ERTMS ON THE CORRIDOR
ROTTERDAM – GENOA

23 February 2006

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MANAGEMENT SUMMARY

The corridor Rotterdam – Genoa is an important corridor that needs investments in the European Railway Traffic Management System (ERTMS)[1] and related measures as a pre-condition to improve the competitiveness of freight transport by rail. The importance of this corridor is not merely the fact that it connects major ports to important European economic centres, but it will also enhance the further development of a single European interoperable rail freight market.

The corridor shows a steady growing demand for rail freight. The long distances between economic centres on the corridor, topographical circumstances and purely transport economic developments are in favour of use of rail for international transport in Europe. Furthermore, the corridor is competitive to road and inland waterways, two modes of transport that also play an important role and have considerable strengths to offer to the market. The major problems that need to be improved within the rail system are a loss of time (waiting and delays) and ineffective investments in locomotives. ERTMS is the key-element to solve these major problems. The project plan contains a set of investments and supporting measures (ERTMS and others) that can be realised on the short term and will improve the performance of rail freight on the corridor Rotterdam – Genoa.

The implementation of ERTMS will drive the necessary changes to improve corridor performance. In a first phase ERTMS can become operational in the four countries of the corridor in 2012. The stretch Oberhausen–Mannheim will be fitted in a second phase with ERTMS at the latest by 2015. DB-Netz is investigating the possibility to close the last gap between Oberhausen and Mannheim already by 2012. Anyhow in Germany alternative technical solutions (STM/PZB-LZB) will be put in place to ensure interoperability along the whole corridor from 2012 in a non-discriminatory way.
In 2015 locomotives equipped solely with ERTMS should be able to run on the whole corridor.

[1] ERTMS includes the European Train Control System ETCS and the Global System for Mobile Communication Railway GSM-R

To fully experience the benefits, ERTMS needs to be supported by measures improving traffic management and additional investments for improved interoperability. The infrastructure adjustments suggested in this ERTMS project require not major investments, but deal with relative minor alterations of the existing infrastructure and will deliver quick wins for railway undertakings.

The first phase of the ERTMS project requires around € 700 million of investments. GSM-R has not been considered as it is introduced in all four countries independently. Germany and Italy are bearing the main costs since in the Netherlands and Switzerland new lines will open in 2007, which are already equipped with ETCS. The EU is asked to support the project with approximately € 185 million for infrastructure.

The implementation of the project plan will offer efficiency improvements to the railway undertakings resulting in cost reductions of a maximum of 10% by 2012. Locomotives with solely ETCS-equipment will then be able to run on the entire corridor. Due to heavy competition it is very likely that the railway undertakings will pass on this benefit to their customers by reducing prices. This will increase the volumes of rail freight on the corridor and consequently benefit society. Nevertheless, railway undertakings save on the investments, when purchasing new locomotives equipped with ETCS. The investments for retrofitting the current fleet before 2012 needs to be supported financially by the EU.

The key to success for rail freight on the corridor Rotterdam – Genoa is the strong commitment by all parties involved to improve the quality and volume of rail freight services and make it competitive on the long run. Implementing the plan, coordinating all actions, organising the changes and investing within the timeframe will ensure the future growth of a successful rail freight corridor.

INTRODUCTION

Traditionally, the infrastructure in Europe has been divided in national systems. The variety of signalling systems hampers the cross border movements of freight trains. The European Rail Train Management System can become the new signalling system and offer a standardised and interoperable rail infrastructure in Europe in the future.

The EU interoperability directive 2001/16/EC gives the framework for developing standards. The deployment strategy for ERTMS is described in the Communication form of the Commission to the European Parliament and the Council (document COM(2005)298) of July 2005. The implementation of ERTMS on the corridor Rotterdam – Genoa is coherent with these EU-documents.

The corridor Rotterdam - Genoa is interesting for implementing ERTMS for a number of reasons:

- It has the highest volume of rail freight traffic in Europe and links the industrial areas in Germany and Italy to the ports in Northern and Southern Europe, which is of importance considering the fast growth in shipments between Europe and oriental countries. The corridor is geographically in favour of rail and experiences an increasing exchange of goods.
- It is exposed to a very high degree of competition from other modes of transport (trucks and barges) and over the last few years from within the rail sector as well. This makes it a natural 'test-case' of how a fully liberalised European rail freight market could develop.
- The corridor runs through Switzerland, a country that applies ERTMS investments and pricing policies to encourage freight transport by rail.

The governments of the corridor countries are investing in new infrastructure capacity and the infrastructure managers are already closely cooperating. A cost-benefit analysis for the implementation of ERTMS on the corridor Rotterdam – Genoa has been made under the commission of the ministries of Transport of the Netherlands, Germany, Switzerland and Italy. The results of this cost-benefit analysis have been presented to the ministries of Transport, the EU, the infrastructure managers, the railway undertakings and the CER on 14 December 2005. It was concluded that there is a need for a concrete action plan with the necessary measures to improve the quality of rail freight on the corridor. This document consists of a project plan to create a successful ERTMS corridor.

The structure of the paper is as follows:
Chapter I will analyse the corridor in further detail. The current- and the desired market developments will be described. Chapter II deals with the strategy for implementing ERTMS and reveals the necessity for stakeholders to cooperate closely. In chapter III this will be translated in concrete action plans for each stakeholder and the required investments. In Chapter IV the benefits resulting from the action plan are considered.

Status of the project report

The report has no legal status, it remains a working document. The indicated investments and actions are an appropriate start for the final and detailed plan to be approved by the national authorities in 2006. It is the objective of the Ministries concerned to improve the cost-benefit ratio for stakeholders where possible. The Ministers concerned have signed a Letter of Intent at 3 March 2006 and agreed to set up an executive committee to steer the implementation of the project. This executive committee has to organise the required funding of the ERTMS corridor and to prepare a joint request for EU TEN financing before 1 October 2006.

We thank the consultants Martin Kraan, Pim de Feijter of Policy Research Corporation (B), Udo Sauerbrei, Wolf- Dietriech Geitz of Railistics (D) and Peter Winter of SBB (CH) for their studies in logistics and Cost-Benefit Analyses and assistance in drafting the report.

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I. MARKET DEVELOPMENTS

I.1. VOLUME

Growth of international rail freight

The corridor Rotterdam- Genoa takes 35 million tonnes of international freight by rail, which is convoyed by means of 100 million train kilometres per year. The volume is expected to increase to almost 50 million tons by 2020. The traffic with origin the Netherlands (Rotterdam) and destination Germany is the most important one (see table below).

Figure 1 : Million tons on corridor Rotterdam – Genoa in 2007

Origin / Destination	Germany	Switzerland	Italy	Netherlands
Germany		3.5	7.0	3.0
Switzerland	0.8		0.3	0.3
Italy	3.8	0.4		0.8
Netherlands	13.1	0.8	1.3	

Source: Cost-Benefit Analysis Corridor Rotterdam – Genoa, 2005

If national traffic should be included to the cross-border movements, the total volume in 2007 would be around 150 million. The project plan nevertheless uses international transport for calculating the benefits since the ERTMS investments have to be justified by improved cross-border movements.

I.2. OPPORTUNITIES

The corridor Rotterdam – Genoa has huge potential to improve the performance of rail freight transport and make it a success. There is a capable organisation of international transport on both the infrastructure side as the organisational side. Railway operators have the ability to handle heavy flows and there is strong internal competition, resulting in competitive prices for the market and a

favourable position for long distance flows. Moreover, the presence of the major ports of Europe and the development of new infrastructure provides an opportunity to further strengthen rail as the mode of transport on the corridor.

Long distance favours rail transport of freight

The corridor is relatively long, around 1500 kilometres and long distances favour rail transport. This means that the corridor has a natural tendency towards rail. A recent TEN-STAC study shows that rail holds 22% of the market for distances over 1000 km and road takes nearly 75%. Operators of inland waterways nearly take 40% of the market over the shorter distances.

Strong competition between market players

There is a fierce competition between market players in rail freight transportation on the corridor Rotterdam – Genoa. The liberalisation of the rail freight market has resulted in many new players entering the market next to the 'traditional' (former state) railway undertakings. This is especially the case for transport through the Alps and the serving of the mainland of Europe from the port of Rotterdam. For instance, in 2005 five different railways were running freight trains through Switzerland. A number of players have developed shuttle concepts and some of these players' main specialty is this type of transport, which consists mainly out of container transport and regular services.

Pressure on transport prices forces to improve efficiency

Rail prices are falling and railway operators are responding to competitive pressures by finding ways to reduce their costs. This is primarily done through improvements in traffic-management (thus increasing the average length of trains for any given maximum length), using drivers more efficiently and by increasing multilateral cooperation to avoid duplicating fixed cost elements. On average, rail freight prices along the corridor have fallen around 20% over the last five years, with a more than proportionate fall in the last two years.

Opportunities for rail transport and threats for road transport

Rail transport can increase its market share compared to road transport if railway undertakings and inframanagers are able to materialise their potentially competitive advantages in the future. In the past, road transport has been more flexible and adaptive but has reached its limits of efficiency gains. Rail transport on the other hand is facing opportunities while road transport will be confronted with threats such as road taxes, fuel prices and congestion.

Transport by rail brings about social benefits

Rail freight is a political desirable mode of transport as it brings about many societal benefits and it is therefore necessary to stimulate rail transport in general and in particular on this corridor. European-

and national policy aims to create societal benefits and by making optimal use of rail transport these societal benefits can be increased. Therefore, European- and national policy supports the further development of rail freight on the corridor.

I.3. PERFORMANCE

Market requires reliable service

Customer demands will increase if rail transport offers more reliable and high-quality services. The overall quality of trainpaths – measured through punctuality and border crossing delays – can undoubtedly be improved. The Italian network manager RFI recently reported that at the Domodossola border with Switzerland it takes on average 40 minutes to cross. Nevertheless, more than 90% of freight services arrive within less than 60 minutes delay. Nearly 80% of all international freight trains crossing Switzerland in 2004 were on time.

Faster transit times attracts new business

Speed is an important aspect for many customers. It takes approximately one full day for a block train to travel from Rotterdam to Milan, which is an average speed of 60 km/h. This is approximately the equivalent to that of a truck. With an interoperable infrastructure the cross border movements will improve.

If the travel time for example between Rotterdam and Genoa can be reduced to 18 hours rail freight can enter new markets. A segment like trailers-on-train will then be able to compete with road services to a large extent and will change from a niche market to a large volume commodity.

Figure 2 : rail freight services on the corridor Rotterdam – Genoa

	2005	2012 Target
Transport costs of railfreight (average)	15.00 € / km	13.50 € / km
Traveltime Rotterdam – Milan	22 Hours	18 Hours
Punctuality (less than 30 minutes delay)	70%	85%
Efficiency E-locomotives	190 000 Km / year	250 000 Km / year
Market share rail	22%	28%

Source : Cost-Benefit Analysis Corridor Rotterdam – Genoa, 2005

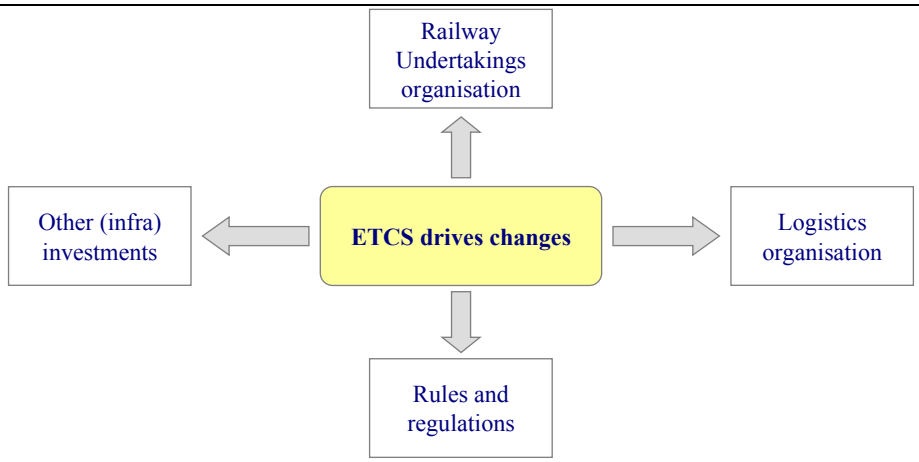
II. STRATEGY FOR IMPLEMENTING ERTMS

II.1. ERTMS

ERTMS is the driver to create an optimal corridor

To improve corridor performance for rail freight there are many different measures to be taken. Although these will be described in the following chapter, there is one key-aspect that drives and facilitates the required changes and will therefore be introduced here. ERTMS provides the framework for a successful course of action on the field of railway undertakings organisation, logistics organisation, rules and regulations and other investments (as can be seen in the figure below).

Figure 3: ETCS drives change



A European Control-Command (CC) system so called ETCS has been developed. Implementing this system on the corridor of Rotterdam - Genoa will improve corridor performance on all relevant aspects. That is to say, the driver of realising a successful corridor is ETCS. Implementation of ETCS will improve the availability of the infrastructure, improve the interoperability on the corridor and provide the necessary conditions for efficient logistic scenarios.

Implement one system – ETCS – on the entire corridor

Traditionally, rail traffic management systems have been developed and deployed on a national basis. This means that each country also has its own CC system, which is incompatible with the CC systems of other countries. For the corridor Rotterdam – Genoa this implies that four different national CC systems are used. This results in cross-border inefficiencies and the use of expensive locomotives. Having ETCS on the entire corridor will enable locomotives to use the rail corridor with just one CC system on board.

Implement ETCS fast in order to reduce costs

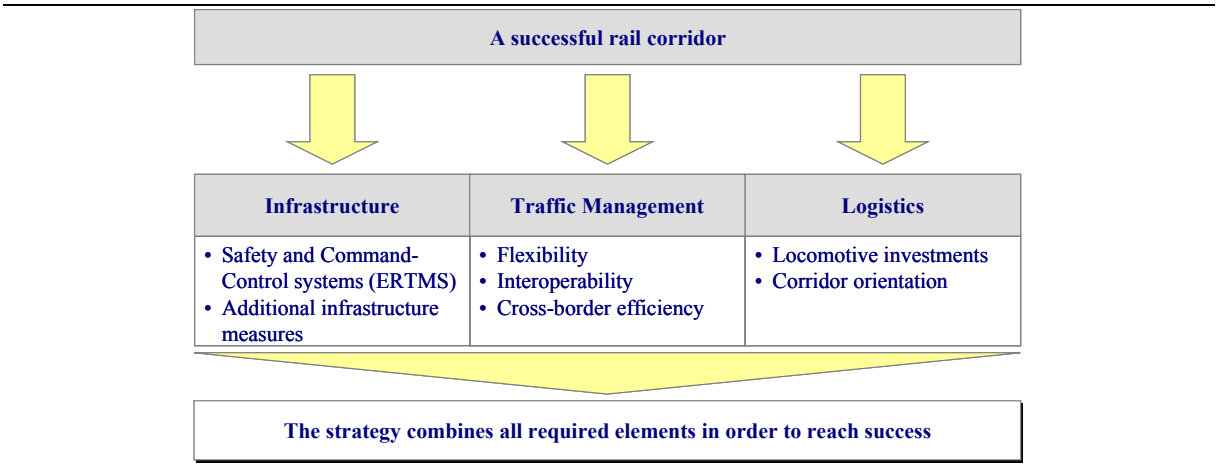
During the implementation of ERTMS in many it is cases inevitable to install ETCS in parallel to the existing signalling systems, which makes the deployment of ERTMS expensive. On the other hand, ERTMS is a costly technology and only recently the developmental phase has been completed. This means that during the transition phase of implementing ETCS the costs for all stakeholders are high. Therefore, a fast migration is necessary in order to limit these additional costs.

II.2. KEY ELEMENTS FOR SUCCESS

Combined approach

In order to create a successful corridor the stakeholders have to make a joint effort to capitalise the opportunities and to make full use of the potential. This means that infrastructure managers, policymakers and railway undertakings have to combine forces to optimise the performance of rail freight services. The implementation of ERTMS on the corridor needs the commitment of the stakeholders to come to a successful rail freight corridor. This is indicated in the picture below.

Figure 4 : Strong commitment by stakeholders to create a successful corridor



Infrastructure: interoperability facilitates cross border movements

Infrastructure managers of the rail corridor Rotterdam – Genoa have a task to make sure there is an availability and accessibility of infrastructure and moreover to put this infrastructure to use efficiently.

ERTMS is the backbone for interoperable infrastructure. The potential benefits of ERTMS can only occur if both the infrastructure managers and the railway undertakings are committed to invest in ERTMS. In addition, within the project various other capacity improvements have to be realised in order to reach the required performance on the corridor.

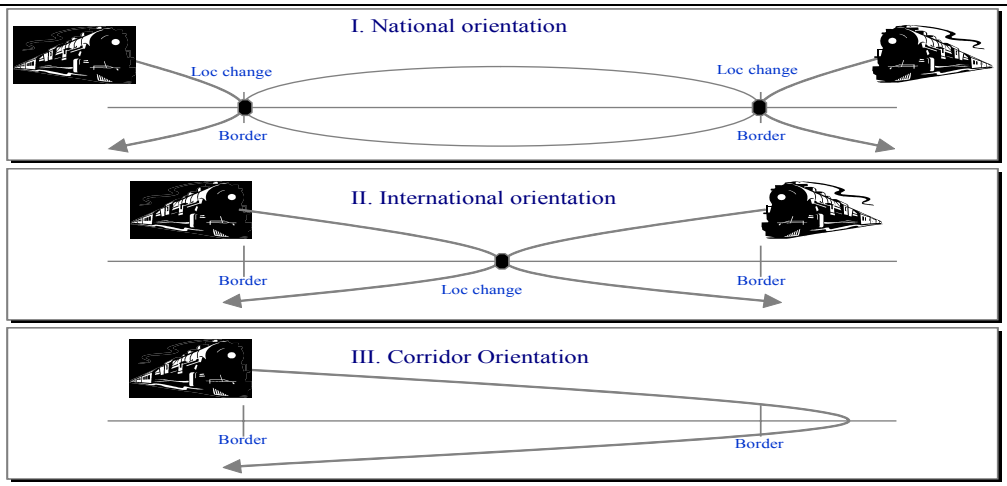
Traffic management will benefit from interoperability

Cross-border efficiency can only materialise if the interoperable tools are used. This means that traffic management has to be organised on a corridor approach. The three basic processes: capacity management, traffic control and performance monitoring have to be organised in a coherent way with modern IT tools. Several interesting initiatives are under construction or under implementation such as Europtirails, Pathfinder and pilot European Performance Regime (EPR). These initiatives must be implemented in a more robust way in order to fulfil modern customer demands.

Logistics: corridor orientation results in efficiency gains for railway undertakings

Railway undertakings can have a national orientation, which is a situation where locomotives are changed at national borders, an international orientation, where locomotive changes will occur at fixed locations along the corridor, or a corridor orientation, which is a situation where the changing of locomotives does not have to occur any more. This is graphically shown is the figure below.

Figure 5 : Railway undertaking orientation on corridor



The implementation of ERTMS on the corridor gives railway undertakings the opportunity to have a corridor orientation, which means that locomotives running on the corridor only need one CC system and thus have lower costs for the locomotives. An interoperable infrastructure on the corridor will give railway undertakings the possibility to put their locomotive fleet to use more efficiently. Time-savings will result from a reduction in the changing of locomotives and fewer non-commercial stops along the corridor. Without ERTMS railway undertakings have an international corridor orientation,

which requires various CC systems onboard of locomotives. This is a relatively costly situation as adding CC systems onboard, becomes progressively more expensive.

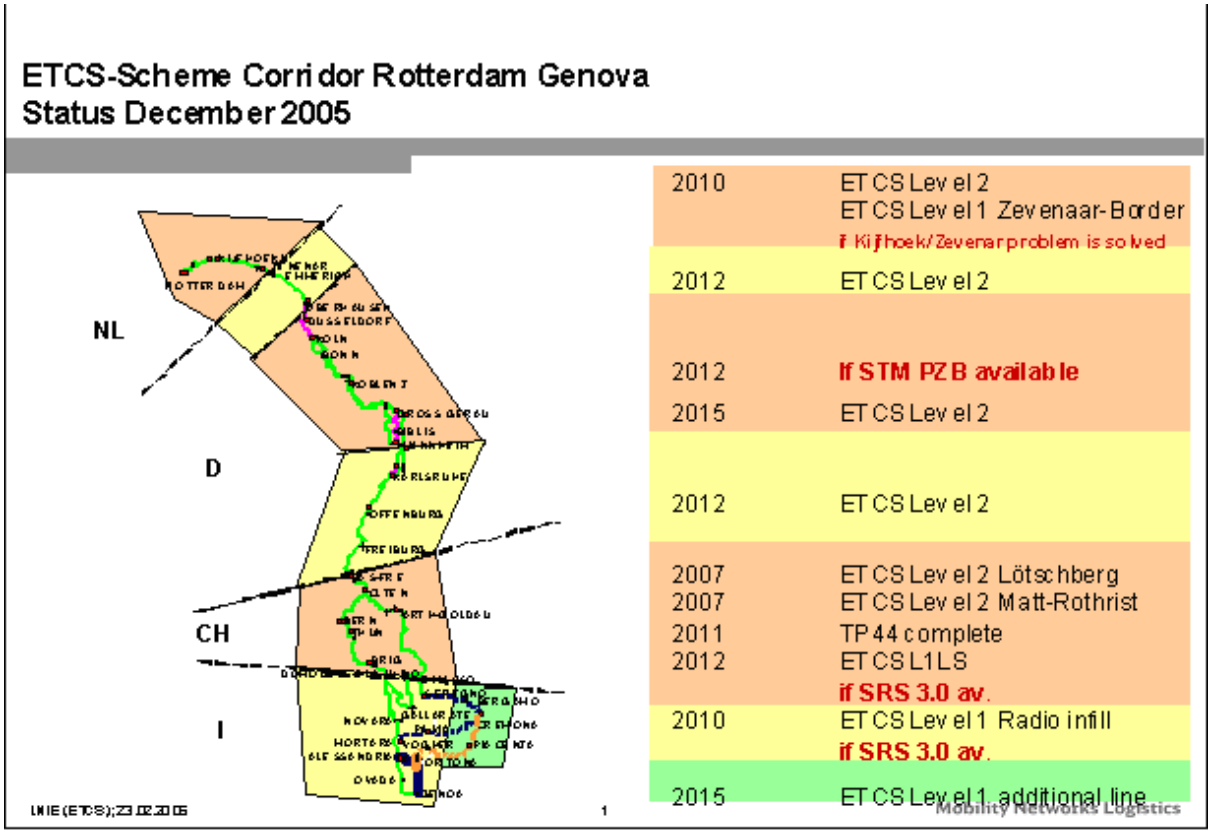
Reduced entrance barrier for locomotives

One CC system on the corridor allows all railway undertakings to enter the corridor with locomotives solely equipped with ETCS. Competition among rail operators will increase due to an interoperable corridor. Today, rolling stock for cross border movements must be equipped with multiple national onboard CC systems. Costs and technology limit the number of signalling systems to be installed on a locomotive and hence its operational radius. Without national CC systems a strong entrance barrier will be removed. The homologation of new locomotives on the corridor will become easier. It should become possible to allow drivers without national infra knowledge to enter to ETCS level-2 sections of the corridor. This will also help the railway undertakings to save a lot of costs for the education of train drivers to get infra knowledge

III. ACTION PLAN

III.1. ERTMS INFRASTRUCTURE

In 2007 The Netherlands and Switzerland will install ERTMS on parts of their new infrastructure projects: Betuweline, Mattstetten Rotrist and Lötschbergtunnel. A joint study of the infrastructure managers has been launched in the summer of 2005 with the objective to implement ETCS on the whole corridor Rotterdam – Genoa in 2012 in order to enable locomotives to use the corridor with just ETCS signalling equipment on board. The graph below presents an overview of the implementation.



Two phases

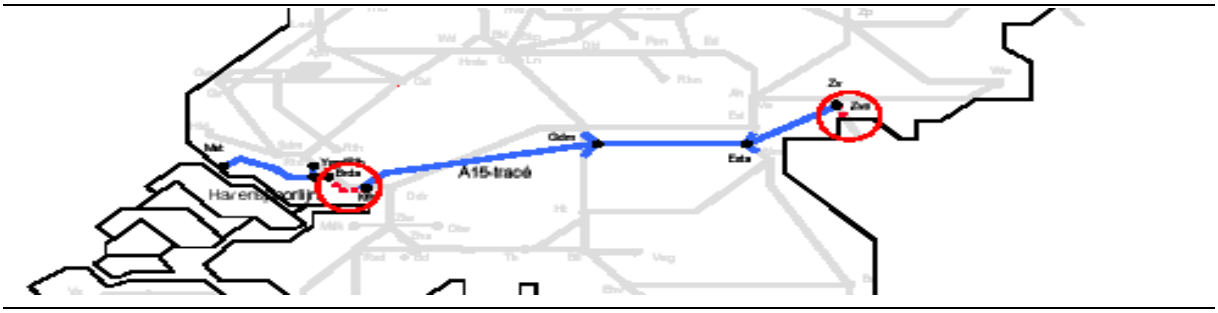
The results show that a first interoperable corridor can already be realised in 2012 or even earlier. In this situation, ETCS will be installed on the infrastructure of Switzerland, the Netherlands, Italy and parts of Germany. This means that ETCS locomotives can run along the corridor without the (expensive) national signalling systems of The Netherlands (ATB), Switzerland (Signum) and Italy (SCMT). The PZB needs to be on board since the German stretch between Oberhausen and Mannheim will have single PZB in the track. With a STM-PZB in addition to the ETCS on board the locomotives can use the whole corridor and railway undertakings can already benefit from an interoperable corridor before finalising ERTMS completely on the infrastructure.

At the latest in 2015 at latest ETCS will be installed on the whole corridor and having ETCS onboard will be sufficient for locomotives using the corridor. The SMT-PZB will not be redundant after the full implementation ETCS on the corridor since PZB enables locomotives to divert from the corridor onto the extensive German network and to use bypass routes on the left side of the Rhine

The Netherlands

The Netherlands will install ETCS as a dual system on the remaining parts of the Betuwe route. This route links the port of Rotterdam to the German border and is still under construction. It will become operational with ETCS level-2 as the signalling system in 2007. However, two imbedded stretches (5 km at Kijfhoek und 13 km between Zevenaar - Emmerich) belong to the existing infrastructure, which has ATB as its signalling system. For these two sections (total tracklength including marshalling yards: 90 km) the Dutch inframanager Prorail suggests an ETCS Level-1 solution in addition to ATB. However, the bypass route Rotterdam - Venlo (and further to Cologne) will not be taken into account in this study.

For the Netherlands an overlay of ETCS on the two sections implies a total investment of € 13.2 million: in 2009 € 4.4 million and in 2010 € 8.8 million. This investment is the implementation with ETCS level-1 on the two ATB islands on the Betuwe route.



ETCS-2 has been investigated as an alternative solution and could be an option if the implementation of ERTMS should be combined with changing the 1500 V voltage.

Germany

Germany will apply a dual system since DB-Netz does not want to interfere with the movements of national traffic. Furthermore, Germany decided to implement ETCS level-2 for reasons of increasing the capacity of its infrastructure and partly because of national high-speed requirements. In its study, DB-Netz has studied the connection Emmerich - Basle (line on the right side of the Rhine). The Rhine line on the left side (Köln - Koblenz - Worms - Mannheim) was not the object of the study.

DB-Netz will install ETCS Level-2 next to the existing punctual (PZB) and line (LZB) train control systems. The implementation project consists of two phases:
In phase 1, ETCS Level-2 implementation is to be realised from the Dutch border to Oberhausen via Emmerich and from Mannheim to Basle. On the section Dutch border - Emmerich – Oberhausen, the block length will be shortened for capacity reasons (connection to the Betuwe route). Between Karlsruhe and Basle, the Katzenberg tunnel (opens in 2009/10) will be equipped with ETCS Level-2 (parallel with PZB). On the section Karlsruhe – Basle, LZB / CIR-ELKE (Computer integrated Railroading – Erhöhung der Leistungsfähigkeit im Kernnetz) is already installed. DB-Netz estimates that the equipment of these two sections could be completed in 2010.
In phase 2, the gap between Oberhausen and Mannheim will be filled with ETCS Level-2. On this stretch, ETCS will be installed in addition to PZB. This section will be completed by the end of 2015 if EU funding comes available for the second phase. Alternatives for closing the gap between Oberhausen and Mannheim have been investigated. Level-1 in order to accelerate the ETCS implementation of the gap does not provide enough capacity and is therefore no desirable solution. The option of Level-1 Limited Supervision is being investigated and a first result is expected in March 2006. ETCS investments for Germany for the first phase (2012) amount € 101 million and € 134 to fill the gap between Oberhausen and Mannheim (2015).

Moreover, Germany needs to invest in new interlockings along their part of the corridor. The investments in the first phase are € 220 million and € 702 million for the gap between Oberhausen and Mannheim. All further relevant information concerning ETCS development on the Corridor is laid down in the "Technical Study Germany Emmerich – Basle", which current version 1.1 of August 15th, 2005.

Switzerland

In Switzerland, the new sections are and will be equipped with ETCS Level-2. This is already the case on the Basle - Domodossola corridor, for the section Mattstetten - Rothrist (NBS) and the Lötschberg-base tunnel (LBT). Freight trains will be able to run on these ETCS lines from mid-2007 (LBT) respective end of 2007 (NBS). As far as the Basle - Chiasso / Luino corridor stretch is concerned, the Gotthard and the Ceneri base tunnels (opening in 2016) will be equipped with ETCS Level-2 only.

For economic reasons Switzerland does not intend to install ETCS parallel to the existing national train control equipment. It solely wants ETCS as the solution. Therefore, they need ETCS Level-1

Limited Supervision (L1LS) to be specified by EU. The sections on the Swiss part of the corridor that do not have ETCS Level-2 (approximately 1400 km of total track) will be equipped with ETCS L1LS. SBB and BLS expect the work to be completed by the end of 2012. Moreover, in Switzerland the stretches equipped with ETCS L1LS can also be used by vehicles which already have the train control systems specific to the Swiss national system on their locomotives (by reading the information of national packet P44).

Trackside investments in Switzerland will be approximately € 52 million spread over the period from 2007 to 2011. On the Swiss part of the corridor ETCS level-1 Limited Supervision is put into operation if ETCS level-1 Limited Supervision is in the specification and available as product. There are no additional maintenance costs as the national system is replaced by ETCS, which means that in Switzerland there will no longer be a dual system.

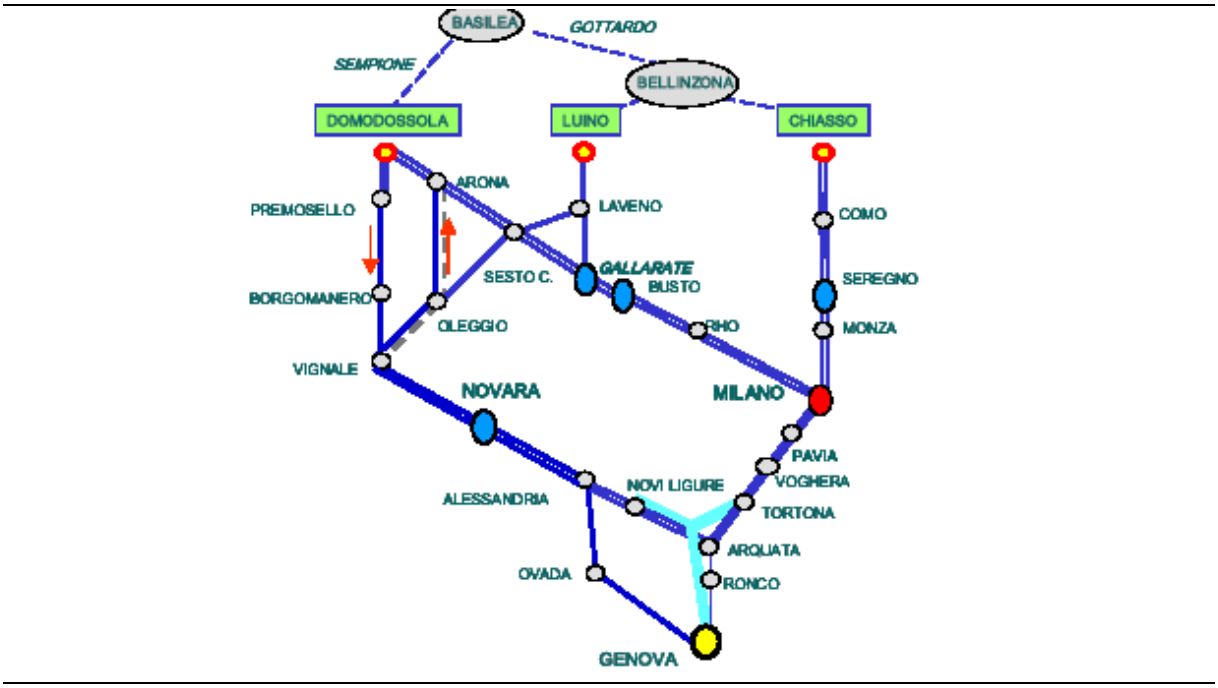
For Switzerland, ETCS L1LS is a transitory solution, which means that on the long term ETCS L1LS will be replaced by ETCS Level-2 technology. This will occur when signal boxes need to be replaced or infrastructure adaptations aimed at increasing capacity are necessary.

Italy

In Italy, the RFI has started implementing SCMT, which is a new train control system based on the existing ETCS component 'Eurobalise' and on the existing track-circuit current system. As a result of this situation, the RFI suggests that the Italian part of the corridor should be equipped with ETCS Level-1 and 'Radio Infill' (instead of Euroloop). In this framework the RFI can rely on the existing SCMT infrastructure and only has to implement 'Radio Infill', which is in principle foreseen in the existing ETCS specifications. The implementation project consists of two phases:

Phase 1 comprises the stretches Domodossola / Luino - Gallarate - Busto, Domodossola / Luino - Novara – Genoa and Chiasso – Seregno. This means that approximately 680 km of tracks are concerned. The RFI is of the opinion that an implementation by 2012 is possible if 'Radio Infill' can be realised.

In phase 2, the so-called 'Belt Line' is to be implemented. This will allow trains to bypass Milan from Seregno. This means that the stretches Seregno - Bergamo - Cremona - Pavia – Mortara and Novi Ligure – Genoa (approximately 328 km of tracks) have to be installed with ETCS Level-1 and 'Radio Infill'. RFI estimates that an implementation by 2015 is feasible if 'Radio Infill' is realised.



Italy will invest in ETCS level-1 in the period starting in 2008 and ending in 2011. A total amount of € 66.4 million will be invested in trackside ETCS. Investments of ETCS in the new Belt between Milan and Genoa after 2012 - 2015 will require € 32 million.

Technological development

In the studies performed by Switzerland and Italy the conclusion is that ETCS Level-1 Limited Supervision respectively ETCS Level-1 with Radio Infill are the most economical solutions on their corridor sections. Today, no operational product is available for either solution. Various ETCS Level-2 projects have been implemented proving the technical feasibility in Zofingen – Sempach (Switzerland), Jüterborg – Halle – Leibzig (Germany) und Rome – Naples (Italy). However, these projects were not yet critical for the proof of interoperability. According to the experiments done by Switzerland, there is still an important risk. In the meantime, the UNISIG firms have acknowledged the problem and taken the first measures (implementation of Subset 108 and extension of SRS to

version 2.3.0). To reach the performance and the necessary functionality it is necessary to provide additional functionalities in a short time frame.

The main required functions for the proposed corridor solution are:

- braking curves,
- key management,
- level crossing,
- limited supervision and
- radio infill.

These issues request the SRS 3.0.0.

In detail for each railway the following listed change requests for the corridor Rotterdam Genova are required.

For the Netherlands the baseline SRS 2.3.0 is sufficient.

For Germany the following change requests (CR) are necessary to run the Corridor:

U070, U124, U170, U233, U265, U299, U397, U410, U413, U459, U481, U487, U514, U519, U544, U583, U584, U586, U595, U601, U637, U656, U657, U659, U675, U676, U678, E220, E224, E225, DB99, DB100, DB101.

For Switzerland at least the change request U637 limited Supervision is necessary.

For Italy at least the following change request are necessary.

CR 481 (EEIG ref 134: Supervision of the Radio link) is absolutely important (and urgent); it has to be included in the SRS 3.0.0.

CR 638 (concerning the train categories).

Investments

A summary of the investments in ERTMS infrastructure is presented in the figure below.

Figure 6: Overview ETCS investments on infrastructure corridor

ETCS investments (€ million)	Phase 1: 2012	Phase 2: 2015
Switzerland	51	-
Netherlands	13	-
Germany ETCS signalling	101	134
Germany interlocking	321	702
Italy	66	32
Total	**548**	**868**

III.2. OPTIMISING INFRASTRUCTURE

The project combines ETCS with other improvements on the corridor in order to maximise the benefits for the railway undertakings. The horizon 2012 cannot include all investments, which are necessary to increase capacity. Therefore it only incorporates a relatively limited amount of investments delivering a quick win in efficiency.

Connect Rotterdam with the 15/25 kV network

After the realisation of the Betuweline with 25 kV the corridor between Rotterdam and the Swiss-Italian border offers almost a dual voltage of ac15/25 kV. Just two imbedded stretches at Kijfhoek (NL) and between Zevenaar - Emmerich (NL/D) have dc 1500 V. If these stretches are changed into either 15 kV or 25 kV all bi-current electric locomotives in middle Europe can enter the corridor and reach the Rotterdam harbour.

Railway undertakings will benefit from this change in infrastructure since 15/25 kV locomotives:

- have lower operational costs than 4- voltage locs (ac 15/25 kV + dc1500/3000 V).
- are largely available among the railway undertakings in Europe. Without 1500 V a threshold for new entrants will disappear and competition on the destination Rotterdam will increase.
- are mostly pre-fitted for ETCS which reduces the retrofitting costs .

DB-Netz and ProRail investigated the required investments for changing the section Zevenaar - Emmerich at approximately € 30 million. Kijfhoek will have to be redesigned in order to create a 25 kV connection. The options have yet to be investigated and the costs will be at least € 30 million.

Connection Domo II: the 3kV DC network to the 15 kV AC network

Construction of the double track line through Domo II with mixed catenary 3 kV DC and 15kV AC will allow easier exchange of the locomotive tension (for multi-tension locomotives) or exchange of the locomotive itself. The estimated investment is € 5 million.

Increase of capacity and regularity 2012 between Simplon – Novara

The adjustment of the gabaridge / profile to P80 of the line Premosello – Arona – Oleggio – Vignale will allow the "container highcube" and "autostrada viaggiante" to run from Novara to Simplon in south - north direction. This solution will enhance the capacity and the regularity of the Premosello – Borgomanero – Vignale line significantly. In fact, currently the single track line Premosello – Borgomanero – Vignale is used in both directions, because only this line has P80. The estimated investment is € 50 million.

Increase of capacity 2012-2020

On average the current capacity of the corridor is about 150 freight paths per day. New infrastructure capacity will be necessary between 2012 and 2020, especially when rail traffic shows its improved

performance from 2012 onwards. The investments for elimination of infrastructure bottlenecks are required to physically accommodate a steady and sustainable annual growth in the range of 3 - 7%. On crucial sections corridor capacity is actually fully used at peak times. Therefore, major capacity enhancements, such as the Betuwe route and the NEAT-tunnels provide extra capacity on already congested segments of the corridor. However, increased traffic on the new sections will result in the remaining sections getting even more congested.

This provides a strong case for infrastructure investments in Germany (Emmerich – Oberhausen, Cologne – Mannheim, Karlsruhe – Basle) and Italy (Sempione and Luino Platforms and the new line Genoa – Milan) as the performance of a corridor is only as strong as its weakest link. Although these investments are not included in this project plan, investing in the widening of infrastructure in Germany and Italy will also be beneficial for the infrastructure projects currently under construction in the Netherlands and Switzerland as the extra capacity that results from these projects will be reinforced by increased capacity along the entire corridor. In the Appendix are summarized the bottlenecks in the infrastructure along the corridor and measures to be taken between 2012 and 2020. Only then the corridor as a whole will be able to cope with the traffic flows and the freight market demands.

III.3. QUALITATIVE MEASURES

Within the IQ-C project (MOU between Ministers dated 9 January 2003) measures are implemented to improve the quality of rail freight services on the corridor. These measures substantially complement the ERTMS corridor project.

Coordinated traffic management

The traffic on the corridor is managed by five infrastructure managers (Switzerland has two) divided over four countries. The infrastructure managers of the corridor countries have to coordinate all their activities during the process of traffic management. Traffic management consists of the processes:

- Capacity management before the journey (planning and timetabling)
- Traffic control during the journey
- Performance monitoring after the journey

Based on this action plan for implementation of ERTMS on the corridor the infrastructure managers will be asked by the Ministries to work together and develop a coherent program of facilitating measures regarding traffic management that deliver the potential benefits of ERTMS regarding improved efficiency and reliability for international freight trains. The Ministries will be consulted about this program of facilitating measures and in particular regarding the conditions under which the measures can be implemented. In designing this program of facilitating measures the infrastructure managers take into consideration, among other things, the following issues:

One Stop Shop (OSS)

Currently, infrastructure managers are collaborating to shorten planning-times for path requests by 2007. If railway undertakings use one portal (One Stop Shop of RailNetEurope) they no longer need to address the infrastructure managers of the various corridor countries in different languages. The portal coordinates the sales services, before, during and after the train journey. This includes assistance to the customer on traffic planning, international coordination of tailor-made trainpaths and information on the level of infrastructure charges.

The OSS has proven it can play a role on the corridor. However, a lot of work has to be done to optimise the OSS. The challenge in the coming years will be to maximise customer satisfaction by optimising service levels. This can only be done on the basis of up-to-date IT tools that are able to work on a cross-border basis.

Towards a corridor traffic management

Several IT tools for cross-border traffic management have been developed by RailNetEurope in a broader EU-wide context. Pathfinder and EICIS are developed for support of capacity management, Europtirails is under construction for the support of cross-border traffic control (cooperation between France, Italy, Switzerland, Germany and the Netherlands) and a pilot of European Performance Regime (EPR) is planned on the corridor as well. The implementation of these tools, in combination with ERTMS deployment on the corridor, should lead to faster trainpaths and better reliability. Today the processing of trains takes too much time as can be seen in figure 7.

Figure 7 : Processing times on the corridor Rotterdam – Genoa

Border	Processing time per train	Included activities	Remarks
Netherlands / Germany	3 min	Only PVG data transfer	Without change of locomotive or technical equipment
	50 – 60 min 10 – 30 min	With locomotive change of train control system and pantograph	Without locomotive change
Germany / Switzerland	0 hours		Cross border performance rated as good / very good
Switzerland / Italy	2 hours		Via Domodossola / Chiasso
	3 hours	With customs clearance	Customs clearance procedure required for about 70 % of the trains

Cooperation between infrastructure managers and terminals

ERTMS will be implemented on the whole corridor Rotterdam - Genoa including the main terminals and marshalling yards. The aim is to equip the yards of the Rotterdam port, Kijfhoek, Oberhausen –

Osterfeld, Mannheim, Basle, Domodossola, Chiasso, Luino, Gallarate, Novara, Milan, Alessandria and Genoa with at least one double track main link with ETCS.

Terminal operators and infrastructure managers have to work together to construct trainpaths and control the actual traffic. Delays on the terminal can have a dramatic impact on punctuality on the whole corridor and vice versa. Better cooperation in the logistical chain can improve punctuality on the terminal and positively affect the whole corridor. It is not unusual that more than 50% of the trains leave the terminal with delay and as a result loose their requested trainpath. Framework conditions such as performance regimes can stimulate all partners in the chain to maximise punctuality. Further study needs to define the exact problems and solutions. On the basis of this study the right actions can be taken to improve the quality of the interface of terminals and infrastructure.

Cooperation between safety authorities

The cooperation between safety authorities is necessary for implementing borderless traffic. The safety authorities will therefore continue to work on mutual acceptance of drivers and locomotives.

Mutual recognition of train drivers

Germany and the Netherlands have developed a model for cross-border recognition of engine drivers (MOU between safety authorities has been signed in 2005). Where possible this approach will also be implemented on the German – Swiss and Swiss – Italian border. Implementation of the EU directive on licences for train drivers will be gradually implemented from 2010 onwards.

In 2012, the Netherlands may define a qualification regime for foreign drivers, who use the Betuwe route to enter the harbour of Rotterdam. If ETCS level-2 is in operation the driver will be guided by his onboard cab signalling to his destination and does not need any other specific track knowledge. This onboard monitor guidance can also occur on other parts on the corridor.

The interoperability of ERTMS goes beyond the technical level of ETCS and offers operational benefits. To use this opportunity for improving interoperability of human resources a demonstration project must be realised to develop working methods for the simplification of track knowledge requirements for cross-border operations.

Mutual recognition of locomotives

Practical cooperation between certification authorities of the involved countries has been set up. The desirable approach for certification authorities dealing with requests for the cross-border certification of drivers is being dealt with at European level.

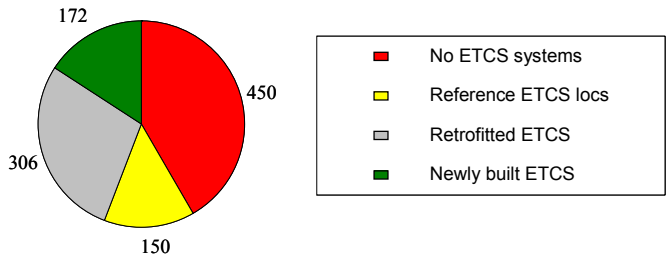
III.4. NEW LOGISTICS

Currently, most international locomotives run on one or two national systems. This means that in order for a train to run the entire corridor it has to change its locomotives at least one time. This is a time-consuming business. Moreover, it is expensive to have more than one Control-Command system onboard a locomotive. As already described, the implementation of ERTMS on the corridor makes it possible for railway undertakings to use only ETCS as its CC system.

As the Betuweline in the Netherlands and the Lötschberg-base tunnel in Switzerland will be implemented with ETCS level-2 in 2007, already 150 locomotives are equipped with ETCS and PZB (reference locomotives in figure 8). However, the majority of the current international locomotive fleet still has to be installed with ETCS, which is a large investment. Therefore, the so-called 'retrofitting' of locomotives will occur just prior to the implementation of ERTMS on the infrastructure of the corridor in 2012. It is estimated that 90 locomotives will be retrofitted with ETCS in 2010, 100 locomotives in 2011 and 116 locomotives in 2012. This will amount to a total of 306 retrofitted ETCS locomotives before the first phase of ERTMS (trackside) implementation is completed. If the PZB remains the single system between Oberhausen and Mannheim for some years after 2012, the existing PZB in the locomotives must be connected to the ETCS or a STM-PZB must be installed.

When ERTMS has been fully implemented on the corridor by 2015, new locomotives will be built with solely ETCS onboard. This means that 72 new ETCS locomotives will run on the corridor in 2013 and another 100 in 2014. After this period the old (non-ETCS) fleet will gradually be replaced by relatively less expensive ETCS locomotives. An overview of the locomotives running on the corridor by 2012 is presented in the figure below.

Figure 8: Locomotives on the corridor Rotterdam – Genoa in 2012



Source : Cost-Benefit Analysis Corridor Rotterdam – Genoa, 2005

Investments in locomotives

Investments have to be made for the retrofitting of 306 locomotives. The so-called locomotive migration costs vary between € 130 000 and € 250 000 per locomotive. This bandwidth is caused by the fact that some locomotives (such as the 15/25 kV BR185) are pre-fitted with an option for ETCS, which means that the STM modules PZB is already on board and the ETCS computer has to be

purchased and connected. The remaining locomotives have to be retrofitted with ETCS completely, which is a relatively expensive procedure. Moreover, if a locomotive has more (national) Command-Control systems onboard, the cost of adding ETCS increases progressively.

It is calculated that the retrofitting of the locomotives will be depreciated over a period of 15 years. The required amount of capital that is needed for such an investment has an annual interest rate of 7%. This means that the total migration costs for locomotives will be between € 65 million and € 124 million depending on the type of locomotive.

III.5. MILESTONES, ORGANISATION AND INVESTMENTS

Milestones

The taskforce group of ERMTS experts was asked to deliver an interoperable ERTMS infrastructure and to deliver benefits for the railway undertakings as soon as possible. The described action plan will realise these objectives in 2012. The milestones in the figure below will have to be executed in a joint effort by the infrastructure managers.

Figure 9: Milestones of phase 1

Organisation

The milestones will only be realised if the implementation is well-coordinated, stimulated and decided upon by an "Organisation", which is dedicated to the realisation of the project on the corridor. Two aspects are of importance:

- The "Organisation" should be able to decide on all issues related to the project plan. That is to say, all decision making authorities such as the Ministries and the infrastructure managers should be part of the "Organisation",
- The "Organisation" should be able to run the required operations on a day-to-day level

The main functions of the "Organisation" will be:

– The planning of the activities

– Centralised purchasing

– Financial planning

–

The planning of activities is required because the project plan is a coherent plan in which all activities interconnect. Having only one responsible "Organisation" will prevent 'isolated' decision-making and tackle the interoperability aspects quicker and more systematically.

The "Organisation" has the task to organise for tendering of the ERTMS investments. A project organisation on behalf of the inframanagers responsible for the implementation of ERTMS on the corridor in 2012 will be able to negotiate and safeguard an interoperable corridor. Apart from connecting the ERTMS to the national systems an ERTMS corridor requires solutions for the cross-border transitions and one SRS version for all countries.

The financial aspects for realising the plan are not simple. There are many financial flows between the Ministries, the inframanagers and the EU. This needs to be managed in order to guarantee the effective use of the available financial means. Presently, the costs for the implementation of ETCS are too high. This can certainly be explained by the fact that no big orders are expected in the face of the huge development costs. Furthermore, all participants (firms, railway undertakings and authorities) have underestimated the effort it takes to introduce such a complex system and consequently have registered substantial losses on their projects.
To set up the "Organisation" the following steps need to be taken:

Step 1: Creating an Executive Committee

The first step is to set up an Executive Committee in which all decision making and responsible authorities are represented. The Committee includes the four ministries of Transport of Italy, Switzerland, Germany and the Netherlands and the five inframanagers that are active on the corridor. Furthermore the Executive Committee has to define the decision making processes within the committee, which have to be in accordance with the internal decision making processes of each

country. The first decisions of the Executive Committee after being put into operation will be aimed to create a framework for executing the plan.

Step2: Forming the Management Committee

The Committee will decide on a Management Committee that carries out the decisions taken by the Executive Committee and is also responsible for the day-to-day management of the corridor project. The Management Committee will finalise the actual plan and organise the planning processes, the way in which the central purchasing is organised, the relation with ongoing business and the financial planning. It is vital for the Executive as well as Management Committee to act as one body and speak with one voice. The "Organisation" must also to deal with communicational aspects such as the informing of other authorities, stakeholders and the general public.

Step 3: Execution of the plan by the management committee

After high level decision making in the Executive Committee has lead to agreement on the plan for the corridor and the setting up of the Management Committee, the required actions to improve corridor performance will start..

The Management committee must keep close contact with their line organisation since they already cooperate for the implementation of the qualitative measures for traffic management. Presently RailNetEurope has assigned a coordinator for the corridor Rotterdam – Genoa to take up these tasks. This initiative should be upgraded to a more robust level in order to be able to handle the complex and heavy implementation tasks that lie ahead.

Investments

In the figure below an overview of the necessary investments for a successful corridor is presented.

Figure 10: Overview of investments per country

EU member	Investment: in million €	2007 – 2009	2009 – 2012	Phase 1
Netherlands	ETCS	4	9	13
	15 / 25 kV	30	30	60
Germany	ETCS	51	50	101
	Signalling	161	160	321
Italy	ETCS	33	33	66
	Simplon – Novara	25	30	55
Traffic management				5
Project management				5
Total infrastructure				**627**
Retrofit locomotives				100
EU member	Investment	2009 – 2012	2013 – 2015	Phase 2
Germany	ETCS	67	67	134
	Interlocking	351	351	702
Italy	ETCS	16	16	32
Total infrastructure				**868**

data +- 30 %

Subsidies

Within the framework of the Trans European Network the Commission is earmarking a significant part of the budget 2007 - 2013 to the deployment of ERTMS. With EU support the ERTMS market will become mature and is able to develop on its own after 2013. An overview of the proposal for EU support is shown in the figure below, which is based on 50 % subsidy for ETCS investments and joint project cost and 20% for investments related to ETCS or cross border. Total EU subsidy for infrastructure will amount to € 184 million and for retrofitting locomotives with ETCS € 50 million.

Figure 11: Proposal for EU subsidies 2007-2012

EU member	EU subsidy in million €	Phase 1				Phase 2
		Investment	2007 – 2009	2009 – 2012	Total Phase 1	2009 – 2012
Netherlands	50 %	ETCS	2	5	7	
	20 %	15 / 25 kV	6	6	12	
Germany	50 %	ETCS	26	25	51	34
	20 %	Signalling	32	32	64	71
Italy	50 %	ETCS	17	17	34	8
	20 %	Simplon – Novara	5	6	11	
Traffic management	50 %				2.5	
Project management	50 %				2.5	
Total infrastructure					**184**	**113**
Retrofit locomotives	50 %				50	

data +- 30 %

IV. BENEFITS

IV.1. BENEFITS RESULTING FROM OPTIMISING CORRIDOR PERFORMANCE

Infrastructure managers face investments for ETCS

The corridor Rotterdam – Genoa is the first European corridor that will be implemented with ERTMS. This means that infrastructure managers face large investments with little return on the short term. This has two reasons. First of all, as the corridor Rotterdam – Genoa is the first corridor on which ERTMS will be implemented, it can be expected that purchasing costs are still relatively high as economies of scale have not yet set in as would be the case if this corridor would be the tenth corridor implemented with ERTMS. Secondly, ERTMS is often implemented in addition to the national systems because national traffic also uses the corridor and have national CC systems onboard their locomotives. This means that infrastructure managers have to invest in an extra system and moreover face high maintenance costs as ETCS maintenance costs are on top of the maintenance costs of the national system. As ERTMS technology is not yet widespread over Europe and as it is implemented in addition to the national signalling systems, increases in capacity due to ERTMS will not occur on the short term.

Fewer Command-Control systems lead to lower transport costs

Current practice for railway undertakings is to use locomotives equipped with more than one CC-system. The implementation of ERTMS on the corridor means that locomotives will require only one system and new locomotives need smaller investments for CC-systems (ETCS only). It is assumed that railway undertakings save on average one CC-system per loc. This means that the annual savings for railway undertakings are on average € 30 000 per locomotive per year. This results in total savings for the railway undertakings amounting to € 208 million.

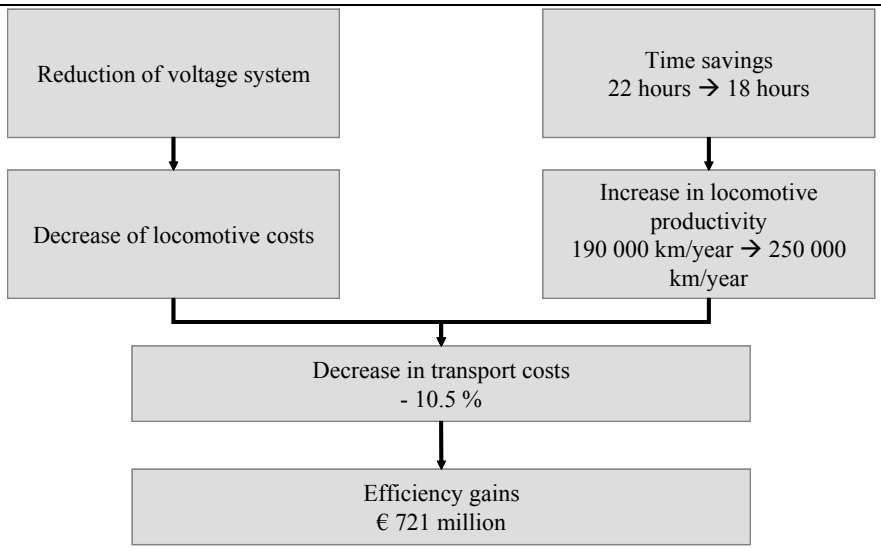
ETCS creates opportunities for time savings

It is calculated that the implementation of ETCS (trackside and train-side) may result in an estimated increase in locomotive productivity of 20 – 30 %. This means that a locomotive will be able to drive approximately an extra 60 000 kilometres per year. However, these productivity gains cannot be reached separately. ERTMS can only be beneficial if other infrastructural measures such as having 2V

locomotives and operational measures such as the mutual recognition of engine drives and locomotives, improving the marshalling yards and creating 'green waves' are taken as well. In short, measures resulting in high quality trainpaths are basic conditions that need to be met in order for railway undertakings to generate time savings.

These time-savings are higher on relatively long distances (Rotterdam – Milan) than on short distances (Rotterdam – Ruhr area) and will only be attained after trackside implementation of ERTMS. Furthermore, time-savings affect approximately 35% of the costs per train-kilometre. This will lead to a maximum reduction of transport costs of 10.5%. The result of the total time-savings will amount to € 721 million. A schematic representation is presented in the figure below.

Figure 12: savings railway undertakings



Source : Cost-Benefit Analysis Corridor Rotterdam – Genoa, 2005

Societal benefits

Competition on the corridor Rotterdam – Genoa will increase as a result of the removal of entrance barriers. It can be expected that this will lead to more competition. Moreover, it is most likely that the efficiency gains that result from ETCS will be handed over by the railway undertakings to the market as well. That is to say, in order for railway undertakings to remain competitive, the efficiency gains that result from time-savings will lead to lower transport prices.

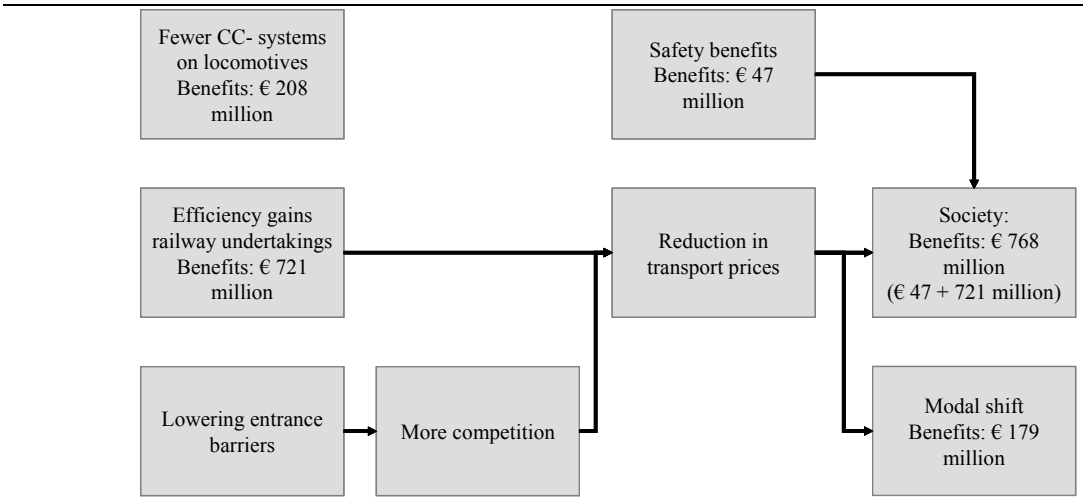
Furthermore, due to the implementation of ETCS (savings on CC-systems, efficiency gains and increased competition) the reduction in transport prices will also result in a modal shift. The modal shift benefits that are generated bring about lower transport costs (meaning lower costs for the same product), environmental advantages (i.e. less emissions from trucks), increased safety (more accidents on road than on track) and a reduction in noise pollution. The results of this modal shift are approximately € 179 million and will be handed over to the market in order to stay competitive.

If railway undertakings have to use these efficiency gains to lower their transport prices they are still faced with the large investments of retrofitting their locomotive fleet with ETCS and only have the benefits of fewer CC systems onboard. However, the benefits of having fewer CC-systems onboard do not out weigh the costs of retrofitting their fleet.

Increased safety performances

ERTMS is specifically designed to reach the highest levels of safety. This means that implementation of ETCS also induces safety benefits. The safety benefits discussed in this section differ from safety results in the last section as here 'internal' safety (within the railway sector) is examined and in the former section railway safety was compared to safety with other modes of traffic. Therefore, implementing ETCS on the corridor Rotterdam – Genoa leads to fewer fatalities in future, which brings societal benefits of € 47 million. A schematic representation is presented in the figure below.

Figure 13: Societal benefits



Source : Cost-Benefit Analysis Corridor Rotterdam – Genoa, 2005

APPENDIX : CAPACITY

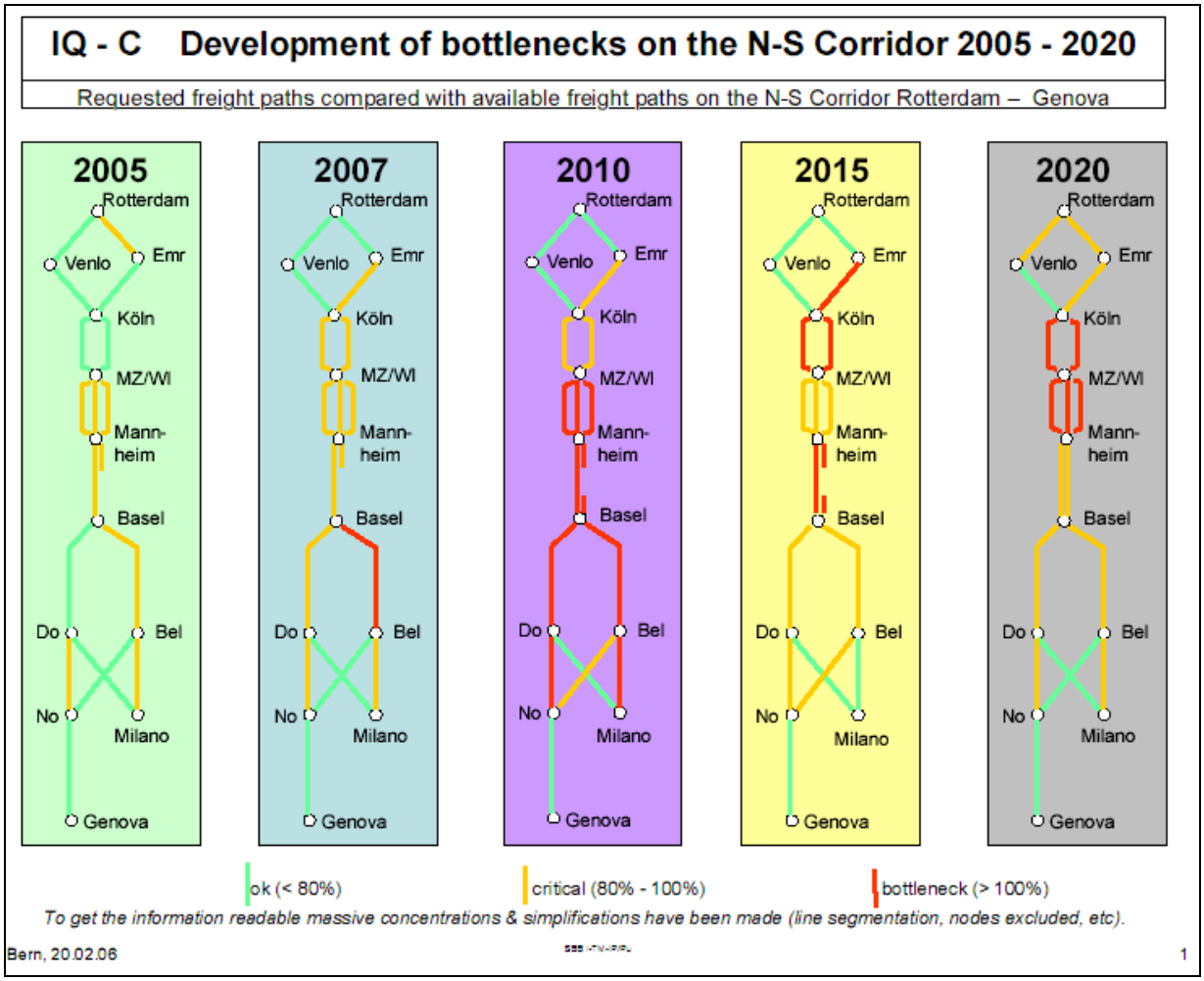
Line section	Description
Rotterdam (RD)/ Kijfhoek - ELST (EST)	The RUs are required to have ATB and ETCS in the Harbour section in parallel for 2007. The concept where ETCS ends and were ATB ends has to be detailed. If the Harbour will have ATB and ETCS, the rolling stock ETCS-equipment will cost 15 Mio € but an increased demand of locos is the consequence. On the other side the existing fleet has to be retrofitted with ETCS with 40 Mio €. New locos have to have ETCS as standard system and STM/ATB as class B system.
Kijfhoek	The marshalling yard has to have ATB in parallel
Zevenaar to Emmerich	Each transition ATB-ETCS is a failure risk. The requirement is to have the moving transition in 2008. The long distance trains are equipped with ETCS and ATB To avoid problems with the four passenger night trains may be routing them via Venlo
Köln (K) - Wiesbaden (WI) - Biblis / Darmstadt - Mannheim (MA)	Slip road Gremberg: crossing with long distance traffic at the south bridge. (Will be disappearing with commissioning Köln Deutz before 2012). Will be release capacity. But: The south bridge is a release which depends on the trass price. There is an pending risks: change of loco staff at "LPW Ratherstraße" at plain section
	Mainz: Risk at Kostheimer bridge: max speed 40 Km/h due problems with stableness of the bridge. New bridge: 100 Mio €. On the other hand the crossing of the S9 at the west head causes a lot of route exclusions. Level crossing bridge releases 36 trains per direction and per day: cost: 50. Mio €
Darmstadt to Mannheim	Platform access on the same level has to be removed at the complete right Rhine side. This causes more capacity and shortness of the travel time. You will get combined traffic. At the left Rhine side it is necessary to upgrade to PC 70.400 profile in 700-800 m tunnel length. This causes a traffic change and a release of capacity at the right side due to running trains direct to Mainz without changing the Rhine side in Koblenz.

	The capacity constraints will only be solved by building the new line (2015). This causes more capacity due the reroute of the High speed traffic to the new line. At the moment there is traffic jam and therefore an increase of travel time. The travel time of the freight trains is below average. The long distance trains have priority.
Karlsruhe to Basel	Freiburg: today filter at the same level of Freight train and oncoming traffic of long distance trains. To remove this bottleneck there are different levels of construction required.
Basel (BS)	The two track Rhine river bridge between Basel Bad and Basel SBB is a bottleneck that needs to be eliminated urgently.
Basel (BS)	"MUBE: Multifunktionale Betriebsanlage" has to be planned as buffer between Germanys and Switzerlands systematised train path systems.
Domodossola (DO) marshalling yard	Six transit tracks with switchable catenary (3 kV / 15 kV) will be open for transit trains 2007/8 limiting the transit time to 30 min (buffer between systems).
Domodossola- Novara	Realisation of unidirectional traffic will release capacity after 2008
Chiasso (CHI), Domodossola (DO)	Customer clearance problems between EU and non EU country.

The table above describes some bottlenecks in the capacity of the corridor Rotterdam- Genoa. It is obvious that additional infrastructure investments are necessary in Germany (Emmerich-Oberhausen, Cologne-Mannheim, Karlsruhe-Basle) and Italy (Sempione and Luino Platforms and new line Genova-Arquate) to support the benefits of the projects under construction in the Netherlands and Switzerland.

The shortage of rail capacity is illustrated in the next graph. It shows the bottlenecks where the requested trainpaths in future have been compared with the available ones.

The inframanagers have jointly investigated all capacity projects up to 2020, which are necessary to increase the capacity and, as a whole, increase the quality of service on the corridor as well as avoiding overbooking.


IQ - C Development of bottlenecks on the N-S Corridor 2005 - 2020
Requested freight paths compared with available freight paths on the N-S Corridor Rotterdam – Genova
2005
2007
2010
2015
2020
Rotterdam
Venlo
Emr
Köln
MZ/Wl
Mann-
heim
Basel
Do
Bel
No
Milano
Genova
ok (< 80%)
critical (80% - 100%)
bottleneck (> 100%)
To get the information readable massive concentrations & simplifications have been made (line segmentation, nodes excluded, etc).
Bern, 20.02.06
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