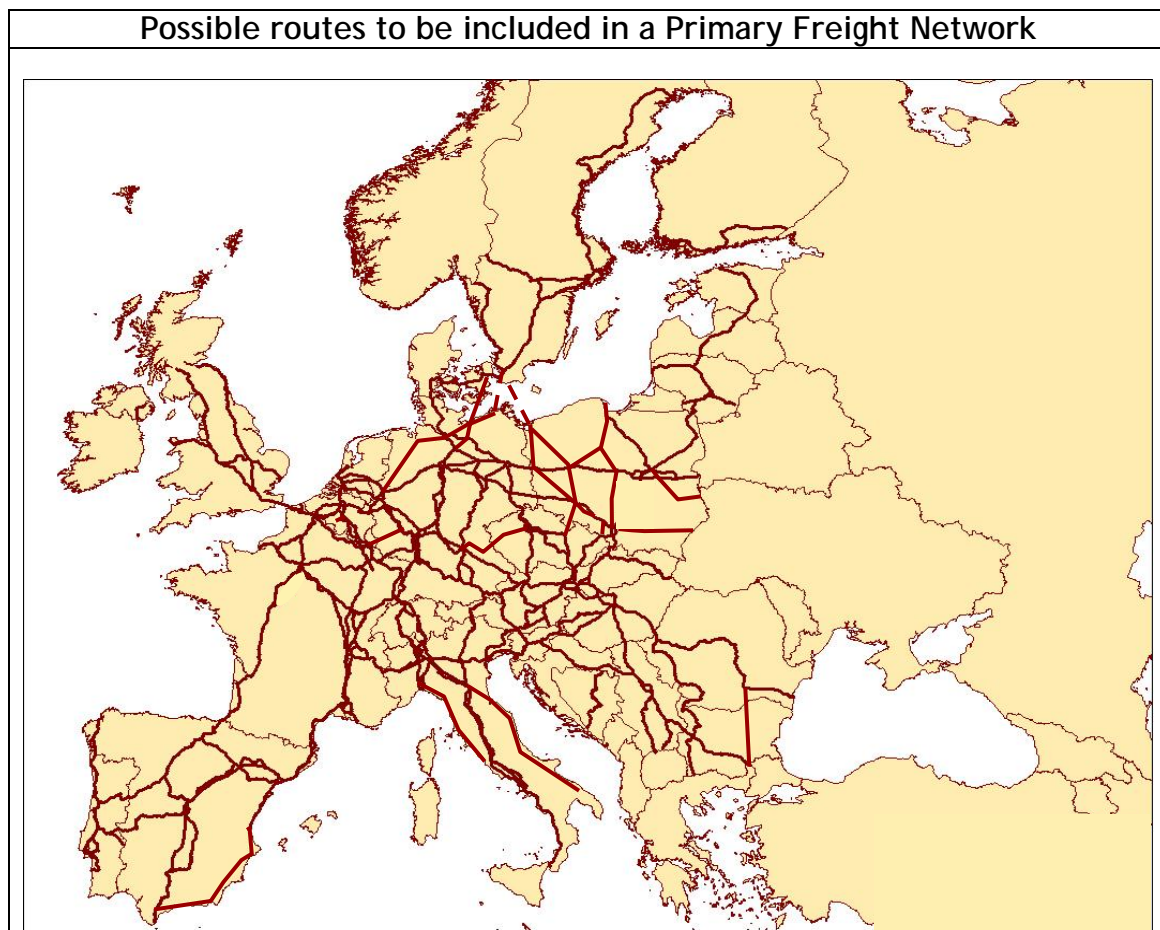
The PERFN should also cater for some other discrete aspects of customer service, like shorter lead-time for ordering transport, flexibility in rescheduling transport time and/or route at short notice, etc.

System performance is the combination of tonnage capacity, maximum number of trains which can run on the network, design speed, and technical network punctuality. This paper proposes, in the chapter 5, a set of performance levels to be achieved by the future Primary European Rail Freight Network.

Finally, the use of the future PERFN should be priced in such a way that the cost of a tonne.kilometre by rail does not exceed the cost of a tonne.kilometre by road.

#### 4. Freight routes to be considered for a Primary Freight Network

In order to cover the “existing” and “potential” flows identified above, it is proposed that the future Primary European Rail Freight Network is established along all or part of the routes shown in the map below.



NOTE: This map should not be seen as portraying actual or future tracks, but rather as an indication of the main trans-European rail “routes” most likely to form the future Primary European Rail Freight Network. It neither pretends to be exhaustive nor binding. The final physical reality of the future European Dedicated Freight Network will very likely contain lines which may vary somewhat from the routes shown here depending on technical construction and track upgrade constraints and on political will.

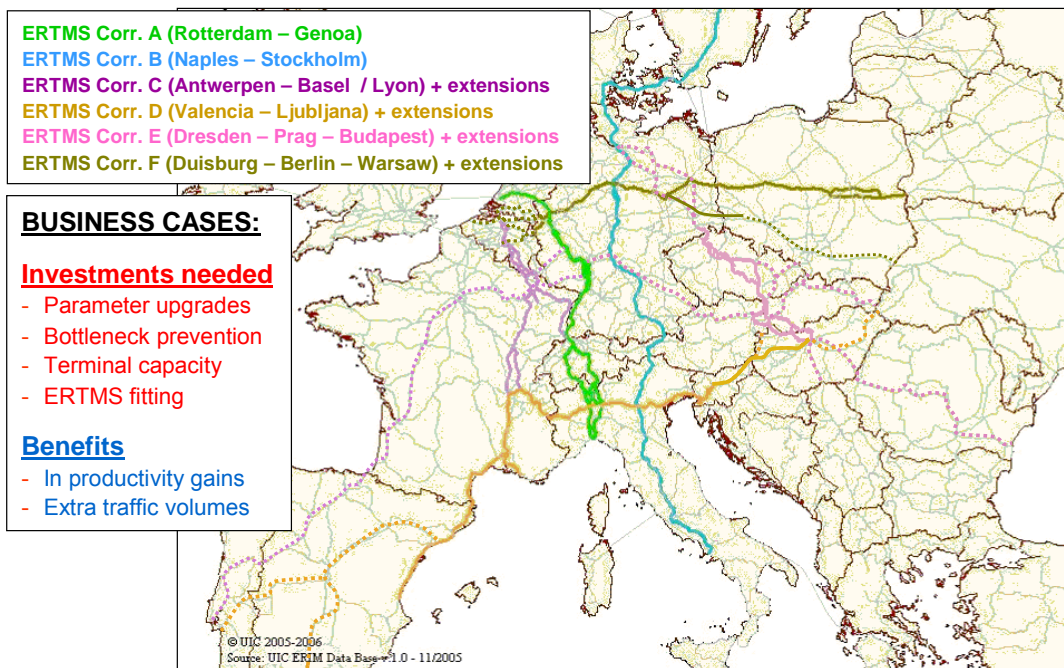
## 5. Technical and capacity requirements of the PERFN

In addition to defining possible relevant routes to be included in the future Primary European Rail Freight Network, it is necessary to also define a set of “recommended” technical characteristics and capacity enhancements necessary to promote interoperability and overall system efficiency and performance.

As mentioned above, between October 2006 and July 2007, CER realised six business cases on six major European freight corridors (using the ERTMS corridors as a starting point). These business cases identify the need for certain infrastructure upgrades and capacity increases and demonstrate the benefits which can be derived from such investments in terms of attracting more traffic to rail.

### Six business cases for a Primary Freight Network...

- Original **ERTMS corridors** are marked in **continuous lines**
- **Extensions** to the original ERTMS corridors are marked in **dotted lines**



These business cases have been realised with the support of UIC and McKinsey & Company. CER and McKinsey produced a report summarising the results of this

exercise. It is called: "Business Cases for a Primary European Rail Freight Network".

## 5.1 Technical requirements of the PERFN

The six corridor business cases made by CER, UIC and McKinsey between October 2006 and July 2007 give precise indications of the characteristics to be expected from the future PERFN. Although the six business cases were produced independently from each other to take into account the various market situations of each corridor, it appears that more or less the same rules can apply for deciding on infrastructure upgrades.

### *Rules for train length upgrades*

In general, the parameter which most requires being worked on is train length. Train length restrictions exist on the infrastructure of all countries. However, the level of restrictions varies greatly from one country to the other along one corridor. For example, on the ERTMS corridor D from Spain to Hungary, trains cannot exceed 600 metres on the Spanish part, 750 metres on the French part, 625 metres on the Italian part, 600 on the Slovenian part and 750 on the Hungarian part. For this corridor, it therefore makes sense to upgrade the infrastructure to accommodate trains of at least 750 metres all along in order to use full train length capacity on longer distances. On some sections, length upgrades can be even higher (up to 1,000 metres) to respond to particular market situations (e.g. on the French part between Lyon and the Spanish border, to accommodate potentially longer intermodal trains coming from Benelux in the future). In the long term, with further technological advances and traffic increases, 1,500-metres or longer trains should remain an open option to consider.

### *Rules for axle load upgrades*

As far as axle load is concerned, the value that applies to most of the six corridors investigated (90% of the length) is 22.5 tons per axle (or more in some parts). Most of the rest (10%) is on 20 tons per axle. Considering the current product mixes observed on the six corridors investigated and considering the expected market trends towards a faster growth of light freight, upgrading the infrastructure on these corridors to higher axle load values or simply harmonising axle loads to 22.5 does not seem absolutely crucial. In cases where infrastructure works are otherwise planned, it is however recommended that the target value should at least be 22.5 tons.

In the long term, higher axle loads (e.g. 25 tons) may also be considered, case by case, whenever a business case exists. Such business case may be provided if at least one of the following two conditions is present:

- Sufficient volume of heavy goods is expected.
- The topography between origins and destinations is relatively flat, allowing longer/heavier trains to run with multiple traction units.

The EU supported FERRMED and NEW OPERA projects are considering such axle load upgrades, with results expected in the second half of 2008.

### *Rules for loading gauge upgrades*

As far as loading gauge is concerned, all six corridors can accommodate trains with a loading gauge equal or superior to the so-called "GB" and "PC45" standards. This loading gauge allows for accommodating most of the existing and future traffic, including high-cube containers and rolling highway (although in these two cases, gauge "GC" - "PC400" is generally preferred).

The NEW OPERA and FERRMED projects are also investigating the issue of loading gauge. In the immediate however, some adaptation of feeder lines may be needed, in France notably, where the so-called smaller Gauge GA applies on many parts of the network.

### *Rules for train speed upgrades*

Finally, on the six corridors researched, it appears that the benefit of increasing the technical speed of the lines to above 100km/hr (which is the rule on 93% of the corridors length) would be minimal from a market point of view and would certainly not offset the costs which such upgrades would incur. In addition, due to the on-average higher weights of freight trains compared to passenger trains, no upgrade will reasonably allow a majority of freight trains to ever reach the same kind of speed as passenger trains (e.g. 160 km/hr).

In effect, this means that the loss of infrastructure capacity which is caused by the difference of speed between passenger and freight trains will not be changed as long as mixed traffic remains the rule. To avoid this, dedication of railway lines to passenger traffic on the one hand and to freight traffic on the other hand would be beneficial. The NEW OPERA and FERRMED projects are investigating the concept of Dedicated Freight Lines.

*Intermediate conclusion regarding infrastructure parameter upgrades*

In the meantime, from a sample of six corridors for which business cases have been done, it is now possible to make a reasoned proposal of what should be the most common characteristics of the future “Primary European Rail Freight Network”. Again, these characteristics might vary slightly from corridor to corridor, depending on the diverse market situation and geographical constraints. But they are all meant to optimise the business and environmental efficiency of rail freight (in summary, better interoperability combined with usually longer and, in some cases, heavier trains) and to increase capacity while limiting overall investments costs.

The third column indicates possible other options to be considered, in the long term.

Characteristic	Most common minimum target values recommended for the future PERFN	Options for the LONG TERM
<b>TECHNICAL</b>		
Loading gauge	Gauge GB (PC 45) minimum	GC minimum
Axle load	22,5 tons/axle minimum	25 tons/axle minimum
Signaling system	ETCS/ERTMS: Level 2 (Version 2.3.0)	Level 3*
Telecommunication	GSM-R	GSM-R
Electrification	No indication (depending on the use of multi-current locomotives)	
<b>OPERATIONAL</b>		
Train speed	100km (for 22,5t axles)	Line dedication
Train length	750m or more: 1,000m on some sections	1,500m minimum
Daily capacity	100 trains/day (in each direction of a double track)	More with ERTMS level 3 and with dedication
Equipment	Double track	Double track
Priority rule	Variable, but towards more and more dedication as traffic grows.	Full line dedication

\* although not yet developed, ERTMS level 3 should allow to increase infrastructure capacity.

Below are listed other aspects to be taken into account, notably in case the infrastructure characteristics recommended in the third column above are applied:

1. Operators may have to adapt wagons to be able to resist heavier/longer trains (stronger coupling, non air-pressure-based breaking systems).

2. In some countries, operators will have to adapt traction units characteristics or set ups in order to run heavier and longer trains.
3. In some countries, there will be a necessity either to upgrade feeder lines and customer sidings to accommodate longer trains or to build “**sorting interface yards**” (or “**hubs**”) to cut and form trains in order to access feeder lines and customer sidings.
4. Specific upgrading of feeder lines and sidings may be needed to adapt to possible new axle and loading gauges.
5. The existing network of marshalling yards and terminals may also have to be adapted to accommodate for the new train characteristics. The upgrading of marshalling yards and terminals are taken into account in the “infrastructure parameter upgrade” figures shown in chapter 6 (cost/benefit).

## 5.2 Capacity requirements of the PERFN

The increase of train capacity elicited by infrastructure upgrades is obviously not sufficient to absorb the expected growth in traffic until 2020.

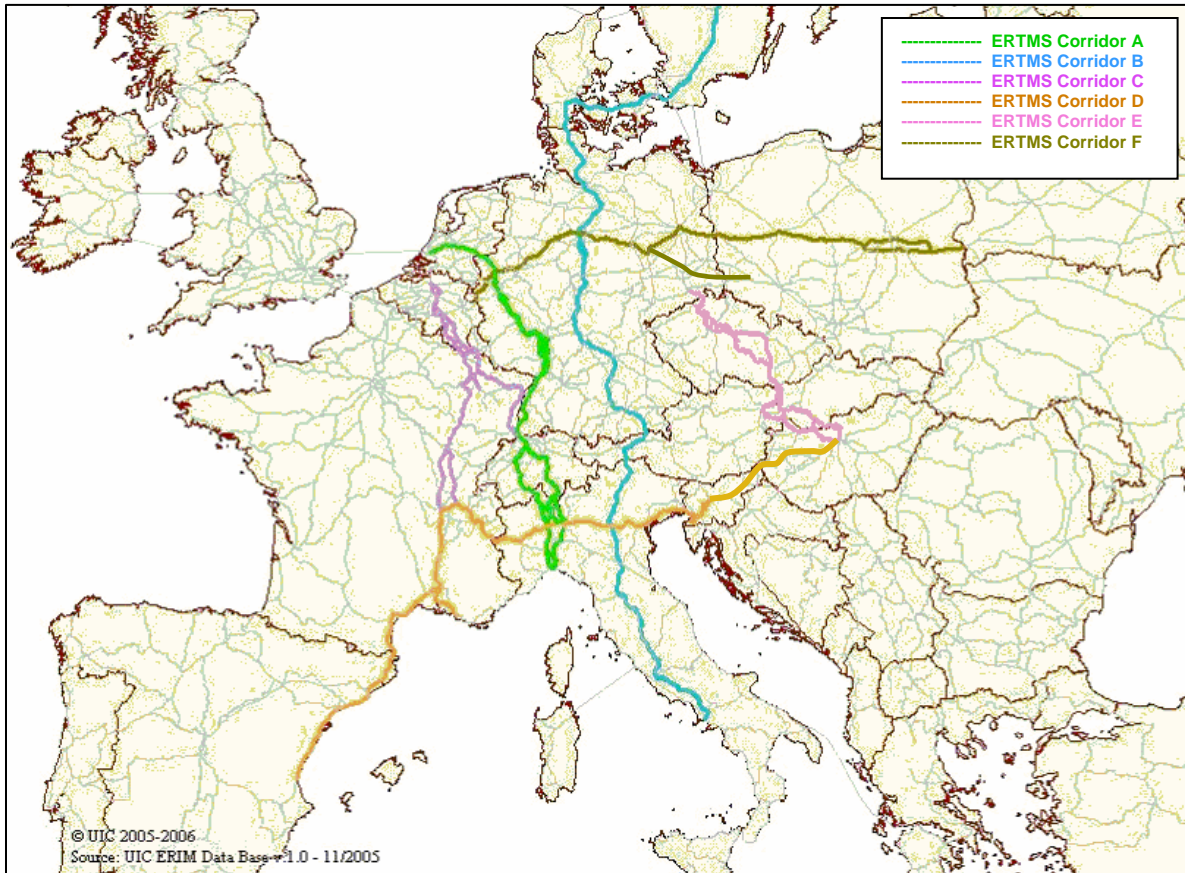
Extra investments are needed to alleviate bottlenecks on the infrastructure and increase the capacity of the infrastructure (including in marshalling yards) to accommodate more traffic. The same applies to freight terminals.

These aspects of capacity increase and bottleneck alleviation have been extensively researched by UIC, notably through the two initiative ERIM and DIOMIS. Chapter 6 shows the cost/benefits of investing in this area on the six corridors investigated, based on ERIM and DIOMIS input.

## 5.3 ERTMS

In the years to come, ERTMS will play a major role as the common European signalling and train control system.

ERTMS implementation is covered by a Memorandum of Understanding signed between the Railway sector and the European Commission in 2005. Six ERTMS corridors have been defined for priority ERTMS investments and individual corridor Memoranda have been signed or are in the process of being signed for each corridor with the aim to organise ERTMS implementation.



The six international freight corridors chosen by CER for its business cases have been defined taking the ERTMS corridors as a starting point.

According to the European ERTMS Coordinator Karel Vinck, the benefits of implementing ERTMS can however only be reached if capacity is simultaneously increased. This can be done through the bottleneck relief actions, infrastructure upgrade actions and internal productivity gains mentioned in the above chapters. The business cases run by CER on six major European freight corridors (which include the corridor specifically chosen for ERTMS implementation) will provide the European ERTMS Coordinator, Karel Vinck, the capacity increase information needed for the successful implementation of ERTMS.

**6. Cost/benefit of investing on six major corridors**

The six business cases run by CER provide a detailed analysis of the cost/benefits of the investments proposed in chapter 5, respectively on:

1. infrastructure upgrade,
2. bottleneck alleviation and terminal capacity enhancement
3. and ERTMS investments.

on six major European freight corridors.

NOTE: In order to reflect market reality, the ERTMS corridors including their extensions had to be regrouped or split during the analysis. New “market-oriented” corridors have been created with the following names and specifications.

NAME	MAIN ITINARY	LINK WITH “ERTMS” CORRIDORS
Corridor A	Rotterdam-Genoa via Germany	Same as ERTMS Corridor A
Corridor B+-	Stockholm - Bologna	ERTMS Corridor B, minus the Bologna-Naples section, plus the Ülzen-Nuremberg section via Halle.
Corridor C/D+	Benelux /Germany - France -Spain/Portugal	ERTMS Corridor C (extended to Spain/Portugal via the Atlantic route) + Western part of ERTMS Corridor D from Lyon to Valencia extended to Portugal and Algesiras.
Corridor D+-	Lyon (France) to Zahony (Hungary)	Eastern part of ERTMS Corridor D, starting from Lyon and extended from Budapest to the Ukrainian border (Zahony)
Corridor E+	Germany - Roumania	ERTMS corridor E extended from Dresden to Hamburg, from Vienna to Mannheim, from Bratislava to Kocice, from Budapest to Constanza.
Corridor F+	Belgium - Poland	ERTMS corridor F extended to Zeebrugge harbour in Belgium and to Ukraine via its South branch.

As most benefits are “market-conditioned”, the cost benefits shown in this chapter are presented following the newly defined corridors A, B+-, CD+, D+-, E+

and F+. The details of the costs associated with the original ERTMS corridors is given in the CER report called: "Business Cases for a European Primary Rail Freight Network".

### 6.1 Cost/benefit of infrastructure upgrades on six corridors

The overall cost for performing the infrastructure upgrades (mainly to allow the infrastructure to accommodate longer trains) mentioned in chapter 5.1 is estimated at 5.1 billion Euros in total (of which 0.8 billions are already firmly committed in existing budgets) just on the six corridors covered by the CER business cases. This figure does however not include the cost of investments to be made on the rest of the network and on the side of the railway operators.

The expected increase of train capacity linked to the above-mentioned upgrades is estimated at +11% on average (with variations from corridor to corridor).

The table below shows the individual business cases for parameter upgrades for each corridor.

INFRASTRUCTURE UPGRADE INVESTMENTS	Total Investment need	Part of investment already committed in existing budgets	Benefits in terms of extra capacity by 2020
Corridor A	0.5 bil. €	0.0 bil. €	About 5%
Corridor B+-	0.6 bil. €	0.0 bil. €	About 5%
Corridor C/D+	1.9 bil. €	0.0 bil. €	About 11%
Corridor D+-	0.6 bil. €	0.3 bil. €	About 10%
Corridor E+	1.2 bil. €	0.5 bil. €	About 7%
Corridor F+	0.4 bil. €	0.0 bil. €	About 25%
<b>TOTAL (6 corridors)</b>	<b>5.1 bil. €</b>	<b>0.8 bil. €</b>	<b>About 11%</b>

### 6.2 Cost/benefit of bottleneck alleviation and prevention on six corridors

Investments in infrastructure bottleneck alleviation and in terminal capacity enhancements have also been identified on the six corridors investigated and amount to a total of 122.9 billion Euros (of which only 34.7 billions are already committed in existing budgets).

The benefits to be expected from this, coupled with the expected internal productivity gains of the railway system itself, would be a 61% increase of capacity (i.e. 41% directly linked to the investments and 20% to internal system efficiency improvements).

The table below shows the individual business cases for capacity investments in tracks and terminals for each corridor.

<b>BOTTLENECK &amp; TERMINAL INVESTMENTS on 6 corridors</b>	<b>Total Investment need</b>	<b>Part of investment already committed in existing budgets</b>	<b>Benefits in terms of extra capacity by 2020 (including productivity gains)</b>
Corridor A - Bottleneck - Terminals	29.0 bil. € 0.1 bil. €	10.5 bil. € -	+86%
Corridor B+- - Bottleneck - Terminals	25.5 bil. € 0.4 bil. €	8.0 bil. € -	+62%
Corridor C/D+ - Bottleneck - Terminals	22.5 bil. € 0.7 bil. €	2.9 bil. € 0.3 bil. €	+63%
Corridor D+- - Bottleneck - Terminals	19.3 bil. € 0.5 bil. €	8.6 bil. € 0.2 bil. €	+55%
Corridor E+ - Bottleneck - Terminals	16.2 bil. € 0.4 bil. €	3.3 bil. € -	+56%
Corridor F+ - Bottleneck - Terminals	8.2 bil. € 0.3 bil. €	1.1 bil. € -	+46%
<b>TOTAL(6 corridors)</b> - Bottleneck - Terminals	<b>120.5 bil.€</b> <b>2.4 bil.€</b>	<b>34.0 bil. €</b> <b>0.5 bil. €</b>	<b>+61%</b>

### 6.3 Cost/benefit of ERTMS implementation on six corridors

First estimate of the cost of implementing ERTMS on the six corridors covered by the CER business cases was done based on reports produced for the European Commission in 2006 on the ERTMS corridors. This cost would amount to about 17.4 billion Euros. This includes the cost of changing interlockings in relevant countries as well as the cost of locomotives' on-board equipments.

The table below shows the estimated investments planned for ERTMS on each corridor (on-track and on-board equipment, plus investments in interlockings wherever relevant).

ERTMS INVESTMENTS	Total Investment need	Part of investment already committed in existing budgets	Benefits in terms of extra capacity by 2020
Corridor A+	1.4 bil. €	0.0 bil. €	unknown
Corridor B+	3.3 bil. €	0.0 bil. €	unknown
Corridor C/D+	1.7 bil. €	0.0 bil. €	unknown
Corridor D+	0.3 bil. €	0.0 bil. €	unknown
Corridor E+	5.2 bil. €	0.0 bil. €	unknown
Corridor F+	5.5 bil. €	0.0 bil. €	unknown
<b>TOTAL (6 corridors)</b>	<b>17.4 bil. €</b>	<b>0.0 bil. €</b>	<b>unknown</b>

These figures will be refined as the individual ERTMS Corridor Memoranda will be carried through. Obviously, extra costs will arise on the rest of the network as ERTMS is deployed beyond the selected six corridors.

#### 6.4 Cost/benefit summary on six corridors

The table below summarises the cost/benefits of all the above actions for all six corridors investigated.

SUMMARY FOR ALL 6 CORRIDORS	Infrastructure upgrades	Bottleneck alleviation	Terminal capacity enhancements	ERTMS fitting
Cost, of which:	5.1 bil. €	120.5 bil. €	2.4 bil. €	17.4 bil.
- Committed	(0.8 bil. €)	(34.0 bil. €)	(0.7 bil. €)	(0.0 bil. €)
- Not committed yet	(4.3 bil. €)	(86.5 bil. €)	(1.7 bil. €)	(17.4 bil. €)
Productivity gains	+2-4%	Not assessed	Not assessed	None
Benefits (in traffic growth)	+72%			

\* including 5.5 billion Euro interlocking costs.

In summary, for an overall investment of 145.4 billion € on six corridors (of which 35.5 billion € are already committed and 109.9 billion € remain to be found), an overall increase of 72% system capacity can be expected for freight. This includes 20% obtained through own internal productivity gains of the system itself. **This amount would have to be spent over a period of 14 years and investment decisions would have to be taken in the short term.**

In order to obtain equivalent growth rates on the rest of the PERFN and on the network, it is fair to assume that more would have to be spent outside the corridors too. This aspect should be subject to further research.

Except for the ERTMS fitting costs, the extra costs incurred by the railway operators is not taken into account in the above figures. The assumption is that these costs would be supported by the operators themselves and recouped by them through the extra earnings generated by increased volumes and productivity gains.

The CER report "Business Cases for a Primary European Rail Freight Network" gives detailed cost/benefit analysis for each of the corridors investigated.

## 6.5 Putting figures into perspective

The total 145.4 billion € investment required over a period of 14 years until 2020 on the six corridors investigated corresponds to an average rate of 10 billion € spending per year. This represents **one third** of the planned annual budget of China into railway bottleneck relief (i.e. 31 billion € in 2006).

Of these 145.4 billion €, 33 billion € would have to be spent in Germany at an average rate of 2.4 billion € per year over 14 years. This represents:

- 74% of the planned annual investment (3.2 billion €) of Germany into rail infrastructure for passenger and freight altogether and
- 18% of Germany's annual investments into road infrastructure.

Likewise, of the total 145.4 billion € required, 11 billion € would have to be spent in France at an average rate of 0.8 billion € per year over 14 years. This represents:

- 54% of the planned annual investment (1.5 billion €) of France into rail infrastructure for passenger and freight altogether and
- 4% of France's annual investments into road infrastructure.

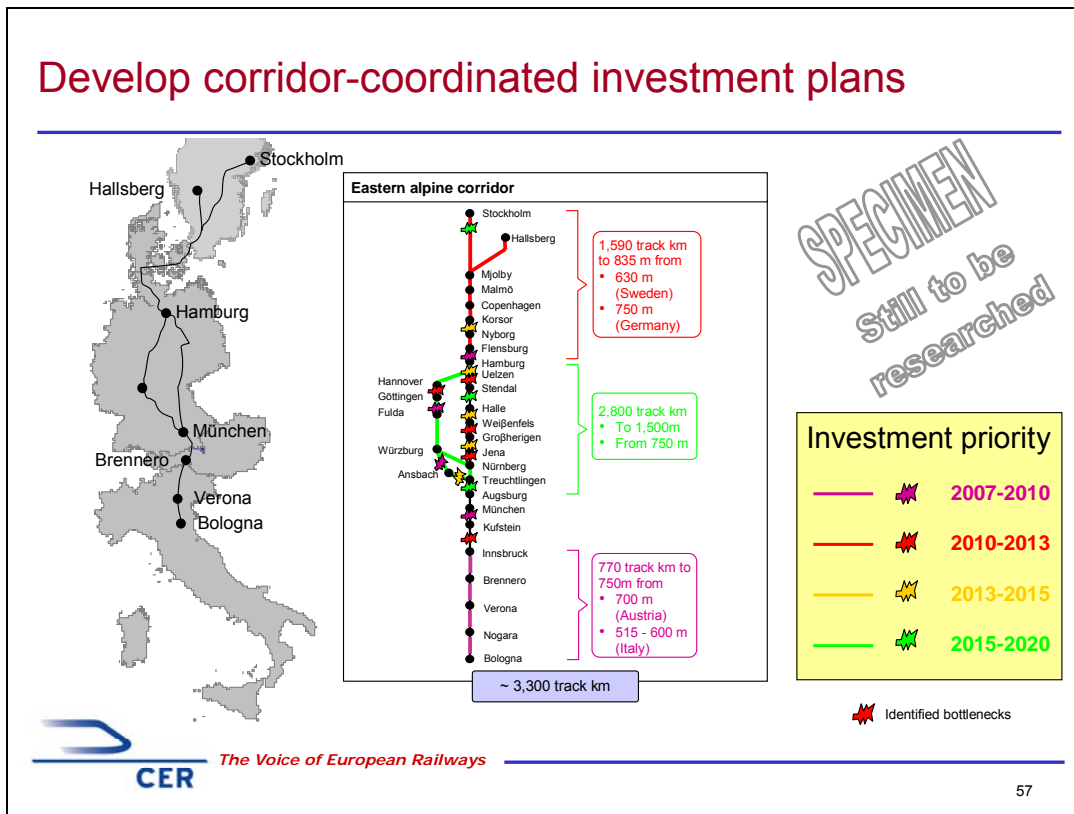
## 7. Proposal for an implementation strategy with corridor-coordinated plans

As seen before, the approach recommended by CER is a corridor-by-corridor approach whereby investment plans are developed following the particular market situation of each corridor. The type of market served by the corridor and the projected volumes to be attracted to it will condition the required infrastructure investments in terms of train length, bottleneck alleviation, terminal investments and ERTMS adaptations.

As the necessary investments have been identified on each corridor, the order and timing of these investments must be defined in a corridor-coordinated manner so that the corridor can progressively increase its traffic volumes and productivity, following market demand. The timed coordination is crucial as it is important that upgrading one part of the corridor does not result in creating a new bottleneck in another part of it. This typically happens when national investment plans are carried out without prior coordination between countries.

For example, the business case on the corridor from Sweden to Italy shows that, within 14 years, 17 bottlenecks must be alleviated, 1,590 km of tracks must be upgraded to accept 835m-long trains, 770 km must be upgraded to accept 750m-long trains and another 2,800 km may be upgraded to accept 1,500m-long trains. All these investments must be made in the right order and timing. The map below shows a possible timeframe for the various corridor works.

## Develop corridor-coordinated investment plans



This exercise of prioritising investments has been attempted on all six corridors. The detail of the investments to be made on all corridors and a first indication of the dates by when these investments should be completed is annexed to the CER report: "Business Cases for a Primary European Rail Freight Network". Obviously, the exact order of investments must be finally agreed between the ministries concerned along each corridor.

The advantages of such an implementation strategy are as follows:

1. Investments are planned in logical sequences (allowing for a gradual building up of traffics): congested nodes and links are taken care of first and, as far as possible, to fulfil the final target characteristics. In this way, early benefits can be reached in terms of punctuality, speed and extra volumes.
2. Early dedicated loops are built around city areas limiting nuisance to the neighbours to a minimum (noise, emissions), increasing security and safety, freeing capacity for passenger services and building up public opinion support for continued future investments.
3. Capacity of the whole network to accommodate freight traffic is gradually increased to meet rail freight demand both in terms of volume and quality by 2020 (and beyond).

## 8. Financing

The deployment of a Primary European Rail Freight Network (PERFN) implies not only infrastructure costs, but also costs related to operations, especially in terms of new locomotives and wagons investments by operators:

### 8.1 - Financing the operating side

Regarding the operators costs (wagon investments, locomotive investments, ERTMS) it is proposed that most of it can probably be funded (except ERTMS) by railway operators through their normal renewal and procurement process. First, most of the existing fleet (which is aging, especially in the Central and Eastern European countries) will reach renewal age between today and the time when the primary freight network will be fully operable. Secondly, the potential increase of demand which the new network will attract will prompt operators to proactively procure additional new rolling stock. In most countries, this will be part of normal business deployment. In Central and Eastern European countries, which start from a more unfavourable position, public support to rolling stock investment might however be still needed.

In any case, in order for operators to integrate the procurement of new material into a long-term business plan, there is a need for them to have **firm advanced commitment from public authorities** on the scope, the exact nature and the timeframe for the development of the infrastructure. This means that the investment commitment on the Primary European Freight Rail Network must be made over a period of 14 years (i.e. about 2 times the current EU budget perspectives timeframe).

### 8.2 - Financing the infrastructure

As far as infrastructure is concerned, CER proposes that the European Commission organises six corridor-dedicated conferences of Transport Ministers along each of the corridor concerned as was done between the Dutch, German, Swiss and Italian transport ministers in 2004 on the Rotterdam-Genoa Corridor. With these conferences, each concerned minister along any one corridor will have a chance to review and evaluate the business case on the corridor and agree with his peers on the course of actions. These ministerial conferences, which should involve also representatives from the infrastructure managers, railway undertakings and customers along each corridor, can obviously be done in

connection with the ERTMS corridors deployment projects and in association with the European ERTMS coordinator Karel Vinck.

In doing so, the following aspects should be taken into consideration by Member States and by the European Commission:

1. Any investment for the benefit of freight should be considered as an investment also allowing passenger services to develop (whether on urban/suburban traffic or on main line traffic). As far as the benefits for passenger services can be demonstrated, contributions to the Primary European Rail Freight Network should not be disconnected from investments for passenger services.
2. The specific situation of the Central and Eastern European Countries should be given special attention, as financing needs might be higher in these countries.
3. As far as EU financing is concerned, national projects which benefit international freight should enjoy the same level of EU contribution as strictly cross-border projects.

## 9. Conclusion

- In the perspective of continuing economic growth, transport should not become a limiting factor to expansion. The rail sector can contribute to the objective of sustainable growth and employment set out in the Lisbon Strategy.
- Promoting the immediate emergence of a Primary European Rail Freight Network (and, in the long term, of a dedicated freight network) will stimulate the growth of rail freight transport.
- A European Primary Rail European Rail Freight Network will best emerge through the progressive corridor-based implementation strategy proposed in this paper, which is in line with the approach pursued by the ERTMS Coordinator, Karel Vinck; in this, it is essential to anticipate the bottlenecks and remove these proactively.
- In order to ensure the emergence of a consistent Primary European Rail Freight Network, its technical parameters and routes need to be specified in a coordinated time-bound plan based on future traffic demand.
- Securing rail infrastructure investments in the long term should be sufficient to prompt private investments in freight locomotives and wagons, and other operational facilities. Special considerations should however be given to the particular situation of Central and Eastern European Countries.

## 10. Recommendations

In conclusion, CER would like to recommend that the communication intended by the European Commission in October 2007 on a rail freight network focuses:

- on significantly increasing some infrastructure characteristics and overall capacity as suggested in Chapter 5;
- and on the scenario proposed in this paper, as described in chapter 7.

In doing so, CER recommends that corridor-specific conferences involving all concerned ministries and other stakeholders along each corridor are organised and moderated by the European Commission at the highest level. Corridor actions should indeed be coordinated at European level in order to insure that national investments are planned in a coherent manner along each corridor.

Finally, CER recommends that, in addition to the corridor studies initiated by CER, further analyses are carried out **on the rest of the network** (in order to adapt technical characteristics to market requirements) and that these analyses primarily rely on the existing expertise accumulated by the railway sector.