PRICEWATERHOUSECOOPERS Advisory

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To:

EUROPEAN COMMISSION

DIRECTORATE GENERAL ENERGY AND TRANSPORT

PREPARATORY STUDY FOR AN IMPACT ASSESSMENT FOR A RAIL NETWORK GIVING PRIORITY TO FREIGHT

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1 CONTEXT OF THE PRESENT SITUATION

1.1 Description of the freight rail transport market in the EU

In the past few years, freight transport has been constantly increasing in the European Union, at a yearly average of 2.8% in the 1995-2005 decade. Indeed, thanks to advances in transport technology, costs have considerably decreased, thus allowing higher trade volumes. In addition to this, the recent enlargements[1] of the EU and of its Internal Market have resulted into higher West/East trade volumes. Against such overall increase in freight transport, the share of rail freight transport has been declining, and most of this new transport has taken the road. In 2005, only 10% of freight were transported by rail in EU-25 Member States. Yet, such figures varies widely across the EU: some countries have a higher share of rail transport, while in some other ones rail is insignificant in the national freight transport system.

1.2 European policies in the rail sector

The promotion of freight rail transport is at the centre of several common transport policy guidelines. The European Commission considers the implementation of long-term agreements for rail service quality as a key factor in order to sustain a rail revitalisation strategy. Such objective is a key issue in the whole European Policy for railways.

The main policy documents to be considered when dealing with the EU strategy for revitalising railways are the White Paper "European Policy for 2010: Time to decide" and its Mid-Term review[2]. In the 2001 White Paper the Commission stated the key role of the rail transport in the European transport framework, according to what already stated in the Communication "COM(96) 421 final", in which the Commission had identified the need to establish a "strategic framework for Community action to revitalise rail transport".

In the framework of the strategy for revitalising rail transport provided by the 2001 White Paper, the Commission has identified the following points to be analysed:

- set up of rail transport finances and State aids rules to relieve the railways of debt and improve their finances,
- extension of access rights to infrastructure in order to promote the establishment of trans -European rail freeways with open access and simplified arrangements,
- higher quality and lower costs for users,
- integration of national systems through the promotion of interoperability for conventional rail,
- social aspects connected with possible loss of jobs due to rail sector restructuring within Member States.

As clearly stated in the White Paper "European Policy for 2010: Time to decide" and in its Mid-term review, the Commission has pointed three key actions to revitalise rail transport in Europe:

- integrating rail transport into internal markets,
- making optimum use of infrastructures by opening-up the market, and

[1] 1 May 2004 and 1 January 2007
[2] Communication of 22 June 2006 Keep Europe moving – Sustainable mobility for our continent

- building a dedicated European rail freight network, and promoting the modernisation of rail transport services.

A specific Communication issued in 2007[3], deals with the objective of identifying a European rail network – consisting of corridors – over which freight should be given priority. This would enable more coordination between Member States and infrastructure managers (IM) and thus improving the quality of the service. The content of this Communication will be more accurately analysed in the following paragraphs.

1.3 Legislative actions already undertaken by the European Commission in the rail sector

As described in the paragraph above, the promotion of freight rail transport is a priority in the European Union's policies and legislation. This is because rail is a cleaner and more efficient mode of transport, which produces less carbon dioxide emissions as compared to road transport. It is also a safer mode of transport, with a considerably lower accidentality rate than road transport. For these reasons, the European Commission believes it is important to have more goods transported by rail, thus reducing the number of trucks on the road, with related accidents, congestion and air pollution. As it is known, road transport is one of the most important sources of CO_2 emissions. Therefore, rail definitely represents a more sustainable mode of transport.

Three subsequent Railway Packages, each consisting of several Directives, have therefore been introduced in the past 15 years, with the aim of promoting rail transport by opening up national markets and thus fostering competition and quality of transport. More specifically, the first and second packages aimed at gradually opening up the freight rail market (completed by January 2007) and restructuring the incumbent undertakings. They have produced the beneficial effect of decreasing rail freight costs by 2% per year between 2001 and 2004 and of decreasing rail transport tariffs by 3% per year.

The First Railway Package, issued on 26 February 2001, is made up of three Directives:

1. Directive 2001/12/EC relating to market opening and integration. The Directive provides the Member States to adapt their national legislation to enable the extension of access rights for international freight transport services to the national section of the Trans European Rail Freight Network (TERFN). The Directive also provides that different organisational entities must be set up for transport operations and infrastructure management;

2. Directive 2001/13/EC relating to licensing, sets the framework for the financial, economic and safety conditions to which railway undertakings must comply with to obtain a licence. The licensing authority will issue licenses that will be notified to the Commission and that will be valid throughout the territory of the Community;

3. Directive 2001/14/EC relating to the access to the network and charges, provides that the Infrastructure Manager shall publish a network statement, which contains information on the (technical) nature and limitations of the network, the access conditions to the network and rules on capacity allocation. With the availability of such information becomes possible for the new operators to establish services creating competition inside the market and maximising the welfare for the consumer.

[3] Communication from the European Council and the European Parliament COM(2007) 608 final "Towards a rail network giving priority to freight", 18.10.2007

A following piece of legislation was the Second Railway Package[4] of measures to revitalise the railways by rapidly building an integrated European railway area. The five measures are based on the guidelines set out in the White Paper on transport and aim at greater safety, interoperability and opening of the rail freight market. To give strong impetus to this process, the Commission also proposed the establishment of a European Railway Agency to steer the technical work on safety and interoperability. The five measures consist in the:

- Development of a common approach to rail safety
- Bolstering the fundamental principles of interoperability
- Setting up an effective steering body: the European Railway Agency
- Extension and speed up of opening of the rail freight market, in particular by opening the market for international freight transport to the entire European rail network as of 1 January 2006. Moreover, opening of the market for national freight transport ('cabotage') to be effective as of 1 January 2007.
- Membership of the Intergovernmental Organisation for International Carriage by Rail (OTIF).

The Third Railway Package[5] contains provisions about market opening for international rail passenger services, rail passenger rights and obligations as well as the certification of train drivers.

Another aspect addressed by the European Commission relates to technical interoperability and common safety rules. For example, a European train driver's licence has been introduced, as well as the proposed cross-acceptance of rolling stock. A key element in the development of interoperability is represented by the implementation of ERTMS (European Rail Traffic Management System), a common control, command and signalling system designed to replace the existing national systems.

In addition to this, the European Commission, in its policy of promotion of rail transport, has adopted a corridor-based approach in the context of the Trans-European transport Network (TEN-T). This has allowed the allocation of financial subsidies to rail development projects by means of the TEN-T funds. In fact, it is in this framework that ERTMS is being developed.

With the objective of setting up a European rail network giving priority to freight, several technical and operational initiatives have been launched, among which:

- the development of interoperability, by way of the Technical Specification for Interoperability relating to Traffic Operations and Management (TOM TSI) and the deployment of the Technical Specification for Interoperability relating to Telematics Applications for Freight (TAF TSI);
- the introduction of Europtirails, which is an international real-time traffic management system supporting international train traffic control. The purpose of Europtirails is to gather, centralize and publish train running information on European rail corridors. The published information can be used for traffic management purposes during the train run and quality reviews on European corridors. Thus it can be used as a basic data input for the European Performance Regime (EPR).

[4] Safety Directive (COM(2002)21), Amendment of the Interoperability Directives (COM(2002)22), Regulation on the European Agency (COM(2002)23), Recommendation on the COTIF (COM(2002)24), Amendment of Directive 91/440 (COM(2002)25)

[5] Directive 2007/59/EC, Directive 2007/58/EC and Regulation 1371/2007

- the creation of RailNetEurope,. an organisation bringing together 33 Rail Infrastructure Managers from across Europe. Its main objective is to enable easy and fast access to European railway infrastructure and to increase the quality and efficiency of cross-border rail traffic. It offers its customers international train paths and provide with a useful coordination framework among infrastructure managers.
- the creation of corridor structures by the Member States and IMs as part of the development of ERTMS along 6 major European routes, important for freight.

2 PROBLEM ANALYSIS

2.1 Problem definition

As described in the previous paragraph, the market share of freight rail transport has been steadily declining over the years across the EU, reaching a minimum share of 10% in 2005 (EU-25 countries), the lowest level since 1945. Although the performance of rail freight in the EU is now slightly increasing in absolute terms, the trend is not sufficiently strong to maintain rail's modal share. Hence, the main problem is represented by the declining role of rail in the transport of freight in the European Union, at the advantage of road transport

Many are the reasons behind such decline. One of the most important ones is the fragmentation of the European rail markets and networks. Indeed, there is not sufficient coordination between Infrastructure Managers (IM) and Member States concerning the management of the infrastructures, the provision of ancillary services and the priority to be given to freight on particular axes.

Secondly, there is a lack of investment in railway infrastructure. Rail has suffered for decades of considerable underinvestment (particularly in the new Member States), causing an investment backlog in maintenance and modernisation. Instead, for a competitive rail market, an efficient infrastructure is a prerequisite. The usage of the track and limited life cycle of the infrastructure assets cause wear and deterioration. In order to preserve a quality standard, regular expenditure in infrastructure maintenance is necessary. Without such maintenance, the length of renewal cycles becomes lower, so resulting in higher total lifecycle costs.

In addition to this, rail freight transport in Europe suffers of deteriorating quality, in terms of journey times, reliability and capacity for freight. These factors lead to delays at the borders, caused by interoperability bottlenecks, which often hinder a smooth circulation of trains.

A final cause behind the decline of rail freight transport is represented by the fact that the legislative initiatives put forward so far have not produced the expected benefits. Member States have not entirely transposed the EU rail legislation and the progress towards interoperability is slow. Therefore the difficulties at the borders persist, thus still generating delays.

2.2 The European Union's right to act

To develop an Impact Assessment of an EU policy initiative, it is important to assess whether it is proper to intervene at the EU level and if regulatory intervention is needed in the field.

The EU's right to act in the railway infrastructure field has been examined on the basis of the compliance with the fundamental principles of EU action: principles of subsidiarity, proportionality and conferral, governing the limits and use of the Union competences.

According to **principle of conferral**, "the Union shall act within the limits of the competences conferred on it by the Member States in the Constitution to attain the objectives set out in the Constitution. Competences not conferred on the Union in the Constitution remain with the Member States".

Such principle is met because the development of an EU Communication introducing a rail transport policy measure, as the development of a rail network giving priority to freight, is linked to Art 70 of the Treaty of Rome[6], stressing the importance of a Common Transport Policy, granting also the respect of article 71.

The respect of the **subsidiarity principle** can be observed, looking at the following issues:

- some of the problems, which the EC identifies as affecting the railways sector (e.g. the decline of the competitiveness of the railway sector and the lack of coordination between Infrastructure Managers and Member States), involve transnational aspects that require an action to be taken at the EU level (*necessity test I*).
- the lack of coordination in the relationships between Member States and between Infrastructure Managers along the same corridor will reduce the efficiency of the international rail freight transport, so that more traffic will be shifted to road transport producing congestion and pollution on the territories of the MS; national measures alone then would significantly damage Member States' interests (*necessity test II*);
- the creation of a freight oriented rail network can be better achieved by the Union than by Member States individually (*clear benefit test*);

Under **principle of proportionality**, the content and form of Union action shall not exceed what is necessary to achieve the objectives of the Treaties. In other words, the extent of the action must be in keeping with the aim pursued. This means that when various forms of intervention are available to the Union, it must, where the effect is the same, opt for the approach which leaves the greatest freedom to the Member States and individuals

In order to examine the respect of the proportionality principle, the objective to which the content and form of Union action have to be compared, is the development of a "European Common Transport Policy", which is present in all the EC policy documents since its very beginning (Treaties of Rome, 1957).

As regards the content, the consideration of the different complexity of obligations both for Member States and for IMs to be introduced by the identified policy options (mainly Options B and C) allow to conclude that they do not exceed what is necessary to achieve the objectives of the Common Transport Policy. Indeed, international coordination between Infrastructure Managers in managing the network and planning the investments leaves freedom to Member States.

[6] Article 70, states that *the objectives of this Treaty shall, in matters governed by this Title, be pursued by Member States within the framework of a Common Transport Policy*.

3 OBJECTIVES OF THE INITIATIVE

3.1 General objectives

The objective of this initiative is, essentially, the creation of a strong European rail freight-oriented network composed of corridors, part of the TEN-T. The creation of such network will contribute to promote rail transport and thus acquiring it a larger share in the modal mix in Europe. Because of rail transport's higher energy efficiency (compared to road transport), less emissions will be produced, in line with the objectives of reducing transport's contribution to global CO_2 emissions.

The creation of a European rail network giving priority to freight, therefore, entails the stimulation and the consolidation of cooperation between Infrastructure Managers and Member States. It also implies the need of ensuring reliable and sufficient capacity for freight on strategic axes and of ensuring fair competition on such axes.

A key aspect to point out is that the network has to be of high quality. High quality translates into competitive journey times, reliability of goods transport and capacity adapted to needs.

3.1.1 Consistency with EU policies in the railway sector

Such general objectives are fully consistent and in line with the European Union policies in the railway sector and, more in general, in the transport sector.

As above stated, the European Commission considers the creation of a European freight-oriented rail network as a key factor in order to sustain a strategy of revitalisation of freight rail transport. Such objective is a key issue in the whole European Policy for railways. In this direction are the 2001 White Paper "European Policy for 2010: Time to decide" and its Mid-Term Review. Moreover, as already described, there are the three Railway Packages.

Promoting rail transport is a key element of the EU's transport policy, because it is a more sustainable mode of transport compared to road transport, from the environmental point of view. Indeed, the Commission, in its attempts to cut CO2 emissions, puts the promotion of freight rail transport at the top of its priorities. It is also in line with the EU energy policy, aimed at increasing the energy efficiency of the transport industry. The creation of a freight-oriented rail network, which stimulates international competition between various rail undertakings, is also positive in terms of competition. In fact, the European Commission, through three Railway Packages, has opened up previously monopolistic national markets and thus introduced competition in this industry.

Finally, the promotion of rail transport undoubtedly leads to positive employment gains, thus fulfilling the objectives of the Lisbon Agenda.

A "Strategic Group of Expert", set-up by the European Commission, evaluated the establishment of a "Rail Freight-Oriented Network" defining in details the set of measure to be taken on the basis of the analysis of problems and needs of international rail freight operators.

3.2 Specific objectives

The specific objectives are defined as the immediate objectives of the policy: the targets that first need to be reached in order for the General Objectives to be achieved. They are expressed in terms of the direct and short-term effects of the policy[7].

[7] European Commission, "Impact Assessment Guidelines", 15 June 2005, SEC(2005) 791

A list of the specific objectives, related to single corridors, is provided by the European Commission in its Task Specifications[8].

- Planning of investments and heavy maintenance works: investments on networks should be coordinated between the various Infrastructure Managers along the same corridors. Also the maintenance works should be carried out in a coordinated fashion, so as to minimise disruptions along the corridor. The available capacity on the network should be more transparent and visible, thus allowing an optimal use of the corridor.

- Technical harmonisation of infrastructure: an increase in the productivity of each freight train, in terms of volumes transported, as well as the coordination of the development of harmonised infrastructure and deployment of interoperability.

- Path allocation process: the path allocation process for the international trains on the same corridor should be smooth and efficient. Moreover, there should be the possibility, on all corridors, for applicants other than railway undertaking to request train paths.

- Path allocation rules: it is necessary that freight trains have good and reliable paths, and that ad hoc path allocation is sufficiently flexible and performing.

- Traffic management: in case of traffic disturbance, sufficient priority should be given to rail freight. Additionally, traffic management along the corridor must be coordinated between the various Infrastructure Managers.

- Transparency: fair access to information about the conditions and modalities of use of the infrastructure and the terminals has to be given to all users.

- Terminals: adequacy between infrastructure capacity, terminals capacity and needs of freight trains. Moreover, it is necessary that fair access is granted in accessing ancillary services.

- Quality of service: Infrastructure Managers along the corridor must be committed in providing high quality service towards freight trains. Furthermore, performance schemes are indispensable, and they should be implemented in a consistent and harmonised way.

- Regulatory bodies: regulatory bodies should be allowed to monitor the international freight traffic. It is also essential that the cooperation between regulatory bodies is enhanced.

- Corridor governance: it is necessary that coordination along each corridor is systematically improved.

3.2.1 Features of the objectives (SMART-ness check)

The objectives of any policy initiative, according to the European Commission's "Impact Assessment Guidelines", should be directly related to the problem and its root causes. Moreover, they need to pass the "SMART"ness check. This means that they need to be specific, measurable, accepted, realistic and time-dependent.

The specificity of the objectives implies that they must be precise and concrete enough not to be open to varying interpretations. Consequently, they must be understood similarly by all. Such criteria is fulfilled by all the objectives set in the Task Specifications. Indeed, beside general objectives, specific objectives are also explicitly laid out. These specific objectives, covering areas like path allocation process/rules, transparency, investments' planning and

[8] European Commission, "Task Specifications to award a specific contract under DG TREN's Framework Contract TREN/A2/143-2007 regarding Impact Assessment and Evaluations (ex-ante, intermediate and ex-post) for the assignment: "Towards a rail network giving priority to freight" under Lot 2 (transport)"

terminals, are very detailed and therefore do not produce confusions and/or misunderstandings. Hence, the specificity requirement is entirely fulfilled.

Another condition of the objectives relates to the measurability. This concept means that they must "define a desired future state in measurable terms, so that it is possible to verify whether the objective has been achieved or not"[9]. Again, all the specific objectives of the policy initiative do fulfil such condition. They all refer to situations which are measurable either in a quantitative way or based on a combination of description and scoring scales (i.e. in a qualitative way). For example, the objective of higher transparency, with fair access to information about the conditions and modalities of use of the infrastructure and the terminals can be measured in rather qualitative terms. By contrast, the objective of technical harmonisation of the infrastructure, with increase in the productivity of each freight train can be measured in a quantitative way.

The objectives must also be accepted by all those who are expected to take responsibility for achieving them. Since the objectives are set directly by the European Commission, and they are functional to accomplish the policy options, they therefore must be accepted by the involved stakeholders. This is the case, for instance, of Infrastructure Managers, which must accept the requirement of higher transparency. In this direction, a public consultation is being carried out by the European Commission, in order to acquire stakeholders' views.

Additionally, it is also indispensable that each objective is realistic. This attribute implies that they have to be ambitious but at the same time reasonable and achievable. The "realisticness" of the objective is thus not defined in absolute terms, but rather in relative terms. In macro terms, all the specific objectives appear to be realistic ones, because they do not refer to unfeasible aims. Obviously, fulfilling this criterion also depends on the thresholds set when measuring the realization of the each objective. This is because some situations and Member States have already partially attained, or are more advanced in the achievement of some objectives. Also, some objectives are readily feasible, while some other ones require an adequate implementation time-frame. Moreover, it depends on the time-range chosen to establish the accomplishment of the objective. For instance, the objective of increased volumes transported by each train depends is feasible if there is enough time for improving the rail infrastructure; its feasibility also depend on the target train length that will be fixed. Supposing that an appropriate choice of the threshold and the time-frame for the implementation, the proposed interventions may be considered as feasible since either they have been already implemented in some contexts, or they require only actions that are entirely in the hands of the stakeholders that will be submitted to the new regulations.

A final attribute of each policy objective is their time-dependence. For each single objective, a specific deadline and time-frame must be set for their accomplishment. This feature is strictly related to their realistic nature: as said above, for them to be realistic, they have to be given an implementation deadline or time-frame, which itself must be reasonable. The chosen time frame is the year 2015, in which the objectives of both Policy Options B and C must be achieved.

[9] European Commission, Impact Assessment Guidelines, page 20

4 DEFINITION OF POLICY OPTIONS

As requested by the Commission in the Task Specifications, the Consortium will thoroughly analyse the following policy options:

- **Option A**: "status quo": continue the initiatives already launched (the 1st railway package (directives 2001/14 and 2001/12), the TEN-T programme, the cooperation between Member States (MS) and infrastructure managers (IM) within the framework of ERTMS corridors, the deployment of the TAF TSI).
- **Option B**: Political initiative: extend the ERTMS initiative to other corridors, disseminate the best practices; check the application of existing legislation; encourage the MS and IM to further cooperate and to create corridors in a voluntary way.
- **Option C**: Legislative strengthening: adjusting the existing legislation to impose cooperation between MS and IM on at least one corridor (*) per MS before 2013. Along this corridor, freight would have sufficient priority and competition between operators will be facilitated.

The terms of reference identifies in detail the “Intervention Areas” that shall be included in the policy to be implemented, and highlights the differences between Option A (mainly the application of existing regulation) and Option C.

The **Strategic Group of Experts** (SGoE) set up by the European Commission to assess Commission proposals regarding the creation of European Rail Freight Oriented Network provided a more precise definition of the type of measures to be taken into account for each intervention area. We consider the SGoE proposals as basis for defining the Option C.

In case of Option B, we have look at each intervention area to evaluate if the likely impacts of the “voluntary” approach of this option is likely to achieve results similar to Option C or, instead, nothing changes compared to the “status quo” (Option A). In some case, the Option B approach is considered to imply effects in line with Option C on some corridors only, due to the specific ex-ante situation of them.

The following table present the resulting options’ definition following the just explained approach.

This table is also the **evaluation** of the differences of Option B against Options A and C. In particular, the voluntary approach of Option B will, in our view, bring to effects very similar to Option C in the case of the intervention concerning the path allocation process, quality of service and corridor governance, whereas less important impacts are expected in the area of investment coordination and technical harmonisation. For the other intervention areas (path allocation rules, traffic management, transparency and terminals), the Option B is expected not to generate significant effects. The inertia of the rail business has already shown in the past that a legislative framework shall be put in place to impose the expected evolution in these areas towards a rail network giving priority to freight.

Intervention area	OPTION A STATUS QUO (Directive 2001/14/EC)	OPTION B POLITICAL INITIATIVES	OPTION C LEGISLATIVE STRENGTHENING
INVESTMENT PLANNING	Request for cooperation among IMs to achieve the efficient operation of international train services, but no specific measures foreseen (art. 4.3 of the Directive 2001/14)	• Coordinated long-term investment plan among IMs and MS on all corridor (as in option C) • No coordination expected for heavy maintenance works (as in option A)	Coordination between IM and MS and information to users through: • a long-term investment plan (at least at 10 years) based on traffic forecasts for the corridor; • a medium-term plan (at least at 2 years) for investments and heavy maintenance works based on the traffic forecasts for the corridor and renewal needs; • an annual schedule of works;
TECHNICAL HARMONISATION OF INFRASTRUCTURE	• Request for cooperation among IMs to achieve the efficient operation of international train services, but no detailed technical harmonization measures foreseen (art. 4.3 of the Directive 2001/14) • ERTMS deployment	• Increased harmonization of technical parameters (e.g. train length) • ERTMS deployment • No wide scope interoperability between networks allowing the elimination of border stations' operations due to difference in regulations and practices[10] (except in some "mature" corridor where such interoperability is likely to be obtained even in option B) • No mutual recognition of rolling stock and staff qualification	Based on market analysis and a cost-benefit assessment, each corridor will adopt strategies on: • interoperability deployment. This will initially concern ERTMS and shall also concern other interoperable systems (including procedures[10]) • train capacity increase to pre-defined targets agreed at corridor level (primarily train length). National authorities of the concerned MS will conclude agreements for mutual recognition of rolling stock and staff qualifications.
PATH ALLOCATION PROCESS	Possible allocation of an international path by one single IM.	• As in option C	• IM will set up a One Stop Shop (OSS) service for all procedures relating to planned and ad hoc path allocation. The use of the OSS service will be mandatory. • Authorized applicants will have the possibility to apply for path allocation along the corridor.

[10] While differences in signalling systems will be solved by ERTMS, other differences among network regulations and practices might impose waiting time at borders. These differences might concern, for instance, brake test regulations, type of tail lamps to be used, wagon list report, rule of out-of-gauge loads and data interchange between networks.

Intervention area	OPTION A STATUS QUO (Directive 2001/14/EC)	OPTION B POLITICAL INITIATIVES	OPTION C LEGISLATIVE STRENGTHENING
PATH ALLOCATION RULES	• IM shall cooperate to enable the efficient creation and allocation of infrastructure capacity which crosses more than one network. They shall organise international train paths, in particular within the framework of the Trans-European Rail Freight Network (Art. 15.1) • IM meet shall as far as possible meet all requests for infrastructure capacity including requests for train paths crossing more than one network. (Art 20.1) • On congested infrastructure, the priority criteria shall take account of the importance of a service to society (Art. 22.4) • The importance of freight services and in particular international freight services shall be given adequate consideration in determining priority criteria (Art 22.5)	• As in Option A	• IM will reserve a pre-defined amount of good paths to freight after having carried out a needs assessment by way of a market study; • IM will set up a catalogue of good ad hoc paths; • it will not be possible for IM to cancel paths for freight to serve passenger traffic; • IM will revise their timetabling procedure so that requests for freight paths can be better satisfied; • IM will propose differentiated paths in terms of quality, i.e. in terms of journey time and/or risk of delay and attach commitments, for both contractors (operator and IM), to these different quality levels • IM will set up procedures and processes to ensure the consistency of the capacity distributed to freight applicants for cross-border trains composed by paths from different IM.
TRAFFIC MANAGEMENT	• In the event of disturbance to train movements caused by technical failure or accident the IM must take all necessary steps to restore the normal situation (Art. 29.1) • In an emergency and where absolutely necessary on account of a breakdown making the infrastructure temporarily unusable, the paths allocated may be withdrawn without warning for as long as is necessary to repair the system (Art 29.2)	• As in Option A (no strict priority rules are likely to be applied without a EU legislative framework)	• Corridors will publish priority rules for traffic management in the reference document of the corridor • These rules can : o either include 2 or 3 levels of priority that will be set according to socio-economic value of trains; o or be "a train on time remains on time". • Corridors will also set up procedures, processes and systems that will ensure a good coordination of traffic management along the corridor.
TRANSPARENCY	Request for cooperation among IMs to achieve the efficient operation of international train services, but no specific measures foreseen (art. 4.3 of the Directive 2001/14)	• As in Option A (obligation for publishing the "reference document of the corridor" with the proposed content require a legislative intervention)	IM and terminal managers will publish a "reference document of the corridor" that includes: • all information published in the national network statements that concern the corridor; • all information concerning the conditions and modalities for access to ancillary services (notably terminals); • a link to a regularly updatedpublication of temporary constraints/ works.

Intervention area	OPTION A STATUS QUO (Directive 2001/14/EC)	OPTION B POLITICAL INITIATIVES	OPTION C LEGISLATIVE STRENGTHENING
TERMINALS	Request for cooperation among IMs to achieve the efficient operation of international train services, but no specific measures foreseen (art. 4.3 of the Directive 2001/14)	• As in Option A, in particular with reference to the coordination between terminal operations and main network management (such coordination require a legislative framework to be implemented) • Improvement of terminal infrastructure in particular concerning harmonisation of transhipment track length	IM will: • identify the needs in terms of terminals (intermodal and marshalling yards) along the corridor; • define a network of strategic terminals (on which the infrastructure will be improved in particular concerning harmonisation of transhipment track length); • plan and stimulate the development of the strategic terminals; • set up procedures and systems to coordinate traffic management of the infrastructure and management of the operations in strategic terminals.
QUALITY OF SERVICE	Infrastructure charging schemes shall through a performance scheme encourage railway undertakings and the infrastructure manager to minimise disruption and improve the performance of the railway network. This may include penalties for actions which disrupt the operation of the network, compensation for undertakings which suffer from disruption and bonuses that reward better than planned performance (Art 11.1)	• As in Option C (action for performance schemes' harmonisation can be implemented in a voluntary way, given that IMs are already involved in international workgroup on that issue)	• IM will harmonise, as far as possible, the performance schemes in force along the corridor. • IM will set up processes and systems to monitor the quality (at least in terms of delays) along the corridor and publish data on the level of quality delivered.
CORRIDORS GOVERNANCE	Request for cooperation among IMs to achieve the efficient operation of international train services, but no specific measures foreseen (art. 4.3 of the Directive 2001/14)	• Structured cooperation and exchange of information among IM, MS RB and NSA along the corridor (as in Option C, even if the specific form of the cooperation might be different)	• Setting-up of governance structure for corridors involving IM and MS, and possibly also terminal managers. Such structure that will monitor the implementation of the Corridor Development Plan, and it will regularly consult all users of the corridor • Cooperation among Regulatory Bodies (RB) and National Safety Authorities (NSA) To efficiently supervise the international activities of IM and RU on the corridor. RB/NSA will exchange information, consult each other and provide sufficient information if they are consulted. • To facilitate such cooperation, RB and NSA will resp. create two working groups attached to the governance structure of the corridor.

The three proposed options allow the analysis of very different situations in terms of the likely evolution of international rail freight along European corridors. The assessment of the impacts of Option B and Option C, to be compared against the "status quo" evolution as foreseen in Option A, will allow then the EC services to highlight the specific effects of the implementation of a corridor-based rail network giving priority to freight, and to appreciate the differences between the voluntary, political approach and the legislative intervention. Thus, the proposed options are appropriate for the impact assessment exercise, and no other option is necessary to explore the likely action alternatives.

The main **risks** that may be identified at this stage for the given intervention policies are the following one:

- for option B, the main threat is the lack of results in some intervention areas that require obligatory measures to be cope with, so that the expected priority for freight in the European rail corridor might not be achieved, or achieved only in the corridors that are already quite mature in terms of actors' cooperation and developed in terms of technically-harmonised infrastructure;
- for option C, two possible threats shall be considered:
    - imposing excessive additional burden on the business, because of the additional administrative costs required by the coordination activities and related bodies;
    - for the more technical areas, such as the infrastructure technical harmonisation and the performance schemes harmonisation, ambitious targets shall be preferred, otherwise the risk is that each corridor will define harmonisation at the minimum level that requires no or limited effort, and that will produce no or limited effects.

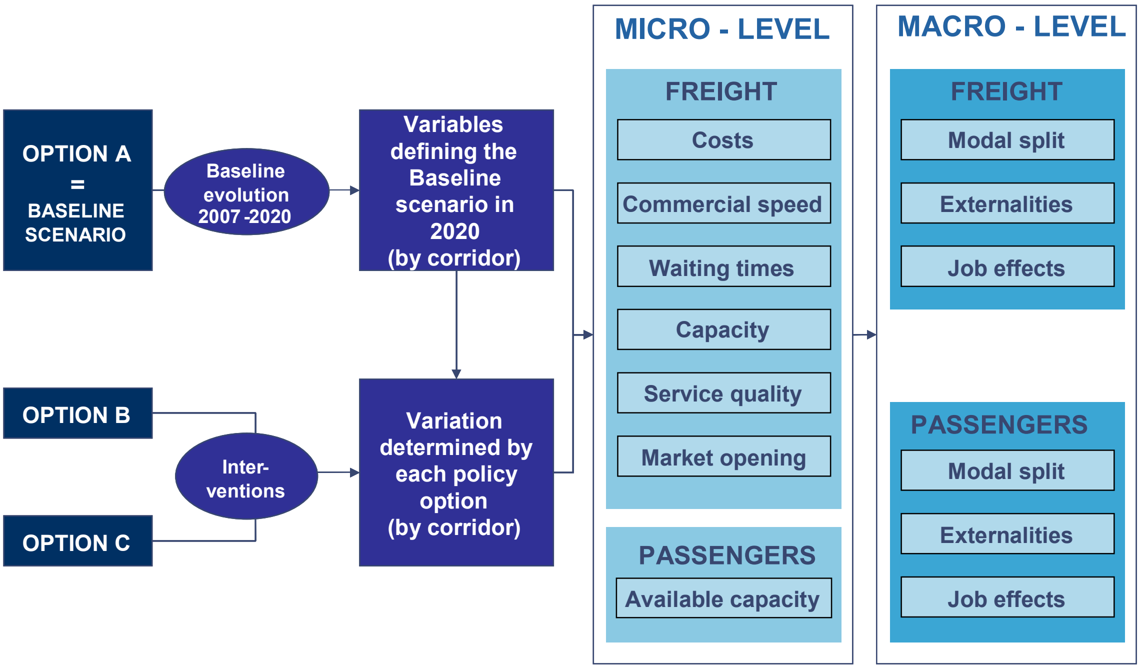
5 METHODOLOGY FOR IMPACT ASSESSMENT

5.1 General Description

Given that the "problem identification" and "definition of policy options" phases of the IA have been already drafted in the Commission's previous work and in the Task Specifications, the "analysis of the impacts" has been the key aspect of this study, being also the basis for the comparison of the policy options. The policy options identified by the Commission have been translated into specific actions in the Report of the Strategic Group of Experts dedicated a specific analysis on the proposed measures (as presented in chapter 4).

The subsequent impact analysis consisted of an examination of the likely impacts across the main policy dimensions (i.e. economic and social impacts) as well as potential trade-offs and synergies, of the short listed options, including the 'business as usual' option.

The following figure gives a picture of the methodological approach applied to estimates both micro and macro – level impacts.



Impacts for passengers traffic are likely to be generated, due to increased priority and capacity availability for freight, and shall then be evaluated in the impact assessment.

As highlighted in the picture the **first step** of the methodological approach consisted in the definition of a baseline scenario which is hypothesised to correspond to the "option A" defined in the Tasks Specification: "continue the initiatives already launched [11]".

In order to properly define the baseline scenario the following tasks were performed:

[11] Initiatives considered within "option A" are: the 1st railway package (directives 2001/14 and 2001/12), the TEN-T programme, the cooperation between Member States (MS) and infrastructure managers (IM) within the framework of ERTMS corridors, the deployment of the TAF TSI.

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- Corridor's network characteristics identification (through the identification of the corridor's sections, border stations and terminals);
- Technical data collection per each section of the corridors (e.g. data in the UIC ERIM DB);
- Collection of data on other relevant corridor characteristics (IM coordination level, path allocation rules, traffic management, etc.);
- Projection of the baseline situation (Option A) for all aspects exogenous to rail freight business as at the end of the year 2007 to year 2020, i.e. definition of the hypothesis for the evolution of macro socio-economic variables affecting such as, for example, GDP growth rate, passenger growth, and characteristics of other modes;
- Projection of the baseline (Option A) evolution of the rail infrastructure on the corridors to 2015.

The following table synthesises the main variables quantified to define the baseline situation (data followed by * were not collected because of lack of data availability at corridor level).

Table 5-1 - Variables used to define the baseline scenario for corridors

International traffic	Freight modal split (% per mode over total tkm)
	Passenger modal split (% per mode over total tkm)
Capacity	Number of train per type (per day) and daily theoretical capacity
Quality of services	Freight trains punctuality (e.g. % of trains arriving late < 1h) *
	(Freight) trains security (n. derailments / millions trains.km) *
Technical features	Maximum train length (m) and length of related critical sections
	Maximum train tonnage (t) and length of related critical sections
	Maximum loading gauge and length of related critical sections
	Maximum axle load (t/axle) and length of related critical sections
	Sections with track gauge different of normal gauge (Y/N, km)
	ERTMS (Y/ N/ foreseen) and not-harmonized sections length
Path allocation process / rules	OSS (Y/N), Path with priority for freight (Y/N)
	Waiting time at border because of uncoordinated paths (Y/N, hours)
Traffic management	Priority to (certain) freight trains in case of disruptions (Y/N) *
	Coordinated traffic management along the corridor (Y/N)
Investment / maintenance coordination	No agreement / Only bi/tri-lateral agreements / Corridor coordination
Terminals	Coordination between terminal slot and path planning (Y/N), Unnecessary delays because of lack of coordination (hours)

The available data on the above variable on corridors are presented on "ANNEX I – Baseline Scenario description of corridors".

The **second step** was to identify, for each area of intervention, the impacts that are likely to occur as a consequence of implementing the policy.

The links between cause (the action, instrument, etc) and effects (the impacts) was explored, as well as the extent to which the proposed action(s) are likely to contribute to reaching the objectives and who is affected by the identified impacts and the timescale over which the impacts will occur.

The main task of this is to divide the impacts into two main categories, namely:

– Quantitative impacts occurring if, in a specific intervention area, the proposed action is expected to affect one or more of the variables identified to measure the micro – level impacts (such as operating costs, commercial speed, waiting times, capacity and punctuality). These impacts have been measured in terms of variation produced by the proposed policy options / actions with respect to the baseline situation.

– Qualitative impacts occurring on intervention areas for which data availability is not sufficient for their calculation such as, for example, the impacts produced by the proposed policy/actions on intervention areas such as the quality of service and transparency. In these cases the impacts have been assessed in terms of qualitative estimates (i.e.: high, medium, low, no change). This judgement allows evaluating, for the specific intervention area, the intensity of the impact produced by each different option in the general context of the rail freight business.

As stated, for quantitative impacts the effect induced by the intervention was assessed by measuring the variation in the value of the above listed variables in the baseline situation. The changes produced by the interventions included in the option will either:

a) Affect rail freight attributes (time, cost, quality);
b) Affect capacity available for rail freight (and possible also for rail passenger traffic)
c) Be preparatory to other measures impacting on a) or b).

Once these changes were quantified, a cluster approach was applied for extrapolating micro data, whereas a network-wide traffic simulation was required for extrapolating **macro-impacts**, intended as the variations in:

– Modal split;

– Externalities (impacts on environment, congestion and transport safety) linked to traffic level by modes;

Job effects were also calculated starting from the changes in modal traffic volumes.

The table reported in the following page indicates, for each intervention areas identified in the Tasks Specifications, whether the impact produced by the proposed policy options was judged as qualitative or quantitative and, in the second case, the micro –level variables affected by the interventions.

The table also highlights:

– the impacts showing to be preparatory to reach other intervention areas' objectives;
– intervention areas on which there are impacts on administrative costs.

Table 5-2 - Variables affected by each intervention area

	INTERVENTION AREAS	Introductory to other intervention areas (*)	Qualitative Impacts	Quantitative						Administrative costs
				Operating costs	Speed	Waiting times	Capacity		Punctuality	
							Train size	Line capacity		
A	**Investment planning**		X							
B	**Technical harmonisation of infrastructure**			X (**)		X	X			
C	**Path allocation process**	Y (D)	X							X
D	**Path allocation rules**				X (***)			X (***)		
E	**Traffic management**								X (***)	X
F	**Transparency**	Y (D, G)	X							X
G	**Terminals**			X (**)		X	X			
H	**Quality of service**		X							X
I	**Corridors governance**	Y (A)								X

X indicate the variables affected by the proposed measures

(*) when there is Y in the column "Introductory …", then the intervention area depending on that is indicated (e.g. intervention in path allocation process is introductory to D = intervention in path allocation rules)

(**) Impacts on operating costs are derived as an effect of improvements in train capacity

(***) This impact is relevant and consistent with the proposed measures. Nevertheless its measurement could present some difficulties because of missing data on this subject (both on the baseline situation and on the likely impact). Case study developed in the New Opera project might be used as basis for the quantification.

5.2 Definition of the quantitative impacts (micro - level)

5.2.1 Technical harmonization

The main objectives within the technical harmonisation this intervention area are:

- increase in the productivity of each freight train (in terms of volumes transported)
- coordinated development of harmonised rail infrastructure and deployment of interoperability

The following actions have been identified by the Strategic Group of Experts to reach the above mentioned objectives:

- interoperability deployment. This will initially concern ERTMS and may also concern other interoperable systems;
- train capacity increase (this should primarily concern train length);

Technical harmonisation and interoperability throughout the different sections of the examined corridors are key factors for the creation of a rail network giving priority to freight. Harmonised infrastructures imply standardised technical features such as train length limits, loading gauge, train tonnage limits, maximum axle load.

As a consequence of the above mentioned effects, actions in this intervention area are expected to generate impacts in terms of:

- **waiting times**: reduction because of a decrease in operations of at the border stations thanks to the implementation of interoperability (i.e. safety checks such as brakes control, train signalling light, etc.). The hypothesis is that in the case of a fully harmonised the full interoperability of each section of the network will eliminate these operations and reduce the waiting times at the border stations to those strictly necessary to change the driver (5 minutes) and/or the locomotive (locomotives). These impacts are going to be expressed in terms of reduction of minutes of waiting times along the corridor;
- **capacity:** increase as a consequence of trains set at the higher standard harmonized size of each section (750 m). This impacts are going to be expressed in terms of increase in tonnes of capacity per train.
- reduction in **operating costs not variable with train size** (driver and loco amortization & maintenance). In fact, an increase in train size does not imply increase in costs items such driver wages and locomotive amortization & maintenance (as far as a second locomotive is not required), while the tonnage transported by the train increases. As a consequence, an increase in train size generates a reduction of the driver costs per ton (expressed in terms of €/tons*hour) and of the costs for locomotives amortization & maintenance per ton (expressed in terms of €/tons*km).

The above-described approach is synthesized in the following tables.

Affected variable	Situation	Practices and expected effects on the variable	
		Lines requiring locomotive change even after intervention	Lines not requiring locomotive change even after intervention
Waiting times	Baseline situation	Current waiting times (*)	Current waiting times (*)
	Situation after intervention	30 minutes (due to loco change)	5/10 minutes (due only to driver change)
Train size	Baseline situation	Trains set at the minimum (common) size (depending on the corridor) (**)	
	Situation after intervention	Trains set at the standard harmonized size of each section (usually 750 m)	
Operating costs	Baseline situation	Baseline operating costs Train cost = $X_0 + x_0 * t_0$ → Cost per ton = $c_0 = (X_0/t + x_0)$	
	Situation after intervention	Reduction of the cost per ton that are not variable with train size (driver and locomotive amortization & maintenance ***) No change on other operating costs Train cost = $X_0 + x_0 * t_1$ with $t_1 > t_0$ → Cost per ton $c_1 = (X_0/t_1 + x_0) < c_0$	

(*) Source data: TEMA

(**) Source data: ERIM

(***) an increase in train size might require in some situations additional locomotives creating also an increase in fixed costs.

5.2.2 Path allocation rules

For the intervention area "path allocation rules" the Tasks Specifications have set the following objectives:

- smooth and efficient path allocation process for international freight trains;
- possibility for applicants other than railway undertakings to request train paths.

The Strategic Group of Experts has identified the following actions to be but in place by the Infrastructure Managers to meet the above listed objectives:

- reserve a pre-defined amount of good paths after having carried out a needs assessment by way of a **market study**;
- set up a **catalogue** of good ad hoc paths;
- it will not be possible for IM to cancel paths for freight to serve passenger traffic;
- **revise timetabling procedure** so that requests for freight paths can be better satisfied;
- propose **differentiated paths** in terms of quality, i.e. in terms of journey time and/or risk of delay and attach commitments, for both contractors (operator and IM), to these different quality levels;
- set up procedures and processes to ensure the consistency of the capacity distributed to freight applicants for cross-border trains composed by paths from different IM.

The above listed actions are expected to affect the following variables:

- **commercial speed**: the actions identified by the Strategic Group of Experts aim at providing paths set at (relatively) high speed for strategic freight trains, as result of the approach of differentiating paths in terms of quality;
- **line capacity**: all of the actions proposed by the Strategic Group of Experts go in the direction of a better usage of line available capacity for freight. Such improvement shall be expressed in the number of new paths available on the network result as a consequence of a strategy aiming at setting rail train paths according to market needs.

It is worth noticing that, even if the expected impact of the proposed actions is on quantitative variables, data availability on these issues is relatively poor. As presented in chapter 7.3.1, a case study carried out within the New Opera study provided a basis for evaluating impacts on "scheduled waiting times" (i.e. those resulting from the solution of timetable conflicts) due to increased priority for freight. For capacity increase, the approach for impact evaluation was instead a "what if" scenario (calculation of the impacts in case the capacity available freight is augmented by a given percentage). It is then checked if this additional capacity is higher or lower than the additional market estimated with the traffic model to be attracted by rail thanks to the intervention in other areas.

Affected variable	Situation	Practices and expected effects on the variable
Commercial train speed	Baseline situation	Most/ freight train path set at the same speed
	Situation after intervention	Better journey time/commercial speed for "strategic" freight trains Increased priority for freight taken into account in timetable definition
Line capacity (for freight)	Baseline situation	Current path allocation : number / type of freight train path set mainly according to residual capacity after planning the passenger path (even if according to dir 2001/14, international freight trains shall already have "adequate" priority)
	Situation after intervention	Path allocation on the basis of a specific market study → Number of available freight train paths set according to market needs

5.2.3 Traffic management

In the traffic management intervention area two main needs have been identified in the Tasks Specifications:

- the need for a sufficient priority to freight trains in case of infrastructure congestion. Performance schemes are mandatory and should ensure a good reliability of train paths. Unfortunately such schemes are not in force in many MS. When they exist, they are not sufficiently efficient and there is a high risk that they will not be in the next years. Furthermore, binding financial compensation scheme exist for passenger trains customers and not for freight trains. This may lead, in cases of mixed traffic where prioritisation of traffic is necessary, to a form of discrimination unfavourable to freight trains;

- good coordination between national/regional operational centres for international traffic.

In order to meet these objectives the Strategic Group of Experts has recommended the publication of priority rules for traffic management in the reference document of the corridor, providing that these rules can :

- either include 2 or 3 levels of priority that will be set according to socio-economic value of trains;
- or be "a train on time remains on time".

The Strategic Group also proposed that Corridors will also set up procedures, processes and systems that will ensure a good coordination of traffic management along the corridor; dispatching centres on both sides of the borders will thus coordinate their action on cross-border traffic.

These actions appear to have an high potential in terms of generating positive impacts on punctuality. It is expected that their implementation is going to reduce the percentage of freight trains on delay on the network. Nevertheless a lack in data availability (both on the baseline and on the to-be situation) makes it difficult to proceed to a quantitative measurement.

The following table shows the comparison on the basis of which the above impacts were measured as the gap existing between the baseline and the after – intervention situations.

Affected variable	Situation	Practices and expected effects on the variable
Punctuality **(% of freight train arriving on delay)**	Baseline situation	No publication of priority rules Current traffic management procedures do not always include specific measures for punctuality → Current punctuality on the corridor
	Situation after intervention	Implementation within traffic management procedures of specific measures for punctuality → Reduction/Elimination of high priority freight train delays due to disruptions on passenger traffic → Relative increase of delays for passenger trains

The New Opera case study on changing priority among trains (increasing the one of freight trains) supported the estimate of the change in expected delays due to operation disruptions ("unscheduled waiting time"), as it is presented in chapter 7.3.1.

5.2.4 Terminals

Concerning terminals, the main needs have been identified in Tasks Specifications:

- adequacy between infrastructure capacity, terminals capacity and needs of freight trains;
- fair access to ancillary services.

To meet these objectives the Strategic Group have indicated the following actions to be put in place by infrastructure managers:

- identify the needs in terms of terminals (intermodal and marshalling yards) along the corridor;

- define a network of strategic terminals;
- plan and stimulate the development of the strategic terminals;
- set up procedures and systems to coordinate traffic management of the infrastructure and management of the operations in strategic terminals.

These actions are expected to affect the following variables:

- **Train size**: planning and stimulating the development of a network of strategic terminals characterized with the highest technical standards, would bring to an higher capacity per train eliminating the necessity to split the trains in two or three parts in order to perform transshipment operations;
- **Waiting times**: the coordinated planning and stimulation of the development of a network of strategic terminals is expected to lead to a situation with no lack of shunting for cutting/assembling trains. As a consequence of this average reduction in waiting times are expected to occur up to, in the case of the highest impact, 30 minutes;
- **Operating costs**: reduction on operating are expected as an effect in terms of a reduction in:
    - o <u>shunting operations costs</u> only for trains transfer into terminals;
    - o <u>operating costs not variable with train size</u> (driver and loco amortization & maintenance), as explained in the paragraph 5.2.1..

Affected variable	Situation	Practices and expected effects on the variable
Train size	Baseline situation	Transshipment tracks shorter than maximum train length allowed on the main network → Necessity to split the trains in two or three parts in order to perform transshipment operations (and to assembly the parts before departing) → More shunting operations required
	Situation after intervention	Transshipment tracks longer at least as the maximum train length allowed on the main network → No train split / assembling operations required
Waiting times	Baseline situation	Waiting times due to uncoordinated planning of long run rail path and terminal slot and no need of shunting for cutting/assembling trains → Current waiting times
	Situation after intervention	Reduced waiting times due to coordinated planning and no lack of shunting for cutting/assembling trains → Expected reduction in waiting times after intervention (up to 30 minutes)
Operating costs	Baseline situation	Cost of shunting operations required due to train cutting / assembling & trains transfer into terminals
	Situation after intervention	Cost of shunting operation only for trains transfer into terminals

5.3 Definition of the quantitative impacts (macro-level)

5.3.1 From micro to macro impacts

Most of the micro-effects evaluated according to the methodologies explained in chapter 5.2 modifies the attributes of the rail freight transport that affect the modal choice. Thus, the following quantitative micro-changes that are likely at corridor level (because of the implementation of Option C or B) might be given as input to the transport model (Transtools):

- **Reduction of rail freight prices**, due to better productivity of freight operations

  The expected change in rail freight operating costs, due to operation of longer trains (as a consequence of the intervention in technical harmonisation and terminals) and elimination of some shunting operation at terminals, will be expressed in terms of % variation of total rail freight operating cost.

  It will be supposed that an identical reduction of rail freight prices will be generated, considering that the cost reduction will be entirely transferred to the market. Needless to say, the reduction will affect only:
  - the O-D flows that actually are concerned by the productivity increase, i.e. the flows that in the "status quo" situation are moved by shorter trains than the one operated in the Option C, because either they cross the section limiting the train length in the "status quo" or they start / end their journey at terminals limiting the train length in the "status quo" situation;
  - the commodities that are likely to be moved by trains that are set the maximum train length.

- **Reduction of border station waiting times, due to the improved interoperability** produced by the intervention in technical harmonisation allowing to eliminate all border operations except the change of the train driver; the reduction will affect all flows that cross the border stations concerned by this intervention;

- **Reduction of terminal-related waiting times**, due to
  1. the reduction of shunting for assembling / disassembling trains because of the harmonisation of terminal transhipment tracks length;
  2. the coordination between network management and terminal operations, for all flows starting / ending their journey at the terminals concerned by this coordination;

- **Reduction of the average journey time for all freight flows**, because of the reduction of scheduled and unscheduled waiting times resulting from change in path allocation and traffic management rules; due to the lack of extensive information on the current freight punctuality level on the corridor, the case study developed in the New Opera project will be used as basis for estimating the minutes that are likely saved per km of journey; the same source will be used for estimating the likely **increase in passenger journey time** due to change in priorities;

As far as the expected **increase in the available capacity** for freight trains is concerned, the Transtools models define modal split and traffic assignment without considering rail capacity constraints. In order to take into account this likely effect of the policy options, the following approach was applied

- estimate of the effects of an increase in freight capacity by a given percentage (e.g. +10%) in particular in terms of additional freight trains, potential additional freight traffic, and likely reduction of passenger trains (in case the line is saturated);
- check if the additional freight traffic as resulting from the macro-level analysis is higher or lower than the potential additional freight traffic as from the previous point.

The approach is more detailed explained in

Annex IV – Approach for estimating cost and benefits of the additional capacity.

5.3.2 Modelling the impacts on the transport market

Taking into account the input from the micro-analysis specified in the previous chapter, the TRANSTOOLS models were used to estimate the change in the modal split for both freight and passenger traffic between the baseline (Option A) and the situation with intervention (Option C or Option B),.

Both absolute value in terms of ton.km (passenger.km) moved by rail over the corridor, and modal shares, were provided as output of Transtools).

5.3.2.1 The Transtools model

The 5th Framework funded research and development project SPIN (Scanning the Potential of Intermodal Transport) coordinated by NEA provides initial information from the demand side of the market to support a modal shift from pure road transport to more sustainable means of transport.

The SPIN applies a toolbox for scanning the potential for a modal shift towards intermodal transport, mainly through the use of three tools: The Quick Scan, the Advanced Scan and the Macro Scan. These Scans have been developed to investigate at different levels (business level and regional level), whether there is potential for a modal shift from road to inland shipping, short sea or rail transport. The Macro Scan was specifically developed to support policy issues and impact analyses regarding modal shift questions.

Besides basic quality requirements such as reliability and security, the most decisive aspects in assessing modal shift potential is the comparison of transport costs and transit times between the origin and destination of goods transported with the available alternatives.

NEA has developed further and maintains in-house a model system for freight transport flows (WORLDNET/TRANSTOOLS/NEAC). The TRANSTOOLS system incorporated the functionalities of SPIN Macro Scan model. TRANSTOOLS can for instance be used for a calculation of the potential for modal shift on regional level (NUTS-3). Analytically, the tool can be used for making an assessment of the potential for intermodal rail transport in whole of Europe. Secondly the tool can be used for the evaluation of specific corridors covering all modes of transport, including also passenger transport flows.

Hence, for the purposes of a neutral assessment of modal shift opportunities, the Transtool project is applied:

- to assess competitiveness and the potential for modal shift in specified corridors
- for sensitivity analysis in these corridors
- to assess the competitiveness of intermodal transport on a Macro level.

The system contains a huge database kept regularly updated (the most recent completed year is 2006). The system is supported by the network model and contains an integrative forecasting component. The system is being applied to produce forecasts for year 2030 in different European transport policy scenarios.

The freight flows database covers all flows that go on transport networks (road, rail, maritime, inland waterways, ports, terminals) in Europe having origins/destinations in any parts of the world. The freight flows matrix within the system is based on a transport chain approach and has the following structure:

- Origin zone
- First transhipment zone
- Second transhipment zone

- Destination zone
- Mode at origin
- Mode between transhipments (active mode)
- Mode between transhipments (passive mode)
- Mode at destination
- Commodity
- Cargo type
- Weight of the commodity

Table 5-3 - Dimensions of the variables of the freight OD transport chain matrix

Core countries	EU-25, Norway, Switzerland
Regional detail	NUTS 3 or similar regional detail where no NUTS classification is valid.
Country and country group detail	All European countries separate with exception of the smallest (like Andorra, Vatican, etc), MEDA countries separate, USA, Rest North America, Middle and South America, Japan, Rest Asia, Rest Africa, Australia and New Zealand, Rest world
Transhipment location	Selection of Ports. Selection of inland terminals
Modes	Road, Rail, Inland navigation, Sea, Rest
Commodities	NSTR 2 digits as much as possible and aggregation to NSTR 1 digit when modelling becomes necessary
Cargo types	liquid bulk, dry bulk, other general cargo
Cargo characteristics	Hazardous, conditioned, other
Containerized	Yes/No
Other Typologies	Vehicle/vessel types
Measuring units	Values Tonnes Ton-km Number of vehicles/vessels Vehicle-km/vessel-km TEU TEU-km
Most recent base year	2006

The freight flows modeling system is widely applied by NEA in different studies for carrying the policy analysis at European, regional, national and corridor scale. It is also extensively used for the comperative analysis of the competing modes and routes.

The Transtools model system produce passenger and freight flows and assigns them on the European transport networks under specific policy scenario. It consists of a set of integrative models:

- Economic model
- Passenger model
- Freight Component consisting of Trade Model, Modal Split Model, Logistics Model
- Assignment model
- Impact model

The Worldnet model is in fact a geographical extension and further refinement of the Transtools freight and network component.

5.3.2.2 *Reference framework for baseline scenario (Option A)*

A similar exogenous and endogenous reference framework to the one used in the Reference Scenario of the Trans-Tools project for the period 2000-2020 was applied. However, the starting points for the basis year were updated with the actual figures for 2007. The target year will be 2020.

The reference scenario is a 'Business as usual' scenario: i.e. it assumes that the evolution of the transport system is an extension of the current trends observed in 2007. The scenario includes:

- projections concerning the population growth per country for the period 2007-2020;
- projections concerning the GDP growth per country/region per economic sector for the period 2007-2020;
- autonomous changes in transport costs for the period 2007-2020 (i.e. due to more expensive oil price);
- transport network changes due to completed TEN projects until 2020;
- Additional network changes not due to the Trans-European transport network could also be part of the reference scenario according to available data (e.g. from national infrastructure plans).

The socio-economic growth rates are derived from Eurostat data and the outputs of the PRIMES[12] model (DG-TREN). Projections have been recalculated to reflect the expected growth from 2007 onwards. (See attached excel table – Annex II).

Autonomous changes of transport costs will mainly affect fuel components of road costs. The most recent forecasts of international agencies like Energy Information Administration, International Energy Agency, European Environmental Agency, can be used to define a reference growth rate for oil price and, consequently for fuel price. In the recent STEPs research project[13] , a 'Generally accepted energy supply forecast' scenario was defined using the projections of Energy Outlook of the International Energy Agency. Such a scenario assumed an average growth rate of 2% p.a. of the oil price (STEPs, 2005). Still in the STEPs project, through a modelling exercise, this assumption concerning oil price growth was translated into a fuel resource price growth rate of 1% p.a. (STEPs, 2006). Assuming that fuel taxes are varied to keep unchanged their relative weight on total fuel price, this growth rate of 1% p.a. can be adopted for the fuel component of road costs.

Finally, the choice of TEN infrastructures to be included in the reference scenario are those TENs which are expected to be completed up to the year 2020.

[12] http://www.e3mlab.ntua.gr/manuals/PRIMsd.pdf. See also Annex I.

[13] STEPs Scenarios for the transport system and energy supply and their potential effects - Framework Programme 6 – DG RTD; see www.steps-eu.com.

The Trans-Tools modelling software provided the foreseen infrastructure network for the year 2020. This network is based on the TEN expansion plans and assumes the implementation of all TEN-T projects until 2020. The information for the selection of TEN-T projects was provided by ASSESS study lead by TML[14].

The list of TEN projects and their inclusion into the reference scenario is stated in Table 5-4. The details of the projects are reported in Table 5 5.

Table 5-4 - TEN projects for the reference scenario (Source: elaboration from ASSESS, Final Report Annex V - Martens et al., 2005)

Project code	Project name	Completion year	Total cost	Investments up to 2004	Included in Reference Scenario
P01	Railways line Berlin-Verona/Milano-Bologna-Napoli-Messina	2015	166,422	64,056	Yes
P02	High-speed train PBKAL (Paris–Brussels–Cologne–Amsterdam–London)	2014	103,332	92,342	Yes
P03	High-speed railway axis of south-west Europe	2020	213,432	39,758	Yes
P04	High-speed railway axis east	2007	20,509	6,966	Yes
P05	Betuwe Line	2006	14,055	12,390	Yes
P06	Railway axis Lyon-Trieste-Divaca/Koper/Divaca-Ljubljana-Budapest-Ukrainian border	2018	89,023	5,581	Yes
P07	Motorway axis Igoumenitsa/Patra-Athina-Sofia-Budapest	2010	62,701	31,016	Yes
P08	Multimodal axis Portugal/Spain-rest of Europe	2015	44,696	25,519	Yes
P09	Railway axis Cork-Dublin-Belfast-Stranraer	2001	Completed		Yes
P10	Malpensa Airport (Milan)	2001	Completed		Yes
P11	Öresund fixed link	2001	Completed		Yes
P12	Nordic triangle railway-road axis	2015	46,116	13,452	Yes
P13	UK-Ireland/Benelux road axis	2013	27,056	15,373	Yes
P14	West Coast Main Line	2008	173,856	154,880	Yes
P16	Freight railway axis Sines-Madrid-Paris	2020	31,760	0	Yes
P17	Railway axis Paris-Strasbourg-Stuttgart-Vienna-Bratislava	2015	36,554	9,475	Yes
P18	Rhine/Meuse-Main-Danube inland waterway axis	2019	7,914	848	Yes
P19	High-speed rail interoperability on the Iberian peninsula	2020	106,136	9,353	Yes
P20	Fehmarn Belt railway axis	2015	17,091	4	Yes
P22	Railway axis Athina-Sofia-Budapest-Vienna-Prague-Nürnberg/Dresden	2017	62,605	0	Yes
P23	Railway axis Gdansk-Warsaw-	2015	24,303	3,406	Yes

[14] For more information see ASSESS documentation Annex V available at http://www.tmleuven.be/project/assess/home.htm.

Project code	Project name	Completion year	Total cost	Investments up to 2004	Included in Reference Scenario
	Brno/Bratislava-Vienna				
P24	Railway axis Lyon/Genoa-Basel-Duisburg-Rotterdam/Antwerp	2018	69,727	4,473	Yes
P25	Motorway axis Gdansk-Brno/Bratislava-Vienna	2013	33,219	77	Yes
P26	Railway-road axis Ireland/United Kingdom/continental Europe	2020	17,942	6,275	Yes
P27	Rail Baltica axis Warsaw-Kaunas-Riga-Tallinn-Helsinki	2018	5,600	0	Yes
P28	Eurocaprail on the Brussels-Luxembourg-Strasbourg railway axis	2013	7,962	0	Yes
P29	Railway axis if the Ionian/Adriatic intermodal corridor	2014	8,561	0	Yes
P30	Inland waterway Seine-Scheldt	2016	5,312	69	Yes

Table 5-5 - Implementation of TEN network in reference scenario (Source: elaboration from ASSESS, Final Report Annex V - Martens et al., 2005)

TEN projects	Subprojects	Deadline after 2004 revision[15] (f): finished	Implementation in reference scenario
1. High-speed train/combined transport north–south	1. Berlin Bahnhof-Berlin/Ludwigsfelde 2. Berlin/Ludwigsfelde-Halle/Leipzig 3. Halle/Leipzig-Erfurt 4. Erfurt-Nurenburg 5. Nurenburg-Munich 6. Munich-Kufstein 7. Kufstein-Innsbruck 8. Innsbruck-Fortezza (Brenner Base tunnel) 9. Fortezza-Verona 10. Verona-Bologna 11. Milan-Bologna 12. Bologna-Florence 13. Florence-Rome (re-electrification) 14. Rome-Naples 15. Rail/road bridge over the strait of Messina	1. 2008 2. 2002 3. 2015 4. 2015 5. 2006 6. 2015 7. 2009-2018 8. 2015 9. 2002 10. 2007 11. 2006-2008 12. 2007 13. 2007 14. 2007 15. 2015	Yes
2. High-speed train PBKAL (Paris–Brussels–Cologne–Amsterdam–London)	1. Belgian/German border Cologne 2. Cologne-Frankfurt 3. London-Channel tunnel rail link 4. Belgium 5. Netherlands 6. Paris-Lille-Calais-Channel tunnel	1. 2007 2. 2004 3. 2007 4. 2006 5. 2007 6. 1994	Yes
3. High-speed railway axis of south-west Europe	1. Spain, Atlantic branch 2. Spain,Mediterranean branch 3. French Atlantic branch 4. French Mediterranean branch 5. International section, Perpignan-Figueras 6. Montpellier-Nîmes 7. Madrid-Barcelona 8. Lisboa/Porto-Madrid 9. Dax-Bordeaux 10. Bordeaux-Tours	1. 2010-2011 2. 2008 3. 2010 4. 2015 5. 2008-2009 6. 2010-2015 7. 2005 8. 2011 9. 2020 10. 2015	Yes
4. High-speed train east	1. Paris-Baudrecourt 2. Metz-Luxembourg 3. Saarbrucken-Mannheim	1. 2007 2. 2007 3. 2007	Yes
5. Conventional rail/combined transport: Betuwe line	1. Port Railway line 2. A15 line	1. 2007 2. 2007	Yes
6. High-speed train/combined transport, France–Italy	1. Lyon-Montmélian-Modane (St Jean de Maurienne) 2. St Jean de Maurienne-Bruzolo 3. Bruzolo-Turin 4. Turin-Venezia 5. Venezia-south Ronchi-Trieste [...]-Divaca (2015) 6. Koper-Divaca-Ljubljana (2015) 7. Ljubljana-Budapest (2015)	1. 2015 2. 2017 3. 2011 4. 2010 5. 2015 6. 2015 7. 2015	Yes
7. Motorway axis Igoumenitsa/Patra-Athina-Sofia-Budapest	1. Via Egnatia 2. Pathe 3. Sofia-Kulata-Greek/Bulgarian border motorway, with Promahon-Kulata as cross-border section 4. Nadlac-Sibiu motorway (branch towards Bucuresti and Constanta)	1. 2006-2008 2. 2008 3. 2010 4. 2007	Yes

[15] http://ec.europa.eu ./ten/transport/projects/doc/2005_ten_t_en.pdf

TEN projects	**Subprojects**	**Deadline after 2004 revision[15] (f): finished**	**Implementation in reference scenario**
8. Multimodal link Portugal–Spain–Central Europe	1. Railway La Coruña-Lisboa-Sines 2. Railway Lisboa-Valladolid 3. Railway Lisboa-Faro 4. Lisboa-Valladolid motorway 5. La Coruña-Lisboa motorway 6. Sevilla-Lisboa motorway 7. New Lisboa airport	1. 2010 2. 2010 3. 2004 (f) 4. 2010 5. 2003 (f) 6. 2001 (f) 7. 2015	Yes
9. Conventional rail link Cork–Dublin–Belfast–Larne,Stranraer	1. UK sections 2. Republic of Ireland sections	1. 2001 (f) 2. 2001 (f)	Yes
10. Malpensa airport,Milan		2001 (f)	Yes
11. Øresund fixed rail/road link between Denmark and Sweden (completed)	1. Øresund fixed link 2. Danish access routes 3. Swedish access routes	1. 2000 (f) 2. 1999 (f) 3. 2001 (f)	Yes
12. Nordic triangle rail/road	1. Road and railway projects in Sweden 2. Helsinki-Turku motorway 3. Railway Kerava-Lahti 4. Helsinki-Vaalimaa motorway 5. Railway Helsinki-Vainikkala (Russian border)	1. 2010 2. 2010 3. 2006 4. 2015 5. 2014	Yes
13. Ireland/United Kingdom/Benelux road link		2010	Yes
14. West coast main line (rail)	West coast main line	2007-2008	Yes
16. Freight railway axis Sines/Algeciras-Madrid-Paris	1. New high-capacity rail axis across the Pyrenees 2. Railway Sines-Badajoz 3. Railway Algeciras-Bobadilla	1. no date mentioned 2. 2010 3. 2010	Yes
17. Railway axis Paris-Strasbourg-Stuttgart-Wien-Bratislava	1. Baudrecourt-Strasbourg-Stuttgart with the Kehl bridge as cross-border section 2. Stuttgart-Ulm 3. München-Salzburg 4. Salzburg-Wien 5. Wien-Bratislava	1. 2015 2. 2012 3. 2015 4. 2012 5. 2010-2012	Yes
18. Rhine/Meuse-Main-Danube inland waterway axis	1. Rhine-Meuse, with the lock of Lanaye as cross border section 2. Vilshofen Straubing 3. Wien-Bratislava, cross-border section 4. Palkovicovo-Mohacs 5. Bottlenecks in Romania and Bulgaria	1. 2019 2. 2013 3. 2015 4. 2014 5. 2011	Yes
19. High-speed rail interoperability on the Iberian peninsula	1. Madrid-Andalucía 2. North-east 3. Madrid-Levante and Mediterranean 4. North/North-west corridor, including Vigo-Porto 5. Extremadura	1. 2010-2020 2. 2010-2020 3. 2010-2020 4. 2010-2020 5. 2010-2020	Yes
20. Fehmarn Belt: fixed link between Germany and Denmark	1. Fehmarn Belt fixed rail/road link 2. Railway for access in Denmark from Öresund 3. Railway for access in Germany from Hamburg 4. Railway Hannover-Hamburg/Bremen	1. 2014-2015 2. 2015 3. 2015 4. 2015	Yes

TEN projects	Subprojects	Deadline after 2004 revision[15] (f): finished	Implementation in reference scenario
21. Motorways of the sea	1. Motorway of the Baltic Sea 2. Motorway of the sea of Western Europe 3. Motorway of the sea of south-east Europe 4. Motorway of the sea of south-west Europe	1. 2010 2. 2010 3. 2010 4. 2010	Yes
22. Railway axis Athina-Sofia-Budapest-Wien-Praha-Nürnberg/Dresden	1. Railway line Greek/Bulgarian border-Kulata-Sofia-Vidin/Calafat 2. Railway line Curtici-Brasov 3. Railway line Budapest-Wien 4. Railway line Breclav-Praha-Nürnberg 5. Railway axis Prague-Linz	1. 2015 2. 2010-2013 3. 2010-2019 4. 2010-2016 5. 2016	Yes
23. Railway axis Gdansk-Warszawa-Brno/Bratislava-Wien	1. Railway line Gdansk-Warszawa-Katowice 2. Railway line Katowice-Brno-Breclav 3. Railway line Katowice-Zilina-Nove Mesto n.V	1. 2015 2. 2010 3. 2010-2015	Yes
24. Railway axis Lyon/Genova-Basel-Duisburg-Rotterdam/Antwerpen	1. Lyon-Mulhouse-Mülheim 2. Genova-Milano/Novara-Swiss border 3. Basel-Karlsruhe 4. Frankfurt-Mannheim 5. Duisburg-Emmerich 6. "Iron Rhine" Rheidt-Antwerpen	1. 2018 2. 2013 3. 2015 4. 2015 5. 2009-2015 6. 2010-2015	Yes
25. Motorway axis Gdansk-Brno/Bratislava-Wien	1. Gdansk-Katowice motorway 2. Katowice-Brno/Zilina motorway 3. Brno-Wien motorway	1. 2010 2. 2010 3. 2009-2013	Yes
26. Railway/road axis Ireland/UK/continental Europe	1. Road/railway corridor linking Dublin with the North and South 2. Road/railway corridor Hull-Liverpool 3. Railway line Felixstowe-Nuneaton 4. Railway line Crewe-Holyhead	1. 2010 2. 2015-2020 3. 2011-2014 4. 2008-2012	Yes
27. "Rail Baltica" railway axis Warszawa-Kaunas-Riga–Tallinn	1. Warszawa – Kaunas 2. Kaunas - Riga 3. Riga - Tallinn	1. 2010-2017 2. 2014-2017 3. 2016-2017	Yes
28. Eurocaprail on the Bruxelles-Luxembourg-Strasbourg railway axis	1. Bruxelles-Luxembourg-Strasbourg	1. 1:2012	Yes
29. Railway axis on the Ionian/Adriatic intermodal corridor	1. Kozani-Kalambaka-Igoumenitsa 2. Ioannina-Antirrio-Rio-Kalamata	1. 2012 2. 2014	Yes
30. Inland waterways Seine-Scheldt	1. Navigability improvements Deulemont-Gent 2. Compiègne-Cambrai	1&2: (2012-2014-2016)	Yes

5.3.2.3 *Attributes for modal split modelling*

With regard to the chosen two corridors, the rail network attributes along the route were updated with the most recent technical data obtained. These led to updated input variables for the modelling modal split along the corridors.

Specifically for modelling the modal split for the freight trip matrix along the corridors the following inputs were used:

a) for road mode

Name	Units	Description
Origin	1010100-	Between Trans-Tools European NUTS 2 zones described by six digit numbers (1010100-)
Destination	1010100-	
Commodity	NST/R	Commodity groups 0-10
Length	KM	Transport distance including connector length
Free Time	Hour	Driving time excluded congested time
Congestion Time	Hour	Congested driving time
Ferry Sailing Time	Hour	Sailing time if ferry is used otherwise 0
Ferry WaitingTime	Hour	Waiting time if ferry is used otherwise 0
Toll Cost	Euro per tonne	Toll costs per vehicle including ferry costs
Driving Cost	Euro per tonne	Calculated costs depending on distance and time
Border Crossings	Number	Number of critical border crossings (0=no critical crossing)

b) rail mode

Name	Units	Description
Origin	1010100-	Between Trans-Tools European NUTS 2 zones described by six digit numbers (1010100-)
Destination	1010100-	
Commodity	NST/R	Commodity groups 0-10
Access/Egress Length[16]	KM	Sum of connectors' length
Access/Egress Time	Hour	Sum of connectors' time
On-board Length	KM	Transport distance
On-board Time	Hour	Transport time
Border Crossings	Number	Number of critical border crossings (0=no critical crossing)
Cost	Euro per tonne	Calculated costs depending on distance and time

The railway cost variable constitutes of:

1) railway tariff per type of commodity (can be country-specific or route-specific)

2) generalised costs derived on the network attributes (distance, time)

The values for the cost variables were updated for the year 2007 (at least for those OD relations which share the corridors).

[16] Access/egress length is the connector's length necessary to connect the origin point to the main network.

5.3.3 Externalities

External costs are costs to society and - without policy intervention - they are not taken into account by the transport users. In order to define external costs properly it is important to distinguish the type of area where the external cost are produced and also the time of the day.

Important examples of external effects of transport are congestion, accidents, air pollution, noise and impacts on climate change. The cost associated to these effects are called the external cost.

Trans-Tools model results provided the number of vehicles kilometres by mode. Next the external cost values from the recently published "Handbook on estimation of external costs in the transport sector (CE Delft, 2008 as part of IMPACT) were used to estimate the external costs. This included the accident costs, air pollution costs, noise costs and the costs of climate change.

The value per traffic unit of each external cost category are taken from the mentioned Commission's Handbook[17].

In general, external costs were then estimated as the product of the change in the transport volume of each mode (generated by the option policy B or C with respect to the baseline) by the value of each external cost per unit of traffic.

5.3.4 Job impacts

A change in the volume of rail traffic is theoretically likely to affect the number of employees in the sector, in particular concerning train staff.

However, the modal shift impact is considered not likely to increase significantly the employment in the rail industry, since this sector, characterized historically by a relatively high job intensity, in the recent years had to become more efficient due to public budget constraints, both in the infrastructure managers and railway undertaking sides. As a result, the job intensity of rail is declining, and relatively moderate changes of the transport volumes, as the ones forecasted, are not likely to imply significant additional staff needs.

In terms of employment, the main effect of the proposed policy Options are then:

- the need of additional staff for administrative tasks, as already identified in the document on Administrative costs
- the likely reduction of the employment in the road sector, resulting from the shift of traffic to rail transport because of reduction in time and costs of the latter.

The Approach for calculating administrative staff needs is presented in the chapter on administrative costs.

For estimating the employment impacts for road sector staff, the following kind of approach was applied:

1. the likely related road freight traffic variation was estimated (Δ^- road freight tonnes.km / year) as part of the Transtools modelling exercise;

[17] CE Delft et al., *Handbook on estimation of external cost in the transport sector*, Produced within the IMPACT study on behalf of the European Commission, December 2007. In the Handbook on estimation of external costs in the transport sector the best practice estimation of congestion costs is based on speed-flow relations, value of time and demand elasticities. For air pollution and noise costs, the impact pathway approach is broadly acknowledged as the preferred approach, using Values of Statistical Life based on Willingness to Pay. Marginal accident cost can be estimated by the risk elasticity approach, also using Values of Statistical Life. Given long-term reduction targets for CO2 emissions, the avoidance cost approach is the best practice for estimating climate cost. Other external costs exist, e.g. costs related to energy dependency, but there is for the time being no scientific consensus on the methods to value them.

2. the variation of the road staff was then calculated using the observed ratio of personnel in this sector per billion of tons.km.

5.4 Corridor selection

The following tables present the characteristics of the 6 ERTMS corridors in terms of freight traffic, technical and harmonisation, institutional coordination, likely interference with passenger traffic and main terminals and border stations.

The choice of the case studies corridor was motivated by the following criteria:

1. choice of two contrasting situation in terms of freight and passenger traffic intensity;
2. different geographic locations;
3. different level of interoperability as resulting from waiting times at border.

On the basis of such criteria, the following two corridors are proposed as case studies for the impact assessment:

- **Corridor A (Genoa – Rotterdam)** has a high international freight density (expressed in terms if million tkm / km) and also potentially high interference of the policies with passenger traffic, since passenger traffic density is also high. This corridor is then likely to represent the situation where changes in path allocation and traffic management rules will produce more effects on both passenger and freight traffic. The corridor presents also high maturity in terms of IM cooperation, so that all coordination measures are likely to be relatively quickly implemented.

  The corridor is not fully harmonised from the technical point of view, and it is close to many important freight terminals. Technical harmonisation and terminal actions are then likely to show significant effects on it.

- **Corridor E (Dresden - Budapest)** is proposed as a corridor with less intense freight traffic density, and also lower passenger traffic density, so representing an opposite situation with respect to Corridor A on these aspects. E is also interesting because touching East European countries, so providing a different geographic situation, and, by the way, it runs through border stations that present, differently from corridor C, relatively high process time for international trains (so that interoperability measures are likely to produce very important effects on border waiting times).

Figure 5-1 – Corridor characteristics (present situation) – (source: UIC ERIM report)

Corridor	Length	Involved countries		Geographic orientation	Border stations (number)	Border stations (list)	2005 Freight traffic level						Level of Technical Harmonisation					IM coordination level		Interfence with pax services		Main ports linked
							International		National		Share of nternational traffic on total freight traffic	Share of international freight traffic on total corridor traffic	Track gauge	Train lenghth		Loading gauge	Axle load	One stop shop (*)	Coordinated investement planning	2005 ERIM Pax traffic	2006 ERIM Pax traffic density	
	km	number	names				Million tkm	Million tkm / line km	Million tkm	Million tkm / line km	% on tkm	% on TU.km	Sections <> 1435 mm (Y/N)	Available length 600 m	Sections <750 m (Y/N)	Sections <Gabarit GB	Sections <22,5 t	Y/N	Y/N	Million pkm	Million pkm / line km	
Corridor A	2.548	4	Germany Italy Netherlands Switzerland	N - S	3	Domodossola Chiasso Basel Bad Bentheim	17.047	6,69	10.408	4,08	62%	42%	0%	73%	Y	79%	99%	Y	Y (TEN-T)	13.112	5,15	Geonoa Rotterdam
Corridor B	3.467	5	Austria Denmark Germany Italy Sweden	N - S	4	Brennero Kufstein Flensburg Lernacken	11.102	3,20	9.150	2,64	55%	30%	0%	87%	Y	97%	97%	Y (but only among Germany, Denmark and Sweden)	Y (TEN-T)	17.277	4,98	Naples Hamburg Malmo-Copenhagen
Corridor C	1.680	4	Belgium France Luxembourg Switzerland	N - S	3	Athus Thionville Basel	6.281	3,74	6.956	4,14	47%	32%	0%	100%	Y	98%	100%	Y	Y	6.150	3,66	Antwerpen
Corridor D	2.220	4	France Italy Slovenia Spain	E - W	5	Cerbere Port Bou Modane Villa Opicina Hodos	5.681	2,56	5.184	2,34	52%	24%	24%	58%	Y	73%	100%	Y	Y (TEN-T)	12.487	5,62	Valencia Barcelona Marseille Trieste
Corridor E	1.621	5	Austria Cz. Republic Germany Hungary Slovakia	E - W	5	Hegeyshalom Sturovo Bratislava-Petržalka Breclav Dolní Žleb / Decin	6.680	4,12	2.277	1,40	75%	56%	0%	94%	Y	100%	89%	Y (but without Austria)	Y (TEN-T)	2.978	1,84	-
Corridor F	1.934	2	Germany Poland	E - W	1	Frankfurt (Oder)	14.826	7,67	11.329	5,86	57%	47%	0%	84%	Y	100%	77%	Y	N	5.386	2,78	-
Total	**13.470**						**61.617**	**28**	**45.304**	**20**	**58%**	**39%**								**57.390**	**4**	

(*) as indicated by Rail Net Europe

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Figure 5-2 – Corridor characteristics (2020 evolution of traffic) – (source: UIC ERIM report)

Corridor	Length	Involved countries		Geographic orientation	Border stations (number)	2020 Estimated Freight traffic level						Interfence with pax services		Main ports linked
						International		National		Share of international traffic on total freight traffic	Share of international freight traffic on total corridor traffic	2020 ERIM estimated Pax traffic	2020 ERIM estimated Pax traffic density	
	km	number	names			Million tkm	Million tkm / line km	Million tkm	Million tkm / line km	% on tkm	% on TU.km	Million pkm	Million pkm / line km	
Corridor A	2.548	4	Germany Italy Netherlands Switzerland	N - S	3	29.774	11,69	17.703	6,95	63%	46%	17.768	6,97	Geonoa Rotterdam
Corridor B	3.467	5	Austria Denmark Germany Italy Sweden	N - S	4	16.201	4,67	13.332	3,85	55%	32%	20.597	5,94	Naples Hamburg Malmo-Copenhagen
Corridor C	1.680	4	Belgium France Luxembourg Switzerland	N - S	3	10.118	6,02	11.533	6,86	47%	34%	8.527	5,08	Antwerpen
Corridor D	2.220	4	France Italy Slovenia Spain	E - W	5	10.714	4,83	9.187	4,14	54%	25%	23.291	10,49	Valencia Barcelona Marseille Trieste
Corridor E	1.621	5	Austria Cz. Republic Germany Hungary Slovakia	E - W	5	8.949	5,52	3.150	1,94	74%	56%	3.889	2,40	-
Corridor F	1.934	2	Germany Poland	E - W	1	18.512	9,57	14.045	7,26	57%	47%	6.971	3,60	-
Total	**13.470**					**94.268**	**42**	**68.950**	**31**	**58%**	**40%**	**81.043**	**6**	

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6 DEFINITION AND ASSESSMENT OF THE QUALITATIVE IMPACTS

As explained in the paragraph 5.1, qualitative impacts occur

- on intervention areas for which data availability is not sufficient for assessing the baseline value and calculating the expected change produced by the proposed policy/actions; it might be the case, for instance, of the impacts on international train freight punctuality, in case no data are available for all corridors on the observed delays of these specific services;
- in case the type of impact is not measurable, e.g. when evaluating the effects on transparency of the rail freight market, a specific quantitative indicator of “transparency” is not easy to be defined.

These impacts are then expressed on the basis of a pre – defined scale of intensity to be associated to each intervention and will allow to evaluate, for the specific intervention area, the intensity of the impact produced by each different option in the general context of the rail freight business.

Within the general strategy drawn from both the intervention areas/objectives specified in the Tasks Specifications and the actions identified by the Strategic Group of Experts these impacts can be placed, in terms of relevance and of effectiveness in promoting the creation of a rail freight network giving priority to freight, at the hierarchical level of the quantitative impacts but the complexity and wideness of the related intervention areas and a situation of scarce data availability do not allow to proceed with a quantitative estimate.

This is confirmed by the circumstance that some qualitative impacts are introductory to some of the quantitative ones, which means that an high intensity of effects in that specific intervention area is a pre – condition to obtain an higher quantitative impact in another.

Nevertheless, in coherence with the general methodological approach, any impact (judgement) should be based on a “logical chain” of assumptions giving the chance to compare one policy option with another.

In particular, the following intervention areas are likely to produce impacts that were assessed in a qualitative way.

6.1 Qualitative impacts by intervention areas

Investment coordination: this intervention area is extremely relevant especially taking into account its connection with the technical harmonisation objectives. In fact, coordinated investment planning should translate into an harmonised development of the network on a corridor scale, and should allow to implement interoperability standards more rapidly. Nevertheless, coordinated investments do not always correspond to synchronized infrastructural intervention. For each of MS crossed by a corridor there are different geological, political, fund raising issues that often result in delays and constraints for investment to become effective.

The main likely qualitative impact of this intervention area is:

- <u>increasing in transparency</u> of the information to users of the corridor (railway undertaking and authorised applicants).

The following impact level will be considered:

- no increase in transparency (either because the policy option is not effective, or the investment & heavy maintenance planning in the corridor is already coordinated and transparent)
- increase in transparency only for long term investment (because the policy option is based on the voluntary approach, that can be effective on the long term, but it is not likely to produce results for the short term plans)
- significant increase in transparency both for long term investment and medium term investment and heavy maintenance works (full application of the Experts Strategic Group proposals).

The Strategic Group stresses also the need of a coordinated identification of infrastructure capacity needs and sections to be renewed. Theoretically this might lead to more capacity available for freight, however it is quite difficult to assess (both quantitative and qualitatively) the amount of additional capacity made available as result of such coordination

Path allocation process

The actions identified by the Strategic Group of Experts are

– IM to set up a One Stop Shop (OSS) service for all procedures relating to planned and ad hoc path allocation. In this case the use of the OSS service should be mandatory.
– Giving the possibility to apply for path allocation to authorised applicants along the corridor.

These actions are of course introductory to the implementation of the path allocation rules described in the paragraph 5.2.2, as they allow to concentrate into a unique body the management of the path allocation to applicants, taking into account market needs and lines available capacity on a corridor scale.

The main likely qualitative impact is

- increased market opening and transparency resulting from a fairer path allocation process

As in the previous case of investment coordination, the intensity of the impact is going to vary from "no impact" (no change compared to the baseline scenario) to "high impact" (significant extension, e.g. doubling, of the number of international path applicants over the corridor).

Transparency: this intervention area has an high strategic relevance, it is, in fact, introductory to the actions provided in the "Path allocation rules" and in the "Terminals" intervention areas.

Within this intervention area the Tasks Specifications have set the objective of fair access to information about the conditions and modalities of use of the infrastructure and the terminals.

The qualitative impact and the possible assessment scale are the one already presented for the "investment coordination" area.

Quality of service: the objectives of the Commission for this intervention area is indicated in the Tasks Specifications and is represented by the clear commitment of IM concerning the quality of their services towards freight trains and by the consistent and the harmonised implementation of performance schemes.

The Strategic Group of Experts has indicated the road to reach this objective by recommending the harmonisation among IM, as far as possible, of the performance schemes in force along the corridor.

This will require the set up of processes and systems to monitor the quality (at least in terms of delays) along the corridor and publish data on the level of quality delivered.

Quality of rail freight transport may be represented, mainly, by the following parameters:

- punctuality (% of train arriving on time or within a given timeframe after scheduled arrival);
- reliability (% of train actually operated);

since safety aspects are not likely to be significantly affected by the proposed policies.

The mentioned parameters are difficult to be measured in quantitative terms (because of lack of detailed data on international freight train punctuality and reliability on each corridor). In case a quantitative measurement will be difficult, a qualitative impact scale will be used, such as:

- no impact
- moderate improvement of international freight train punctuality and reliability (e.g. difficult to be perceived by the market)
- medium-to-high improvement of international freight train punctuality and reliability (clearly perceived by the market).

6.2 Assessment of the qualitative impacts of the options B and C

The following table summarises the expected qualitative impacts as resulting from the description of the options presented in 4, and the above definition of the qualitative impacts level.

Intervention area	*Qualitative impact*	*Impact level*	
		Option B	*Option C*
Investment coordination	Increasing transparency to users of rail infrastructure (RUs and authorised applicants)	Only for long terms investment	Both for medium and long term investment and maintenance works
	Better use of infrastructure because of coordinated investment and maintenance on rail infrastructure	Low (maintenance works are not coordinated)	High (the coordination will allow maintaining sufficient capacity for freight along the corridor and defining alternative itineraries / paths in case of works)
Path allocation process	Increase market opening and transparency because of fairer path allocation process through OSS	High (new operators entering into the international freight transport market will find one single interlocutor for obtaining information and booking their paths)	High (same as for Option B)
Transparency	Increasing transparency to users of rail infrastructure (RUs and authorised applicants)	No or low impact (no obligation of publishing corridor reference document)	High (the obligation of publishing corridor reference document will provide harmonised and complete information to RUs and authorised applicants)
Quality of service	Punctuality and reliability of international freight paths	Medium-to-high Improvement (consistent and harmonised implementation of performance schemes)	Medium-to-high Improvement (same as for Option B)

Higher impacts are expected for Option C in the areas where the legislative obligations are required and/or likely to be largely more effective than the voluntary approach, such as investment coordination and transparency.

7 MICRO LEVEL IMPACTS - CORRIDOR A

7.1 Impacts of intervention on technical harmonisation

7.1.1 Harmonized train length

Decrease of rail freight operating costs

The available information for 2020 (UIC, ERIM database) highlights that the remaining critical sections (max train length < 750 m) are the ones presented in the following tables (in order to clarify the positioning of the sections, they have been grouped by railway axis.

Table 7-1 - Section with maximum train length < 750 m (Corridor A)

Country code	From	To	ERTMS Corridor	Overall route length [km]	Maximum train length [m]
Germany	MAINZ	KOBLENZ	A	92	690
Domossola – Milano					
Italy	GALLARATE	DOMODOSSOLA	A	82	500
Italy	MILAN	GALLARATE	A	44	650
Novara / Milano – Genova					
Italy	MILANO	VOGHERA	A	63	575
Italy	VOGHERA	TORTONA	A	16	575
Italy	TORTONA	ARQUATA	A	25	575
Italy	ARQUATA	GENOVA	A	38	600
Italy	ARQUATA	GENOVA	A	45	575
Italy	ALESSANDRIA	NOVARA	A	67	525
Domodossola – Novara					
Italy	NOVARA	DOMODOSSOLA	A	89	575
Alessandria – Genova via Ovada					
Italy	ALESSANDRIA	OVADA	A	34	575
Italy	OVADA	CAMPOLIGURE	A	14	355
Italy	CAMPOLIGURE	MELE	A	7	355
Italy	MELE	GENOVA BORZOLI	A	15	355
Luino – Novara / Gallarate					
Italy	LUINO	LAVENO MOMBELLO	A	15	600
Italy	LAVENO MOMBELLO	OLEGGIO	A	36	600
Italy	OLEGGIO	VIGNALE	A	13	600
Italy	VIGNALE	NOVARA	A	3	600
Italy	LAVENO MOMBELLO	GALLARATE	A	31	600
Switzerland	GIUBIASCO	PINO CONFINE	A	21	600
Switzerland	PINO CONFINE	LUINO	A	15	600

On the basis of the above table, it is possible to identify the rail traffic flow that will be limited in terms of train length

a. traffic between Milan area and the north via Simplon (limit 500 m) or via Luino (600 m)

b. traffic between Novara area and the north via Simplon (limit 575 m) or via Luino (600 m);

c. traffic between Genoa area and the north via Alessandria – Novara – Simplon or Luino (limit 525 m, critical section Alessandria – Novara), or via Milano – Gothard (575 m)

The change in rail operating costs per tkm on the above mentioned flows has been estimated according to the approach explained in the *Annex III – Methodological approach for estimating rail freight operating cost impact of the harmonized* train length. The change in rail operating costs has been calculated considering average value of the cost factors among the corridor A countries (since the international trains are usually set at the maximum length on the critical section along all the corridor, in order to avoid shunting operations for assembling / dissembling the train that generate additional costs and times), given that some of such factors are country specific (mainly access and energy charges, as well as driver wages).

The following results were obtained.

Table 7-2 - Cost savings due to harmonized train length

Traffic flow	via	Max train length (m)	Intermodal trains **			Single wagon trains **		
			Expected reduction in train cost per tkm (%)	% of train set at maximum length *	Average reduction in train costs per tkm (%)	Expected reduction in train cost per tkm (%)	% of train set at maximum length *	Average reduction in train costs per tkm (%)
traffic between Milan area and the north	Simplon	500	28,83%	20%	**5,77%**	23,53%	50%	**11,76%**
	Luino	600	15,88%	20%	**3,18%**	12,27%	50%	**6,14%**
traffic between Novara area and the north	Simplon	575	20,99%	20%	**4,20%**	15,92%	50%	**7,96%**
	Luino	600	15,88%	20%	**3,18%**	12,27%	50%	**6,14%**
traffic between Genova area and the north	Simplon / Luino	525	26,19%	20%	**5,24%**	21,58%	50%	**10,79%**
	Gothard	575	20,99%	20%	**4,20%**	15,92%	50%	**7,96%**

* Hypothesis defined in coherence with data supplied by SNCF for the traffic studies on the new Lyon – Turin railway line, on the basis of the observed length of international freight trains to/from Italy

** The third main type of freight services, the full trains, are not considered because they are usually limited by the weight (not by length)

The estimated reduction of rail operating costs is considered to be entirely transferred to the market, so that the same reduction is applied to rail tariff for the affected flows.

Since the rail tariffs depend also on the type of goods, it is necessary to identify the typical freight service used to move each type of product. The following table presents the proposed allocation of the main good categories on the three usual rail service types. As far as the traffic modeling is concerned, it is proposed that, when more than 1 service type is likely to be used, an average value of tariff reduction shall be used.

As an example, Manufactured products are moved mainly by Intermodal Trains or Single Wagon Trains; thus the expected reduction in rail tariffs for such products moved, for instance, between the Milan area and the north via Simplon will be (5,77%+11,76%)/2 = 8,77%.

Table 7-3 - Allocation of the goods category per type of train

	Intermodal Trains (IM)	Single Wagon Trains (SW)	Full trains (FT)
Agricultural products			x
Non-perishable food		x	
Perishable food		x	
Bulk products			x
Metallic products	x	x	x
Building materials			x
Chemical products	x	x	x
Manufactured products	x	x	
Transport vehicles			x

Investment costs for upgrading the lines

The average investment costs for upgrading the line to 750 m maximum length will be based on the length of the sections to be upgraded, and on the average cost per km.

Table 7-4 - Hypothesis on section upgrading cost (PwC elaboration on various sources)

Cost per additional m of tracks including land purchase, track bed, ballast and track	5.000 Euro / metre of track
Cost per relocation of signals	30.000 Euro / siding

Table 7-5 - Estimate of section upgrading costs

COUNTRY CODE	POINT_1	POINT_2	Overall route length [km]	Max train length [m]	Siding density (n. sidings / section km)	Additional m of tracks to be built	Additional track cost including land purchase [Mil €]	Signalling relocation costs [Mil €]	TOTAL UP-GRADING COSTS [Mil €]
			A	B	C	D=A*(750-B)*C	D * 5000 / 10^6	A*C * 0,03	
GE	MAINZ	KOBLENZ	92	690	0,40	2.202	11,01	1,47	12,48
IT	GALLARATE	DOMODOSSOLA	82	500	0,25	5.125	25,63	0,82	26,45
IT	MILANO	VOGHERA	63	575	0,25	2.756	13,78	0,63	14,41
IT	VOGHERA	TORTONA	16	575	0,25	700	3,50	0,16	3,66
IT	TORTONA	ARQUATA	25	575	0,25	1.094	5,47	0,25	5,72
IT	ARQUATA	GENOVA	38	600	0,25	1.425	7,13	0,38	7,51
IT	ARQUATA	GENOVA	45	575	0,25	1.969	9,84	0,45	10,29
IT	MILAN	GALLARATE	44	650	0,40	1.760	8,80	0,70	9,50
IT	ALESSANDRIA	NOVARA	67	525	0,20	3.015	15,08	0,54	15,61
IT	NOVARA	DOMODOSSOLA	89	575	0,20	3.123	15,61	0,71	16,33
IT	ALESSANDRIA	OVADA	34	575	0,20	1.173	5,86	0,27	6,13
IT	OVADA	CAMPOLIGURE	14	355	0,20	1.098	5,49	0,11	5,60
IT	CAMPOLIGURE	MELE	7	355	0,20	545	2,73	0,06	2,78
IT	MELE	GENOVA BORZOLI	15	355	0,20	1.153	5,77	0,12	5,88
IT	LUINO	LAVENO MOMBELLO	15	600	0,33	728	3,64	0,19	3,84
IT	LAVENO MOMBELLO	OLEGGIO	36	600	0,20	1.084	5,42	0,29	5,71
IT	OLEGGIO	VIGNALE	13	600	0,20	399	2,00	0,11	2,10
IT	VIGNALE	NOVARA	3	600	0,20	99	0,50	0,03	0,52
IT	LAVENO MOMBELLO	GALLARATE	31	600	0,20	937	4,68	0,25	4,93
CH	GIUBIASCO	PINO CONFINE	21	600	0,20	630	3,15	0,17	3,32
CH	PINO CONFINE	LUINO	15	600	0,20	450	2,25	0,12	2,37
TOTAL UPGRADING COST							157,32	7,82	**165,14**

7.1.2 Reduction of waiting times at borders

A large improvement in interoperability will imply that all the remaining procedures relating to un-harmonized technical or operational rules at the borders will be eliminated.

Stops at the borders will require at most the time for changing the locomotive. In case interoperable locomotives will be in service, only driver changes will take place at the borders, and even these operations may be eliminated if cross acceptance of drivers will be applied by RUs.

However, drivers cannot conduct trains for longer than a few hours per day, therefore in some points of the network drivers have to be changed in any case. This implies that driver cross-acceptance does not automatically mean the elimination of driver changes at the borders.

The differential between the current and future situations indicates the available reduction due to the improved interoperability.

In the table below, the savings for each cross border section are indicated for conventional freight trains (CF) and intermodal trains (CT). "Current" means maintaining of existing procedures, "future" represents the to-be situation where the interoperability concept will be extended to all technical and operational rules.

Table 7-6 - Current and future waiting time at ERTMS corridor A border stations

Baseline waiting times

Name	Pax trains	CF trains	CT trains
Chiasso	5	125	60
Domodossola Domo II	0	145	125
Emmerich	0	0	60
Basel CH/D	3	60	45

Improved waiting times (Option C from 2016, Option B from 2020)

Name	Pax trains	CF trains	CT trains
Chiasso	5	5	5
Domodossola Domo II	0	5	5
Emmerich	0	0	5
Basel CH/D	3	5	5

Differential

Name	Pax trains	CF trains	CT trains
Chiasso	0	-120	-55
Domodossola Domo II	0	-140	-120
Emmerich	0	0	-55
Basel CH/D	0	-55	-40

The estimate is based on considering a relatively poor baseline (with waiting time set to the 2007 observed levels). For this reason, within the risk analyses, a sensitivity analysis on the baseline waiting time has been performed, as presented in chapter 13.

7.2 Impacts of intervention on path allocation rules

7.2.1 Additional Capacity For Freight Trains

The current path allocation implies that the number and type of freight train paths are set mainly according to the residual capacity after planning the passenger path (even if according to Dir 2001/14, international freight trains should already have "adequate" priority).

The proposed intervention will mean that capacity allocation will follow specific market studies, so that the number of available freight train paths will be defined according to market needs.

The information on theoretical capacity and traffic mix (number of trains per type) in 2020 obtained from UIC (ERIM database) is very aggregated, since only average values per each country over the corridor has been supplied.

Table 7-7 - Capacity and traffic information (Corridor A)

Country code	*Railway*	*Overall route length [km]*	*Maximum freight speed [km/h]*	*Theoretical line capacity [trains/day]*	*Number of trains per day and per section in 2020 (average)*			
					national passenger trains	*international passenger trains*	*national freight trains*	*international freight trains*
GM	DB	1080	120	430	150	30	80	120
IT	RFI	722	110	210	70	10	50	20
NL	ProRail*	103	120	320	0	20	20	140
SZ	SBB/BLS**	768	100	265	100	30	40	95

** Betuwe line only*

*** Average values on the two axis Loetschberg & Simplon*

Given the limited level of information available, a very simplified approach has been applied to estimate the likely impacts on freight and passenger capacity due to the growth of available paths for freights.

- Definition of the likely scenarios in terms of number of additional freight paths to be designed following market studies.

  It has been agreed with DG TREN that two alternative scenarios will be considered, with an increase of +10% and +30% respectively;
- Check of the theoretical line capacity saturation before and after the increase of freight paths, in order to check if the additional paths can be accommodated without reducing passenger train paths;
- In case it is not possible to accommodate the additional freight paths within the available capacity, calculation of the number of passenger paths to be cancelled (first regional paths are supposed to be cancelled, than long distance paths).

The following hypotheses have been applied in the above mentioned calculation:

- o freight trains average over-the-line speed: 75% of the maximum freight speed
- o passenger train average over-the-line speed: 160 km/h (long distance); 80 km/h (regional)
- o % of regional trains on total national passenger trains: 50%
- o average section length (distance between overtaking points): 20 km;
- o available capacity: 90% of the theoretical capacity.

On this basis, the following equivalences between freight paths and passenger paths have been calculated (representing the number of passenger paths neutralized by 1 additional freight path).

Table 7-8 - Equivalence between freight and passenger paths (current and 2020 scenario)

Country code	*Railway*	*Average over-the-line speed (freight)*	*Average over-the-line speed (long distance passenger)*	*Average over-the-line speed (regional passenger)*	*Number of long distance passenger paths neutralized by 1 freight path*	*Number of regional passenger paths neutralized by 1 freight path*
GM	DB	90	160	80	2	1
IT	RFI	83	160	80	2	1
NL	ProRail	90	160	80	2	1
SZ	SBB/BLS	75	160	80	2	1

The following results are obtained in the two scenarios. The +30% scenarios does not appear to be feasible because of the strong impact on regional traffic (cancellation of 70-80% of the trains in Germany and Switzerland).

Table 7-9 - Additional freight paths and cancelled passenger paths – scenario freight paths +10% (current and 2020 scenario)

Country code	*Railway*	*Ex-ante traffic distribution (n. trains / day)*			***Variations***			*Ex-post traffic distribution (n. available paths / day)*		
		Freight	*Regional passenger*	*Long distance passenger*	***Additional freight paths***	***Regional passenger paths cancelled ****	***Long distance passenger path cancelled***	*Freight*	*Regional passenger*	*Long distance passenger*
DE	DB	200	75	105	**20**	**13**	-	220	62	105
IT	RFI	70	35	45	**7**	-	-	77	35	45
NL	ProRail	160	0	0	**16**	-	-	176	0	0
CH	SBB /BLS	135	50	80	**14**	**14**	-	148	36	80

** Cancellation is not automatic (e.g. the Infrastructure Manager might re-design the timetable or allocate path on alternative routes). However this impact shall be considered as prudent scenario of freight priority effects.*

Table 7-10 - Additional freight paths and cancelled passenger paths – scenario freight paths +30% (current and 2020 scenario)

Country code	*Railway*	*Ex-ante traffic distribution (n. trains / day)*			***Variations***			*Ex-post traffic distribution (n. available paths / day)*		
		Freight	*Regional passenger*	*Long distance passenger*	***Additional freight paths***	***Regional passenger paths cancelled ****	***Long distance passenger path cancelled***	*Freight*	*Regional passenger*	*Long distance passenger*
DE	DB	200	75	105	**60**	**53**	-	260	22	105
IT	RFI	70	35	45	**21**	-	-	91	35	45
NL	ProRail	160	0	0	**48**	-	-	208	0	0
CH	SBB /BLS	135	50	80	**41**	**41**	-	176	9	80

** Cancellation is not automatic (e.g. the Infrastructure Manager might re-design the timetable or allocate path on alternative routes). However this impact shall be considered as prudent scenario of freight priority effects.*

Assuming the average number of full-service days per year at 250 (freight traffic is concentrated on working days), the following are the likely **total variations of the rail traffic** in terms of train.km / year in the +10% scenario

1) freight trains: + 9.669.261 train.km
2) regional passenger trains: - 6.199.537 train.km

As already explained, these figures has to be compared with the expected macro-level traffic impacts in order to verify whether they correspond to actually expected effect (i.e. additional market attracted because of the other interventions' impacts on costs and travel / waiting times) or only potential ones.

7.3 Impacts of intervention on path allocation and traffic management rules on train priority

7.3.1 Reduction in waiting times of freight trains

The proposed intervention consists in two main actions for the improvement of traffic management rules, in particular:

- either include 2 or 3 levels of priority that will be set according to socio-economic value of trains;
- or be "a train on time remains on time".

The above listed actions are expected to produce relevant impacts in terms of reduction/elimination of freight train delays due to disruptions on passenger traffic.

Unfortunately, information on waiting times due to lack of priority (both in terms of path allocation and traffic management) are not available for all sections, nevertheless the New Opera case study on changing priority among trains (increasing the one of freight trains) supports the estimate of the change in expected delays.

The information on waiting times and traffic mix (number of trains per type) obtained from the New Opera case study only refers to the examined showcase line Béning (France) – Ludwigshafen (Germany) and, in particular, to the following sections:

- Ludwigshafen – Neustadt;
- Kaiserslauten – Homburg;
- Saarbrucken – Béning.

For each of the above listed sections, two different scenarios were elaborated in order to evaluate the reduction of waiting times following an intervention consisting in an increase of freight paths priority in case of adoption of ETCS level 2 and ETCS level 3.

Within this Impact Assessment, the "to be" scenario assumed for 2020 is ETCS level "3" in place, so the results of that scenario were considered as basis for the impact evaluation.

The following table summarises the information provided by the New Opera case study in the scenario ETCS Level 3 for the examined sections.

Table 7-11 - Expected reduction in waiting times due to the increase of freight trains priority (New Opera case study)

Length (km)	Segment	Expected reduction in scheduled waiting times (min/km)	Freight traffic density	Direction
		Scenario ETCS 3		
28,2	LUDWIGSHAFEN - NEUSTADT	0,141514453	25,8%	E/W
28,2	NEUSTADT - LUDWIGSHAFEN	0,090086895	25,8%	W/E
31,9	KAISERSLAUTEN - HOMBURG	0,01502959	34,8%	E/W
31,9	HOMBURG -KAISERSLAUTEN	0,016595172	34,8%	W/E
18,0	SAARBRUCKEN - BENING	0,018888889	61,5%	E/W
18,0	BENING - SAARBRUCKEN	0,007777778	61,5%	W/E

Length (km)	Segment	Expected reduction in unscheduled waiting times (min/km)	Freight traffic density	Direction
		Scenario ETCS 3		
28,2	LUDWIGSHAFEN - NEUSTADT	0,063486434	25,8%	E/W
28,2	NEUSTADT - LUDWIGSHAFEN	0,063486434	25,8%	W/E
31,9	KAISERSLAUTEN - HOMBURG	0,009393493	34,8%	E/W
31,9	HOMBURG -KAISERSLAUTEN	0,00970661	34,8%	W/E
18,0	SAARBRUCKEN - BENING	0,011666667	61,5%	E/W
18,0	BENING - SAARBRUCKEN	0,00500000	61,5%	W/E

Given the limited level of information available, a very simplified approach has been applied to estimate the likely impacts on freight and passenger waiting times due to the increase of available paths for freights. In particular, on the basis of the estimation provided within the New Opera case study the estimates of the reduction on waiting times deriving from an increase in freight train priority are going to be calculated on the basis of the following factors:

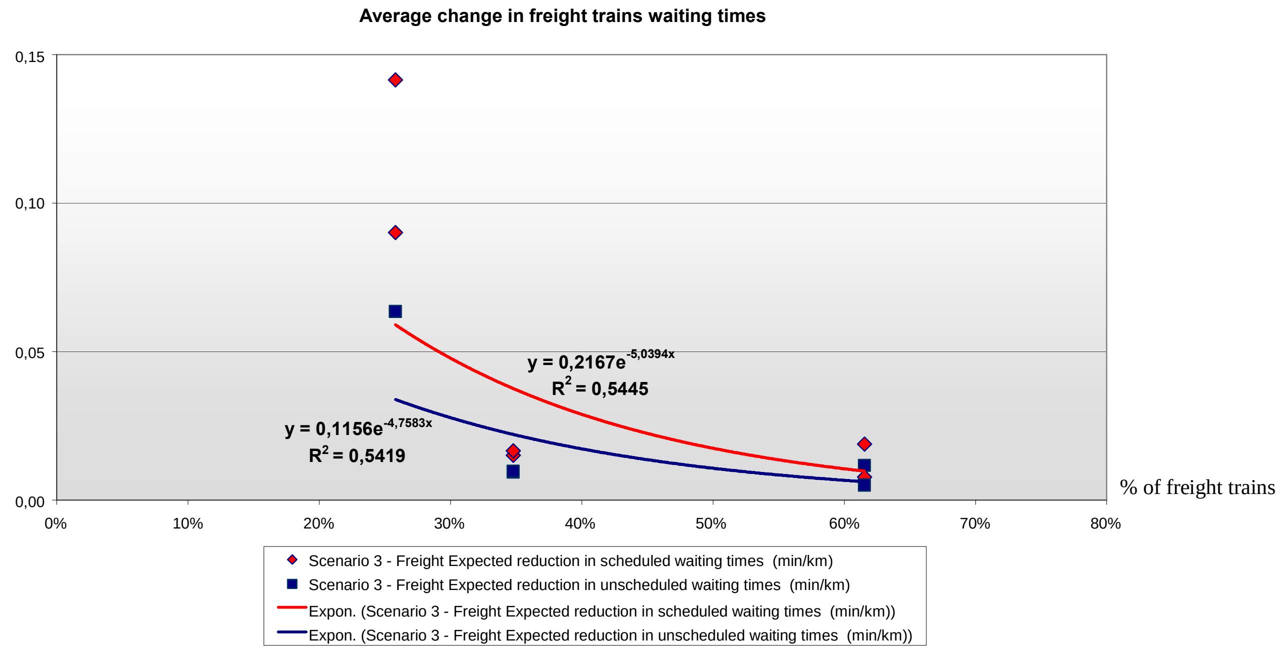
- Route length;
- % of freight trains (on the basis of the passenger / freight traffic mix of each section).

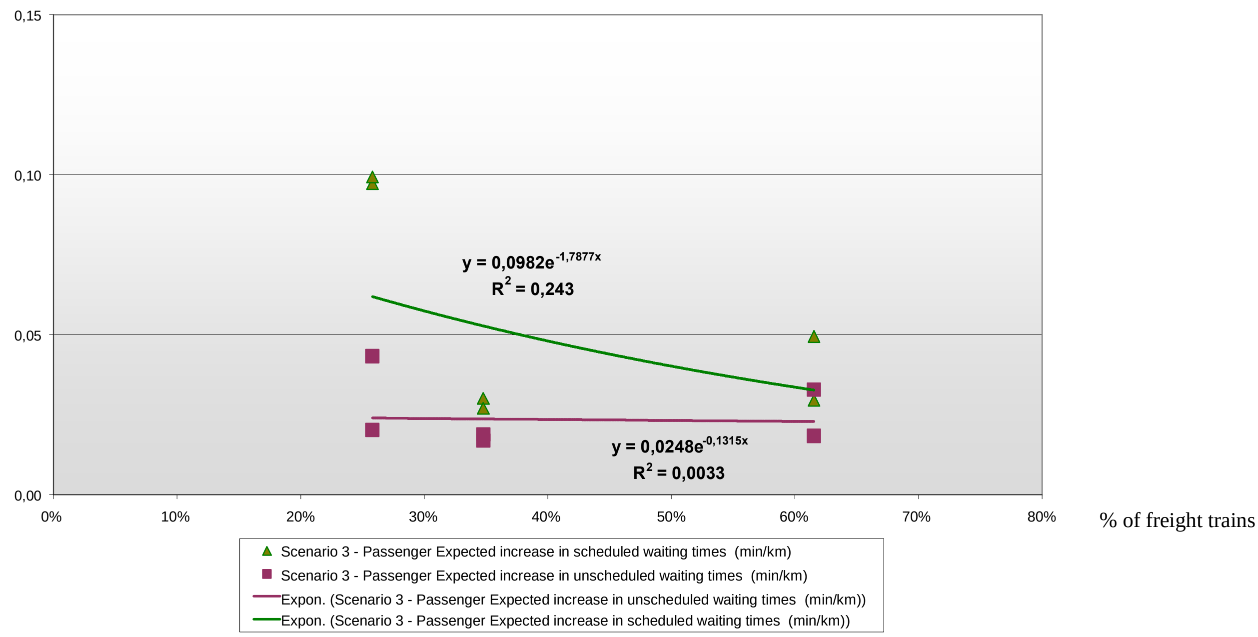
Moreover, if compared to the share of freight train paths, the estimation worked out within the New Opera case study show that the lower is the % of freight paths the higher is the expected reduction in waiting times after an increase of freight trains priority. This reflects the fact that an high share of freight traffic implies that there is not a lot of time to be saved by giving them priority to the few passenger trains. The only exception to this rule (out of six observed section) is the section SAARBRUCKEN – BENING (East → West direction).

Correspondingly to highest % of freight trains, the maximum increase in waiting time for passengers is also observed on most sections (with the exception of SAARBRUCKEN – BENING and BENING - SAARBRUCKEN).

The above described trends were approximated through exponential functions, as shown in the following graphs. The so-obtained exponential functions were used to estimate the estimated average expected change in scheduled and unscheduled waiting times freight trains and for passengers trains in case of priority increase for the first ones, for the sections of the case study corridors.

In particular, since data on traffic mix (% of freight trains) are known from UIC only as average value on all corridor sections of each country, the functions have been applied to such country-specific "theoretical corridor section" having the length of all corridor sections in the country and the above mentioned average traffic mix.





The following tables show the average change in freight and passenger trains waiting times calculated for corridor A through the approach described above.

Table 7-12 - Expected variation in freight and passenger trains waiting times

Country	Infrastructure Manager	ERTMS Corridor	Route length [km]	Average % of freight trains (Scenario 2 New Opera) = x	Corresponding variation of freight waiting times	
					Unscheduled (minutes / km)	Scheduled (minutes / km)
NL	ProRail	A	103	100%	-	-
SZ	SBB/BLS	A	768	51%	0,0102	0,0166
GM	DB	A	1080	53%	0,0093	0,0150
IT	RFI	A	722	47%	0,0124	0,0203

Country	Infrastructure Manager	ERTMS Corridor	Route length [km]	Average % of freight trains (Scenario 2 New Opera) = x	Corresponding variation of passenger waiting times	
					Unscheduled (minutes / km)	Scheduled (minutes / km)
NL	ProRail	A	103	100%	-	-
SZ	SBB/BLS	A	768	51%	-0,0232	-0,0395
GM	DB	A	1080	53%	-0,0231	-0,0381
IT	RFI	A	722	47%	-0,0233	-0,0424

7.3.2 Good and reliable paths for freight trains

Railways undertakers will likely be charged of extra costs in case their freight train will use a faster path. Generally the usage of an infrastructure capacity is charged according the type of capacity used. The use of a network during the off peak time is generally charged with a lower price than the correspondent use in a peak time (see for examples the telephone price during the day).

As indicated by the path price list of DB Netz[18] (the German rail Infrastructure Manager) a “Güterwerkerhrs – Express – Trasse” (i.e. Express Freight Path) costs the 65% more than the standard one.

All the freight trains using this type of path are likely to be charged of an extra cost connected to the quality of the path and the corresponding level of service that can be offered.

Within this impact assessment all freight trains are foreseen to benefit of increased priority. The actual % additional charge shall be set at a level that not offset the time benefit for freight trains thanks to the priority (see chapter 7.5). The above mentioned increase of 65% applied in Germany shall be considered only as un upper bound in case the priority concern only some freight paths, so that they will also benefit of greater time savings.

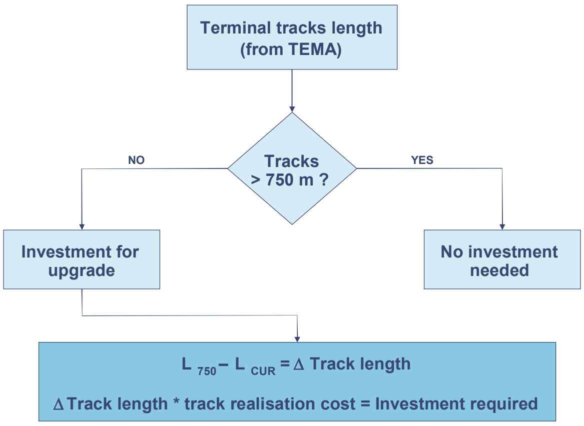
[18] Data obtained from “Das Trassenpreissystem” del DB Netz AG (valid from 9/12/2007 to 13/12/2008).

7.4 Impact of intervention on terminals

7.4.1 Increase of transhipment tracks' length and additional investment costs for lengthening the tracks

In order to estimate the investments needed to upgrade transshipment tracks in the terminals along the corridor, the following methodology was adopted

Figure 7-1 - Adopted methodology to estimate necessary investments in terminal



Given the terminals' track length, it was estimated the additional length to extend the tracks where transshipment operations are performed, in order to load / unload trains of a length of 750 m without splitting them. This ensures time and cost savings, due to the lower shuntingoperations. The value of such additional length was then multiplied by an hypothetical realization cost by metre of track[19], so as to determine a value for the necessary investment. The following table indicates the total metres of tracks to be built in each single terminal, in order to be compliant with the proposed standardised train length of 750 m.

Table 7-13 - Tracks to be realized in the terminal of ERTMS corridor A

Terminal with average transhipment track length < 600 m

Terminal		Tracks n and length		Average length	Meters of tracks necessary to accommodate trains 750 m long	
Germany	Ludwigshafen KTL	3	620	620	130	390
		4	564	564	186	744
Switzerland	Basel-Wolf	3	800	267	483	1.450
Italy	Milano Greco Pirelli	3	1000	333	417	1.250
Italy	Milano Segrate	10	4500	450	300	3.000
Italy	Milano Certosa	3	1130	377	373	1.120
Italy	Milano Smistamento	4	1860	465	285	1.140
Italy	Milano Desio	2	600	300	450	900
Total						**9.994**

Terminal with average transhipment track length > 600 m

Terminal		Tracks n and length		Average length	Meters of tracks necessary to accommodate trains 750 m long	
Germany	Köln-Eifeltor	4	700	700	50	200
		5	630	630	120	600
Germany	Duisburg Ruhrort Hafen Duss	5	680	680	70	350
		1	800	800	750 m standard ready	-
Germany	Mannheim - Handelshafen	4	700	700	50	200
		1	550	550	200	200
Germany	Basel-Weil Am Rhein	4	650	650	100	400
		2	570	570	180	360
Italy	Busto Arsizio-Gallarate	13	8400	650	100	1.300
Total						**3.610**

[19] The following parameter have been used 3.000,00 Euro * meter of tracks realised. This cost takes into account all the expenditures necessary to build up the tracks (land purchase, track bed, ballast, track etc.). Considered that most of crossing/overtaking tracks have to be realized in stations lying in urban areas (and possibly needing also to demolish buildings) this lead to an higher land costs (5,000,00 Euro).

In order to make the terminal compliant to the new standard of trains 750 m long, over 13 kilometres of tracks have to be build. **The required investment accounts to 40,8 M Euro.**

7.4.2 Reduction of shunting costs

The reduction in the shunting operations, indicated above, entails a lower cost for railway undertakings. The cost was estimated through an average cost of the shunting service obtained from interviews carried out with terminal managers in the course of the UIC TEMA (Terminal Management) project. Therefore, a flat rate value of the service was adopted[20], corresponding to 43 Euros for a full shunting service to/from the terminal.

This value was multiplied by the number of operations avoided for disassembling / assembling the trains as a consequence of the extension of transshipment tracks to 750 meters, thus obtaining the expected savings of railway undertakings. In order to estimate such reduction of shunting operations, it is necessary to consider that not all train services may be set at the maximum length, for instance because it is necessary to ensure a daily service to a given destination even if the maximum train length is not reached. Needless to say, the % of services taking benefit of the extended track length is higher if the baseline tracks are very short. The following hypotheses are considered.

Average transhipment track length (baseline)	% of trains taking benefit of track length extension
<= 400 m	100%
Between 400 and 500 m	50%
> 500 m	20%

The number of shunting operation that are likely to be saved is presented hereafter.

Table 7-14 - Savings in shunting operations due to the increased tracks length

Terminal with average transhipment track length < 600 m

Terminal		Tracks n and length		Average length	Nb of shunting operations necessary to tranship the train	Δ operation for tracks < 750 m	Weekly services	Shunting operations to accommodate a train 750 m long with tracks < 750 m	growth rate / y	2020 services	% of trains taking benefit of track lengthning	Saved operations in 2020
		3	620	620	2	1						
Germany	Ludwigshafen KTL	4	564	564	2	1	170	170	10,9%	448	20%	90
Switzerland	Basel-Wolf	3	800	267	3	2	48	96	8,2%	107	100%	214
Italy	Milano Greco Pirelli	3	1000	333	3	2	10	20	11,6%	27	100%	54
Italy	Milano Segrate	10	4500	450	2	1	60	60	11,6%	164	50%	32
Italy	Milano Certosa	3	1130	377	2	1	24	24	11,6%	36	100%	36
Italy	Milano Smistamento	4	1860	465	2	1	48	48	11,6%	132	50%	36
Italy	Milano Desio	2	600	300	3	2	36	72	11,6%	99	100%	198

Terminal with average transhipment track length > 600 m

Terminal		Tracks n and length		Average length	Nb of shunting operations necessary to tranship the train	Δ operation for tracks < 750 m	Weekly services	Shunting operations to accommodate a train 750 m long with tracks < 750 m	growth rate / y	2020 services	% of trains taking benefit of track lengthning	Saved operations in 2020
		4	700	700	2	1						
Germany	Köln-Eifeltor	5	630	630	2	1	190	190	4,3%	313	20%	63
	Duisburg Ruhrort	5	680	680	2	1						
Germany	Hafen Duss	1	800	800	1	-	120	120	16,7%	421	20%	42
	Mannheim -	4	700	700	2	1						
Germany	Handelshafen	1	550	550	2	1	48	48	10,9%	126	20%	25
		4	650	650	2	1						
Germany	Basel-Weil Am Rhein	2	570	570	2	1	79	79	8,2%	176	20%	35
Italy	Busto Arsizio-Gallarate	13	8400	650	2	1	180	180	11,6%	493	20%	99

[20] From the survey performed, it appears that such form of pricing is more common than the one envisaging a cost/km to be paid for the kms of service requested.

As indicated in the two previous tables, 1.034 shunting operations weekly might be saved in the case each track in the terminals is standardized to the reference length of 750m. **The elimination of such extra shunting procedures will result in a reduction of the shunting costs amounting up to € 2,3 M Euro yearly**

The average saving per intermodal train having origin or destination in the terminal with track <750 m is between 1 and 2 shunting operations at each end (depending on the track length at the initial / final terminal), so that up to 4 operations in case both origin and destination terminal do not have 750 m tracks in the baseline situation. In terms of cost, this represent a maximum saving of about 170 € / train, i.e. on average **0,179 € / net tonne** (for trains at maximum length of 750 m, that charge about 950 net tonnes).

In terms of time, considering that the access tracks between arrival/departure tracks were 750 m train are dissembled (assembled) and terminal are usually about 2-5 km long and trains are shunted at 20-30 km/h over them, a saving between 1 and 2 hours per train might be estimated. This includes also the time for uncoupling the long distance locomotive, separating the 2 (or 3 sections) and coupling the shunting locomotives.

Given the terminal track length presented in the above tables, the savings are likely to affect the following intermodal traffic flows:

1. to/from Milan area or Busto Arsizio
2. to/from Basel
3. to/from the following German areas: Ludwisghafen, Koeln, Duisburg, Mannheim.

7.4.3 Improvement of coordination between network path definition and terminal slot allocation: Reduction of waiting time at the interface main line – terminal

Within the above mentioned TEMA project, it emerged that the implementation of coordinated procedures for the allocation of slots for the use of terminal and tracks and the path for accessing the rail network determine a better efficiency in the arrival and departure operations of intermodal trains in the so-called “last mile” [21] of tracks accessing the terminal. Moreover, the overall capacity of the railway system is improved.

Table 7-15 - Average time saving per train due to the improved coordination between rail path and terminal slot.

Registered waiting times for combined train departure from terminal (*)

Registered waiting times (min)	Time savings (min)	Time savings (h)
120		
45	75	1,25
30	90	1,5

Average time savings (min)	82,5

A number of expected time savings was therefore identified, following the implementation of such coordination. An average value has finally been calculated. This value corresponds to the estimated time saving, obtainable in every terminal deciding to implement the coordination procedures in the allocation of the terminal slot and the railway path.

[21] The last mile is the part of rail track where the train is normally passed handed over from the railway undertaking to the terminal operator (who moves the train under the crane for the loading/unloading of containers). The integration between the path along the line and the terminal becomes a central element in increasing the efficiency of the capacity of both the terminal and of the whole rail system (for example, it is avoid that trains stops outside the terminal, waiting for a loading/unloading slot).

7.5 Cost-Benefit Analysis (Micro-level)

The costs and benefits presented in the previous chapters 7.1-7.2-7.3-7.4 may be converted in monetary values and aggregated in a overall cost-benefit analysis in order to estimate the overall impacts of Option C and Option B. The following chapter summarises the hypothesis applied in order to calculate cost and benefits of each intervention area.

Intervention area	*Impacts*	*Approach for converting the impacts in monetary value and for forecasting the evolution over the time*
Technical harmonisation	Train length – investment cost for prolonging the tracks	Distributed over 7 years (period 2009 – 2015)
	Train length – rail cost reduction	A. The total traffic concerned by the intervention is the traffic Milan, Novara, and Genoa ← → North of the Alps, estimated as the ERIM 2020 international traffic to/from Italy on corridor A i.e 2.013 million tkm / year, + the national traffic in Italy over that corridor (2.821 million tkm / year). It is also taken into account that the international traffic to/from Italy will benefit of the cost reduction for all its journey, not just for the transit trough Italy, that represent on average about 20-25% of the total journey length. B. The Intermodal trains and single wagons trains are the type of traffic interested by the cost reduction. Based on previous PwC analyses of corridor A, the traffic is supposed to be moved at 60% by Intermodal trains, 20% by single wagon trains and the remaining by block trains. C. Since no traffic data by OD or by crossing are available per type of trains, the average cost reduction is taken into account, i.e. – Intermodal trains: - 0,0011 € / ton.km – Single wagon trains: - 0,0034 € / ton.km Such cost reduction are obtained as average of the absolute cost reduction by traffic flow (that are equal to the percentual reduction of Table 7-2 multiplied by the ex – ante cost per ton km. On the basis of the above figures A, B, C, the annual benefits on existing rail traffic in 2020 is calculated. Further benefits on modal shift because of rail price reduction is part of the macro-impacts.
	Reduction of waiting time at borders	The savings in border waiting time calculated in chapter 7.1.2 are multiplied by the number of trains (2005 figures on number of trains crossing each border per day available from previous work in ERIM and TEMA projects are extrapolated to 2020 by using ERIM average annual growth rate for freight , i.e. 3,5% / year)

Intervention area	*Impacts*	*Approach for converting the impacts in monetary value and for forecasting the evolution over the time*
Path allocation and traffic management rules	Additional capacity for freight trains	Chapter 7.2.1 estimate in terms of additional freight train.km and reduction of regional train.km shall be translated respectively in additional tkm and reduction in passenger.km. The related benefits / costs are calculated according to the approach presented in Annex IV – Approach for estimating cost and benefits of the additional capacity.
	Reduction in scheduled & unscheduled waiting time	<u>FREIGHT</u> The estimated reduction in minutes per km will be multiplied by the average number of freight trains per country (ERIM data as supplied by UIC), and the average length of the trip (assumed as equal to the total corridor length in the country for international trains[22], and 50% of the corridor length for national trains). The so-calculated total saving in train.h / year will be converted in ton.h / year by considering an average paylod of 600 net tons per trains. The freight value of time (including driver cost) in € / ton.h will be taken by the EC *Handbook on estimation of external cost in transport sector* (2007), i.e. 1,22 € / ton.h in 2002, and then growing according to the real GDP per head growth (supposed to be 1% p.a.).
		<u>PASSENGER</u> The approach is similar to the one above. It is supposed that 50% of national passenger trains will be impacted by the increase in scheduled / unscheduled waiting time, since long distance trains will maintain an higher priority than freight. The passenger value of time for commuters travelling (impacts concern regional traffic) in € / ton.h will be taken by the EC *Handbook on estimation of external cost in transport sector* (2007), i.e.8,48 € / passenger.h in 2002, and then growing according to the real GDP per head growth (supposed to be 1% p.a.).
	Additional charges for priority freight path	The increase in infrastructure charges per train.km for freight trains benefiting from higher priority will be set equal to a level that implies that the additional charge becomes lower than the expected benefits (measured as value of the reduction of freight waiting times – value of the increase of passenger waiting times) no later than in 2020. Maximum percentage is 65% as explained in chapter 7.3.2. However the cost-benefit calculation has shown that only an increase by **6%** is acceptable in order not to annual the direct benefits in freight travel time obtained by the time reduction (freight value of time and driver wage costs reduction). An higher increase might be considered only by taking into account the rail freight traffic growth because of better journey time.

[22] For Switzerland and Italy, only 50% of the corridor length is considered because two itineraries are included in Corridor A.

Intervention area	*Impacts*	*Approach for converting the impacts in monetary value and for forecasting the evolution over the time*
Terminals	Train length – investment cost for prolonging the transhipment tracks	Distributed over 3 years (period 2013 – 2015)
	Reduction of shunting costs because of longer transhipment tracks	The cost estimated in chapter 7.4.2 shall be extrapolated at 2020 horizon considering the grow of traffic (the number of service to/from each terminal will be supposed to grow according to a specific traffic grow rate as estimated in TEMA for the intermodal traffic to/from each traffic area).
	Reduction of shunting time because of longer transhipment tracks	The time saved per train at each end (i.e. origin terminal or destination terminal) is approximately 30' per operation. The time saving in ton.h at each terminal is estimated as the product of 2020 services (see case above) x % of trains actually taking benefit of the extended transhipment track length (cf. chapter 7.4.2) x the average time saving per train, the latter being equal to the number of avoidable shunting operations in case of 750 m tracks multiplied by 30'. The monetary value is then calculated as the product of the saved ton.h x the value in € / th from the *Handbook on estimation of external cost in transport sector* (2007), deducing the part that relates to driver wages (when the train waits at terminals arrival/departure tracks before entering in the main network, there is no need of the driver onboard).
	Reduction of terminal waiting time because of coordination between network path planning and terminal slot planning	A. The maximum time saving has been estimated at 82,5 minutes (chapter 7.4.3). For short distance services, the savings is supposed to be 50% of the maximum one. B. The % of short distance traffic (<500 km) at each terminal is estimated at 30% of total international traffic. Taking into account A and B, the average time saving due to the coordination is estimated for each terminal, and then multiplied by the traffic in tons / year handled at each terminal in year t, calculated as the TEMA 2006 traffic in LU / year x TEMA annual growth rate between 2006 and t x average payload per LU (12 t, considering the empty flow that are significant on this corridor). The monetary value is then calculated as the product of the saved ton.h x the value in € / ton.hour (1,22 €/t.h year 2002) from the *Handbook on estimation of external cost in transport sector* (2007), deducing the part that relates to driver wages (when the train waits at terminals arrival/departure tracks before entering in the main network, there is no need of the driver onboard).

Following the approach illustrated in the previous table, the total costs and benefits obtained in Option B and C are presented in the following table. The Net Present Value is calculated at 5% discount rate with respect to 2008, for a period of 30 years (2009-2038).

For all evaluation, the corridor traffic has been considered to be stable after 2020, because both lack of reliable growth forecast for years > 2020, and need to avoid check of capacity availability at each time horizon (at corridor level, an unbounded traffic growth is obviously not feasible). **This means that the estimated benefits are in most cases a lower bound of the actual ones**.

Intervention on extended interoperability at border crossings is considered to be applied both in option B and C, but with faster implementation in the latter case (effects starting from 2016, whereas for option B they begin in 2020).

All other interventions are considered to be implement in the options B and C according to the options definition presented in chapter 4.

Table 7-16 - Cost and benefits results for ERTMS Corridor A

Intervention area	Cost / benefit	Option C	Option B
		Net present value (Million Euro)	Net present value (Million Euro)
Technical harmonisation	Investment cost for prolonging the tracks	-€ 136,5	-€ 136,5
	Rail freight cost reduction	€ 168,5	€ 168,5
	Reduction of waiting time at borders	€ 1.161,1	€ 878,3
Path allocation rules and traffic management rules	*Additional capacity for freight trains* *	€ 1.135,8	-
	Reduction in scheduled & unscheduled waiting time (Freight)	€ 266,4	-
	Increase in scheduled & unscheduled waiting time (Passenger traffic)	-€ 125,8	-
	Additional charges for priority freight path	-€ 104,4	-
Terminals	Investment cost for prolonging the transhipment tracks	-€ 30,5	-€ 30,5
	Reduction of shunting costs because of longer transhipment tracks	€ 21,5	€ 21,5
	Reduction of shunting time because of longer transhipment tracks	€ 156,8	€ 156,8
	Reduction of waiting time because of coor-dination between network and terminal planning	€ 519,8	-
Total micro-level Net Present Value		**€ 3.032,8**	**€ 1.058,2**
Total micro-level Internal Rate of Return		**43,9%**	**22,6%**
Total micro-level Benefit / Cost ratio		**8,6**	**7,3**

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(*) The related benefits / costs are calculated according to the approach presented in

Annex IV – Approach for estimating cost and benefits of the additional capacity

Both options present a **positive Net Present Value**, even if the above data does not take into account further benefits at macro-level (modal shift and related change in externalities). Cost-side administrative expenditures, which are considered in the overall evaluation, will instead slightly reduce the total benefits.

Benefits of Option B are lower particularly because of the lack of the following intervention:

- coordination between network path planning and terminals slot planning.

that appears to be particularly positive in terms of monetarised impact.

Besides, extended border interoperability encompassing all operational and administrative aspects starts from 2020 instead of 2016;

Option C's benefits due to path design and traffic management **priority rules** to the advantage of freight are considered to be largely annulled by the likely corresponding increase in infrastructure charges (set at +6% of existing charges). The lower that increase will be, the higher the overall positive impact.

It has to be highlighted that the freight waiting time reduction due to priority rules forecasted following the New Opera case study (7.3.1) is relatively small, on average 0,025-0,030 minutes / km, that means 20-25' for a 800 km journey.

Since the effect of the "additional capacity for freight trains" is only potential (it expresses a potential additional traffic), it is relevant to present also the CBA results for Option C without such impact.

Table 7-17 - CBA results without additional capacity for freightOption C

	Option C Net present value (Million Euro)
Total micro-level Net Present Value	**€ 1.897,1**
Total micro-level Internal Rate of Return	**35,5%**
Total micro-level Benefit / Cost ratio	**5,8**

8 MICRO LEVEL IMPACTS - CORRIDOR E

8.1 Impacts of intervention on technical harmonisation

8.1.1 Harmonized train length

Decrease of rail freight operating costs

The available information for 2020 (UIC, ERIM database) highlights that the remaining critical sections (max train length < 750 m) are the ones presented in the following tables (in order to clarify the positioning of the sections, they have been grouped by railway axis.

Table 8-1 - Section with maximum train length < 750 m (Corridor E)

Country	From	To	ERTMS Corridor	Overall route length [km]	Maximum train length [m]
AU	WIEN	BRE-BER	E	78	700
AU	WIEN	PARNDORF	E	49	700
AU	PARNDORF	HEG-PAN (SG nach Nickelsdorf)	E	18	700
AU	PARNDORF	KITTSEE (SG nach Kittsee)	E	22	700
CZ	USTI NLS	VSETATY	E	71	600
CZ	DECIN V	DECIN PZ	E	3	600
CZ	DECIN PZ	DOL-SCH	E	8	600
CZ	KOLIN	PRAHA LIBEN	E	62	600
CZ	HAVLICKUV BROD	KUTNA HORA hl.n.	E	63	600
CZ	HAVLICKUV BROD	BRNO hl.n.	E	121	600
CZ	BRNO hl.n.	BRECLAV	E	59	700
CZ	USTI NLS	DECIN V	E	25	600
CZ	KOLIN	KUTNA HORA hl.n.	E	11	600
CZ	USTI NAD LABEM hl.n.	PRAHA LIBEN	E	108	600
CZ	USTI NAD LABEM hl.n.	DECIN HLN	E	23	600
CZ	DECIN HLN	DECIN PZ	E	4	600
CZ	KOLIN	CHOCEN	E	77	600
CZ	CHOCEN	USTI nad ORLICI	E	15	600
CZ	SVITAVY	BRNO hl.n.	E	74	650
CZ	CESKA TREBOVA	USTI nad ORLICI	E	10	600
CZ	SVITAVY	CESKA TREBOVA	E	17	590
SK	PETRZALKA	RUS - RAJKA	E	15	650
SK	NOVE ZAMKY	KOMARNO	E	29	620
SK	KOMARNO	KOM-KOM	E	6	620

On the basis of the above table, it is possible to identify the rail traffic flow that will be limited in terms of train length

- International traffic of the corridor crossing CZ (Dresden Area / CZ <-> Austria / Hungary)
- International traffic of the corridor crossing the Austrian - Hungarian border (Austria <-> Hungary)
- International traffic of the corridor with O or D Slovakia

Following the same approach as for corridor A, the change in rail operating costs per tkm on the above mentioned flows has been estimated. The following results have been obtained

Table 8-2 - Cost savings due to harmonized train length

Traffic flow	Max train length (m)	Intermodal trains **			Single wagon trains **		
		Expected reduction in train cost per tkm (%)	% of train set at maximum length *	Average reduction in train costs per tkm (%)	Expected reduction in train cost per tkm (%)	% of train set at maximum length *	Average reduction in train costs per tkm (%)
International traffic of the corridor crossing CZ (Dresden Area / CZ <-> Austria / Hungary)	600	16,51%	20%	**3,30%**	12,54%	50%	**6,27%**
International traffic of the corridor crossing the Austrian - Hungarian border (Austria <-> Hungary)	700	4,21%	20%	**0,84%**	0,67%	50%	**0,34%**
International traffic of the corridor with O or D Slovakia	650	10,99%	20%	**2,20%**	6,72%	50%	**3,36%**

* Hypothesis defined in coherence with data supplied by SNCF for the traffic studies on the new Lyon – Turin railway line, on the basis of the observed length of international freight trains to/from Italy

** The third main type of freight services, the full trains, are not considered because they are usually limited by the weight (not by length)

The estimated reduction of rail operating costs is considered to be entirely transferred to the market, so that the same reduction is applicable to rail tariff for the affected flows.

Since the rail tariffs depend also on the type of goods, it is necessary to identify the typical freight service used to move each type of product. The Table 7-3 already shown for corridor A presents the allocation of the main good categories on the three rail service types.

Investment costs for upgrading the lines

The average investment costs for upgrading the line to 750 m maximum length will be based on the length of the sections to be upgraded, and on the average cost per km, as explained for Corridor A (Table 7-4).

Table 8-3 - Estimate of section upgrading costs

COUNTRY CODE	From	To	Route length [km]	Max train length [m]	Siding density (n. sidings / section km)	Additional m of tracks to be built	Additional track cost including land purchase [Mil €]	Signalling relocation costs [Mil €]	TOTAL UP-GRADING COSTS [Mil €]
			A	B	C	D=A*(750-B)*C	D * 5000 / 10^6	A*C * 0,03	
AU	WIEN	BRE-BER	78	700	0,25	975	4,88	0,78	5,66
AU	WIEN	PARNDORF	49	700	0,25	613	3,06	0,49	3,55
AU	PARNDORF	HEG-PAN (SG nach Nickelsdorf)	18	700	0,25	225	1,13	0,18	1,31
AU	PARNDORF	KITTSEE (SG nach Kittsee)	22	700	0,25	275	1,38	0,22	1,60
CZ	USTI NLS	VSETATY	71	600	0,25	2.663	13,31	0,71	14,02
CZ	DECIN V	DECIN PZ	3	600	0,25	113	0,56	0,03	0,59
CZ	DECIN PZ	DOL-SCH	8	600	0,25	300	1,50	0,08	1,58
CZ	KOLIN	PRAHA LIBEN	62	600	0,25	2.325	11,63	0,62	12,25
CZ	HAVLICKUV BROD	KUTNA HORA hl.n.	63	600	0,25	2.363	11,81	0,63	12,44
CZ	HAVLICKUV BROD	BRNO hl.n.	121	600	0,25	4.538	22,69	1,21	23,90
CZ	BRNO hl.n.	BRECLAV	59	700	0,25	738	3,69	0,59	4,28
CZ	USTI NLS	DECIN V	25	600	0,25	938	4,69	0,25	4,94
CZ	KOLIN	KUTNA HORA hl.n.	11	600	0,25	413	2,06	0,11	2,17
CZ	USTI NAD LABEM	PRAHA LIBEN	108	600	0,25	4.050	20,25	1,08	21,33
CZ	USTI NAD LABEM	DECIN HLN	23	600	0,25	863	4,31	0,23	4,54
CZ	DECIN HLN	DECIN PZ	4	600	0,25	150	0,75	0,04	0,79
CZ	KOLIN	CHOCEN	77	600	0,25	2.888	14,44	0,77	15,21
CZ	CHOCEN	USTI nad ORLICI	15	600	0,25	563	2,81	0,15	2,96
CZ	SVITAVY	BRNO hl.n.	74	650	0,25	1.850	9,25	0,74	9,99
CZ	CESKA TREBOVA	USTI nad ORLICI	10	600	0,25	375	1,88	0,10	1,98
CZ	SVITAVY	CESKA TREBOVA	17	590	0,25	680	3,40	0,17	3,57
SK	PETRZALKA	RUS - RAJKA	15	650	0,25	375	1,88	0,15	2,03
SK	NOVE ZAMKY	KOMARNO	29	620	0,25	943	4,71	0,29	5,00
SK	KOMARNO	KOM-KOM	6	620	0,25	195	0,98	0,06	1,04
TOTAL UPGRADING COST							**147,03**	**9,68**	**156,71**

8.1.2 Reduction of waiting times at borders

As illustrated for Corridor A, savings in border waiting time were estimated considering that a large scope interoperability is likely to eliminate all operational stops, apart of the time for changing the locomotive (in case interoperable locomotives will be in service, only driver changes are expected to take).

In the table below, the savings for each cross border section are indicated for conventional freight trains (CF) and intermodal trains (CT). “Current” means maintaining of existing procedures, “future” represents the to-be situation where the interoperability concept will be extended to all technical and operational rules.

Table 8-4 - Current and future waiting time at ERTMS corridor E border stations

Current waiting times

Name	Pax trains	CF trains	CT trains
Bratislava - Petralzka	5	120	60
Breclav	3	54	34
Dolni Zleb / Decin	2	25	121
Hegyeshalom	3	80	80
Sturovo	5	200	170

Future waiting times

Name	Pax trains	CF trains	CT trains
Bratislava - Petralzka	5	30	30
Breclav	3	30	30
Dolni Zleb / Decin	2	25	30
Hegyeshalom	3	30	30
Sturovo	5	30	30

Differential

Name	Pax trains	CF trains	CT trains
Bratislava - Petralzka	0	-90	-30
Breclav	0	-24	-4
Dolni Zleb / Decin	0	0	-91
Hegyeshalom	0	-50	-50
Sturovo	0	-170	-140

8.2 Impacts of intervention on path allocation rules

8.2.1 Additional Capacity For Freight Trains

The information on theoretical capacity and traffic mix (number of trains per type) in 2020 obtained from UIC (ERIM database) is very aggregated, since only average values per each country over the corridor has been supplied.

Table 8-5 - Capacity and traffic information (Corridor E)

Country code	*Railway*	*Overall route length [km]*	*Maximum freight speed [km/h]*	*Theoretical line capacity [trains/day]*	*Number of trains per day and per section in 2020 (average)*			
					national passenger trains	*international passenger trains*	*national freight trains*	*international freight trains*
Austria	OBB	167	120	260	60	40	10	70
Czech R. *	CD	828	90	250	80		60	
Germany	DB	55	120	290	90	20	0	200
Hungary *	MAV	274	110	360	80	30	20	40
Slovakia *	ZSR	297	120	190	20	30	0	20

* Corridor length for these countries encompasses two alternative itineraries

Given the limited level of information available, the same simplified approach of Corridor A was applied to estimate the likely impacts on freight and passenger capacity due to the growth of available paths for freights.

Given the specific corridor E characteristics, the equivalences between freight paths and passenger paths have been calculated (representing the number of passenger paths neutralized by 1 additional freight path).

Table 8-6 - Equivalence between freight and passenger paths

Country	*Railway*	*Average over-the-line speed (freight)*	*Average over-the-line speed (long distance passenger)*	*Average over-the-line speed (regional passenger)*	*Number of long distance passenger paths neutralized by 1 freight path*	*Number of regional passenger paths neutralized by 1 freight path*
Austria	OBB	90	160	80	2	1
Czech R.	CD	68	140	70	2	1
Germany	DB	90	160	80	2	1
Hungary	MAV	83	160	80	2	1
Slovakia	ZSR	90	160	80	2	1

The following results in terms of variation of train numbers are obtained in the two scenarios. The average traffic level on corridor E section does not show (even at the 2020 horizon) situation of saturation. On the contrary, all section appear to still have some margin for additional freight traffic, so increasing the number of freight paths is not likely to reduce automatically the number of passenger paths.

Table 8-7 - Variation of the number of freight paths and passenger paths – scenario freight paths +10%

Country	*Railway*	*Ex-ante traffic distribution (n. trains / day)*			***Variations***			*Ex-post traffic distribution (n. available paths / day)*		
		Freight	*Regional passenger*	*Long distance passenger*	***Additional freight paths***	***Regional passenger paths cancelled***	***Long distance passenger path cancelled***	*Freight*	*Regional passenger*	*Long distance passenger*
Austria	OBB	80	30	70	**8**	-	-	88	30	70
Czech R.	CD	60	40	40	**6**	-	-	66	40	40
Germany	DB	200	45	65	**20**	**20**	-	220	25	65
Hungary	MAV	60	40	70	**6**	-	-	66	40	70
Slovakia	ZSR	20	10	40	**2**	-	-	22	10	40

Table 8-8 - Variation of the number of freight paths and passenger paths – scenario freight paths +30%

Country	*Railway*	*Ex-ante traffic distribution (n. trains / day)*			***Variations***			*Ex-post traffic distribution (n. available paths / day)*		
		Freight	*Regional passenger*	*Long distance passenger*	***Additional freight paths***	***Regional passenger paths cancelled***	***Long distance passenger path cancelled***	*Freight*	*Regional passenger*	*Long distance passenger*
Austria	OBB	80	30	70	**24**	-	-	104	40	70
Czech R.	CD	60	40	40	**18**	-	-	78	35	40
Germany	DB	200	45	65	**60**	**45**	**8**	260	0	57
Hungary	MAV	60	40	70	**18**	-	-	78	50	70
Slovakia	ZSR	20	10	40	**6**	-	-	26	30	40

Assuming the average number of full-service days per year at 250 (freight traffic is concentrated on working days), the following are the likely **total variations of the rail traffic** in terms of train.km / year.

The +30% scenarios does not appear to be feasible because of the strong impact on regional traffic (cancellation of 100% of regional trains in Germany).

Table 8-9 - Total variations of the rail traffic

	Variation (train.km / year)	
	scenario + 10% freight paths	scenario + 30% freight paths
freight trains	**+ 2.260.550**	**+ 6.781.650**
regional passenger trains	**- 273.700**	**- 615.825**
long distance passenger trains	-	**- 109.480**

As explained for Corridor A, the above estimated potential traffic variation shall be checked against the expected market needs as resulting from the macro-approach.

8.3 Impacts of intervention on path allocation and traffic management rules on train priority

8.3.1 Reduction in waiting times of freight trains

The following tables show the average change in freight and passenger trains waiting times calculated for corridor E through the approach described for corridor A and based on the evaluation of New Opera case study.

Table 8-10 - Expected variation in freight trains waiting times

Country	Infrastructure Manager	ERTMS Corridor	Route length [km]	Average % of freight trains	Corresponding variation of waiting times	
					Unscheduled (minutes / km)	Scheduled (minutes / km)
AU	OBB	E	167	44,4%	0,0139	0,0231
CZ	CD	E	828	42,9%	0,0150	0,0250
GM	DB	E	55	64,5%	0,0054	0,0084
HU	MAV	E	274	35,3%	0,0216	0,0366
SK	ZSR	E	297	28,6%	0,0297	0,0514

Table 8-11 - Expected variation in passenger trains waiting times

Country	Infrastructure Manager	ERTMS Corridor	Route length [km]	Average % of freight trains	Corresponding variation of passenger waiting times	
					Unscheduled (minutes / km)	Scheduled (minutes / km)
AU	OBB	E	167	44,4%	-0,0234	-0,0444
CZ	CD	E	828	42,9%	-0,0234	-0,0456
GM	DB	E	55	64,5%	-0,0228	-0,0310
HU	MAV	E	274	35,3%	-0,0237	-0,0523
SK	ZSR	E	297	28,6%	-0,0239	-0,0589

8.3.2 Good and reliable paths for freight trains

Railways undertakers will likely be charged of extra costs in case their freight train will use a faster path. Generally the usage of an infrastructure capacity is charged according the type of capacity used. The use of a network during the off peak time is generally charged with a lower price than the correspondent use in a peak time (see for examples the telephone price during the day).

As for Corridor A, the actual % additional charge shall be set at a level that not offset the time benefit for freight trains thanks to the priority (see chapter 8.5).

8.4 Impact of intervention on terminals

8.4.1 Increase of transhipment tracks' length and additional investment costs for lengthening the tracks

In order to estimate the investments needed to upgrade transshipment tracks in the terminals along the corridor, the methodol ogy presented in chapter 8.4.1 was adopted.

The following table indicates the total metres of tracks to be built in each single terminal, in order to be compliant with the proposed standardised train length of 750 m.

Table 8-12- Tracks to be realized in the terminal of ERTMS corridor A

Country	Terminal Name	N tracks and overall length		Average length	Meters of tracks necessary to accommodate trains 750 m long	
Austria	Wien Nordwest/Inzersdorf	3	400	400	350	1050
		1	180	180	570	570
		1	120	120	630	630
		1	100	100	650	650
		1	65	65	685	685
Czech Republic		8	580	580	170	1360
	Praha Uhrineves	2	650	650	100	200
	Praha Zizkov	4	900	225	525	2100
	Praha Melnik Labe	2	800	400	350	700
	Praha Lovosice	3	750	250	500	1500
Hungary		4	750	750	750 m ready	0
	Budapest Bilk Kombiterminál	1	50	50	700	700
Slovakia	Bratislava Palenisko	1	300	300	450	450
		1	150	150	600	600
	Bratislava Uns	1	290	290	460	460
		1	297	297	453	453
		1	325	325	425	425
Grand Total						**12.533**

In order to make the terminal compliant to the new standard of trains 750 m long, over 13 kilometres of tracks have to be build. **The required investment accounts to 37,6 M Euro**.

8.4.2 Reduction of shunting costs

The reduction in the shunting operations, indicated above, entails a lower cost for railway undertakings. The cost was estimated through an average cost of the shunting service obtained from interviews carried out with terminal managers in the course of the UIC TEMA (Terminal Management) project. Therefore, a flat rate value of the service was adopted[23], corresponding to 43 Euros for a full shunting service to/from the terminal. This value was multiplied by the lower number of services necessary for the loading and unloading of the train as a consequence of the extension of transshipment tracks to 750 meters, thus obtaining the expected savings of railway undertakings.

[23] From the survey performed, it appears that such form of pricing is more common than the one envisaging a cost/km to be paid for the kms of service requested.

Table 8-13 - Savings in shun ting operations due to the increased tracks length

Terminal Name	N tracks and overall length		Average length	Nb of shunting operations necessary to tranship the train	∆ operation for tracks < 750 m	Weekly services	Shunting operations to accomodate a train 750 m long with tracks < 750 m
Wien Nordwest/Inzersdorf	3	400	400	2	1	70	310
	1	180	180	5	4		
	1	120	120	7	6		
	1	100	100	8	7		
	1	65	65	12	11		
Praha Uhrineves	8	580	580	2	1	83	83
	2	650	650	2	1		
Praha Zizkov	4	900	225	4	3	18	54
Praha Melnik Labe	2	800	400	2	1	32	32
Praha Lovosice	3	750	250	4	3	14	42
Budapest Bilk Kombiterminál	4	750	750	1	0	62	62
	1	50	50	16	15		
Bratislava Palenisko	1	300	300	3	2	6	21
	1	150	150	6	5		
Bratislava Uns	1	290	290	3	2	n.a.	n.a.
	1	297	297	3	2		
	1	325	325	3	2		
							604

As indicated in the two previous tables, more than 600 shunting operations might be saved, weekly, in the case each track in the terminals is standardized to the reference length of 750m. **These extra shunting procedures will result in a yearly reduction of the shunting cost of nearly € 1,4 M Euro** (in coherence with the hypothesis taken in paragraph 7.1.1 only about 20% of intermodal trains are likely to be set at maximum length, but more than 20% of the trains will benefit of the increase terminal track length, since in some terminal such length is even below 200 m).

The average saving per intermodal train having origin or destination in the terminal with track <750 m is (on average) between 1 and 3 shunting operations at each end (depending on the track length at the initial / final terminal), so that up to 6 operations in case both origin and destination terminal do not have 750 m tracks in the baseline situation. In terms of cost, this represent a maximum saving of about 255 € / train, i.e. on average 0,260 € / net tonne (for trains at maximum length of 750 m, that charge about 950 net tonnes). In terms of time, considering that the access tracks between arrival/departure tracks were 750 m train are dissembled (assembled) and terminal are usually about 2-5 km long and trains are shunted at 20-30 km/h over them, a saving between 1 and 3 hours per train might be estimated including also the time for uncoupling the long distance locomotive, separating the 2 (or 3/4 sections) and coupling the shunting locomotives.

Given the terminal track length presented in the above tables, the savings are likely to affect the following traffic flows:

- Intermodal flows to/from Wien
- Intermodal flows to/from Praha Zizkov
- Intermodal flows to/from Budapest.
- Intermodal flows to/from Bratislava

8.4.3 Improvement of coordination between network path definition and terminal slot allocation: Reduction of waiting time at the interface main line – terminal

As illustrated for Corridor A (cf. chapter 7.4.3), the implementation of coordinated procedures for the allocation of both terminal slots and for rail network paths is likely to produce time savings equal to 82,5 minutes per each combined transport train.

8.5 Cost-Benefit Analysis (Micro-level)

The costs and benefits presented in the previous chapters 8.18.2-8.3-8.4 may be converted in monetary values and aggregated in a overall cost-benefit analysis in order to estimate the overall impacts of Option C and Option B.

The following chapter summarises the hypothesis applied in order to calculate cost and benefits of each intervention area.

Intervention area	*Impacts*	*Approach for converting the impacts in monetary value and for forecasting the evolution over the time*
Technical harmonisation	Train length – investment cost for prolonging the tracks	Distributed in 7 years (period 2009 – 2015)
	Train length – rail cost reduction	A. The traffics concerned by the intervention are the following - International traffic of the corridor crossing CZ (Dresden Area / CZ <-> Austria / Hungary) - International traffic of the corridor crossing the Austrian - Hungarian border (Austria <-> Hungary) - International traffic of the corridor with O or D Slovakia These flows correspond roughly to Corridor E international traffics in Czech Republic, Hungary and Slovakia as estimated by ERIM. It is taken into account that such international traffic will benefit of the cost reduction for all its journey, not just for the transit trough the three mentioned points. However. It is considered that most of the journey over the corridor is already considered by including the mentioned flows, so that there are increase by 30% only to take into account the impacts on the cost for the overall journey. Since national traffic on the corridor are relatively low, and it is not easy to assess if it will take benefit of the maximum train length increase (the limit will remain on other section not on the corridor), no effect on national traffic is foreseen. B. The Intermodal trains and single wagons trains are the type of traffic interested by the cost reduction. Based on expert assessment, the traffic is supposed to be moved at 40% by Intermodal trains, 40% by single wagon trains and the remaining by block trains. C. Since no traffic data by OD or by crossing are available per type of trains, the average cost reduction is taken into account, i.e. - Intermodal trains: - 0,00052 € / ton.km - Single wagon trains: - 0,00114 € / ton.km On the basis of the above figures A, B, C, the annual benefits on existing rail traffic in 2020 is calculated. Further benefits on modal shift because of rail price reduction is part of the macro-impacts.
	Reduction of waiting time at borders	Same approach as Corridor A

Intervention area	*Impacts*	*Approach for converting the impacts in monetary value and for forecasting the evolution over the time*
Path allocation and traffic management rules	Additional capacity for freight trains	Chapter 8.2.1 estimate in terms of additional freight train.km and reduction of regional train.km shall be translated respectively in additional tkm and reduction in passenger.km. The related benefits / costs are calculated according to the approach presented in Annex IV – Approach for estimating cost and benefits of the additional capacity.
	Reduction in scheduled & unscheduled waiting time	FREIGHT Same approach as Corridor A[24].
		PASSENGER Same as corridor A[25].
	Additional charges for priority freight path	Same approach as for Corridor A
Terminals	Train length – investment cost for prolonging the transhipment tracks	Distributed in 3 years (period 2013 – 2015)
	Reduction of shunting costs because of longer transhipment tracks	Same approach as for Corridor A
	Reduction of shunting time because of longer transhipment tracks	Same approach as for Corridor A
	Reduction of terminal waiting time because of coordination between network path planning and terminal slot planning	Same approach as for Corridor A

Following the approach illustrated in the previous table, the total costs and benefits obtained in Option B and C are presented in the following table. The Net Present Value is calculated at 5% discount rate with respect to 2008, for a period of 30 years (2009-2038).

As for Corridor A, the following assumptions have been taken into account:

- For all evaluation, the corridor traffic has been considered to be stable after 2020, so that the estimated benefits are in most cases a lower bound of the actual ones;
- Intervention on extended interoperability at border crossings is considered to be applied both in option B and C, but with faster implementation in the latter case (effects starting from 2016, whereas for option B they begin in 2020).

[24] For Czech Republic, Hungary and Slovakia, only 50% of the corridor length is considered when assessing the average length of the trip because two itineraries are included in Corridor E.

[25] See footnote 24.

Table 8-14 - Cost and benefit results for ERTMS corridor E

Intervention area	Cost / benefit	Option C	Option B
		Net present value (Million Euro)	Net present value (Million Euro)
Technical harmonisation	Investment cost for prolonging the tracks	-€ 129,5	-€ 129,5
	Rail freight cost reduction	€ 46,3	€ 46,3
	Reduction of waiting time at borders	€ 390,4	€ 295,3
Path allocation rules and traffic management rules	Additional capacity for freight trains	-€ 13,3	-
	Reduction in scheduled & unscheduled waiting time (Freight)	€ 77,6	-
	Increase in scheduled & unscheduled waiting time (Passenger traffic)	-€ 24,9	-
	Additional charges for priority freight path	-€ 23,2	
Terminals	Investment cost for prolonging the transhipment tracks	-€ 28,1	-€ 28,1
	Reduction of shunting costs because of longer transhipment tracks	€ 28,2	€ 28,2
	Reduction of shunting time because of longer transhipment tracks	€ 62,1	€ 62,1
	Reduction of waiting time because of coor-dination between network and terminal planning	€ 407,6	-
Total micro-level Net Present Value		**€ 793,2**	**€ 274,2**
Total micro-level Internal Rate of Return		**24,5%**	**13,0%**
Total micro-level Benefit / Cost ratio		**4,6**	**2,7**

Both options present a **positive Net Present Value**, which is likely to be increased considering also the benefits at macro-level (modal shift and related change in externalities), even if on the cost-side administrative expenditures shall also be considered in the overall evaluation.

Benefits of Option B are lower particularly because of the lack of the intervention on coordination between network path planning and terminals slot planning, that is particularly positive in terms of monetarised impact. Besides, extended border interoperability encompassing all operational and administrative aspects starts from 2020 instead of 2016.

Option C's benefits due to path design and traffic management **priority rules** to the advantage of freight are considered to be largely annulled by the likely corresponding increase in infrastructure charges (set at +6% of existing charges). The lower that increase will be, the higher the overall positive impact.

It has to be highlighted that the freight waiting time reduction due to priority rules forecasted following the New Opera case study (7.3.1) is relatively small, on average 0,040-0,050 minutes / km, that means 30-40' for a 800 km journey.

Since the effect of the "additional capacity for freight trains" is only potential (it expresses a potential additional traffic), it is relevant to present also the CBA results for Option C without such impact.

Table 8-15 - CBA results without additional capacity for freight

	Option C Net present value (Million Euro)
Total micro-level Net Present Value	**€ 806,6**
Total micro-level Internal Rate of Return	**24,7%**
Total micro-level Benefit / Cost ratio	**4,9**

9 MICRO LEVEL IMPACTS - EXTRAPOLATION TO THE WHOLE NETWORK

9.1 Proposed approach

The following table synthesizes the approach applied to extend to the whole network the results obtained within the impact assessment for the two case study corridors A and E.

Intervention area		Affected variables	Extrapolation approach
Technical harmonisation	Train length	Investment costs	% of corridor length with section < 750 m x corridor length x (crossing points density, i.e. n. crossing tracks per km) x [(**additional track length**) x (track cost per m) + signalling relocation cost per each point)
		Rail cost reduction	See table of results
	Waiting time at borders	Waiting time reduction	Current WT = actual data (where available) Future WT= same approach as corridor A/E (5' if interoperable locos are likely to be used for all traffics, 30' in the other corridors)
Path allocation rules	Additional capacity for freight trains	Additional freight traffic	Freight traffic in the baseline scenario +10%
		Impact on regional pass traffic	All remaining corridors (B,C,D and F) have several sections used at 85% or more (ERIM), Map 2) --> likely reduction of regional traffic by 20% as observed for corridor A
Path allocation rules & Traffic management rules	Reduction in waiting time for freight trains	Reduction in scheduled and unscheduled waiting time	Based on the estimated exponential functions, on the basis of the average % of freight traffic in the corridor
Terminals	Transhipment track length	Investment costs	Same approach as A/E, based on actual data on terminals of each corridor
		Reduction of shunting costs	Same approach as A/E, based on actual data on terminals of each corridor
		Reduction of shunting time	0,5 h per saved shunting
	Coordination network - terminal	Reduction of waiting time	As for corridor A/E

In the following paragraphs are reported, for each affected variable, the results obtained by the extrapolation exercise through the above described approaches.

For other ERTMS corridors (B, C, D and F), in most cases the approach is identical or very similar of the ones applied for corridors A and E, so with the same degree of accuracy. For the rest of the network, it was necessary to extrapolate the impacts using simplified approaches, since the data availability is much poorer than for the ERTMS corridors.

9.2 Impacts of intervention on technical harmonisation

9.2.1 Harmonized train length

Decrease of rail freight operating costs

The following table presents the expected reduction of rail freight costs resulting from the harmonisation of train length at 750 m. Such reductions are estimated starting from the results of the detailed analyses carried out for corridors A and E, taking into account the specific characteristics of each corridor in terms of train length limits.

Table 9-1 - Expected reduction on rail freight costs

Corridor	Expected reduction on rail freight costs (€ / trkm)			
	Intermodal	Single wagon	Hypothesis	Affected traffics
CORRIDOR B	-0,00071	-0,00211	As corridor A, baseline length 600 m	Traffic between South-Central Italy (up to Bologna) and North
CORRIDOR C	-	-	All sections upgraded at >=750 m in the baseline	-
CORRIDOR D	-0,00151	-0,00461	As corridor A, baseline length 500 m	To/from Spain To/from Slovenia
CORRIDOR F	-0,00085	-0,00227	As corridor E, baseline length 600 m	All international traffics to/from/through Poland
Rest of Europe (ERIM network)	-0,00182	-0,00493	Baseline length 500 m	All international traffics to/from East European countries through rail axes other than corridors D, E,F
	-0,00151	-0,00461	As corridor A, baseline length 500 m	All other traffics to/from Spain and Portugal
	-	-	All sections upgraded at >=750 m in the baseline	All remaining flows

Corridor A & E impacts are included in the respective specific paper.

On the basis of the above assumptions, the overall effects in terms of rail cost savings per year have been estimated. The hypotheses in terms of “rail traffic split” are based on expert assessment of the rail freight traffic characteristics on each corridor.

The results are presented in the table below.

Table 9-2 - Annual rail cost savings

	Impacted traffics	Total Impacted Traffic 2020 (1000 tkm)	Rail traffic split assumption		Overall effect (€ / year in 2020)
			% Intermodal	% Single Wagon	
CORRIDOR A	Traffic from Novara / Genoa / Milan and the north and viceversa	12.886	60%	20%	17.582.504
CORRIDOR B	Traffic between South-Central Italy (up to Bologna) and North	11.955	60%	20%	10.107.885
CORRIDOR C	-	0	60%	20%	-
CORRIDOR D	To/from Spain To/from Slovenia	11.393	50%	20%	19.111.784
CORRIDOR E	International traffic crossing CZ and/or crossing the Austrian - Hungarian border and/or with O or D Slovakia	8.732	40%	30%	4.829.447
CORRIDOR F	All international traffic to/from/through Poland	16.398	40%	30%	16.771.124
Rest of Europe	All international traffics to/from East European countries through rail axes other than corridors D, E,F	61.132	40%	40%	173.156.400
	All other traffics to/from Spain	10.860	60%	0%	9.836.482
	All remaining flows	0	-	-	-
Total		**136.356**			**251.395.626**

Investment costs for upgrading the lines

The estimate of the km of line section requiring upgrading is based on the elements available in the ERIM report. The unit upgrading costs are the same considered for corridors A and E.

Table 9-3 - Investments costs for rail upgradings

Corridor	Length of the section with train length limit < 750 m	track cost (€)	signalling cost (€)	total investment cost (€)
CORRIDOR A	764	157.324.105	7.816.835	165.140.940
CORRIDOR B	333	62.506.010	2.500.240	65.006.250
CORRIDOR C	-	-	-	-
CORRIDOR D	375	117.187.500	2.812.500	120.000.000
CORRIDOR E	968	147.025.000	9.680.000	156.705.000
CORRIDOR F	655	102.987.087	4.119.483	107.106.570
Rest of Europe (ERIM network)	18.630	2.794.486.995	111.779.480	2.906.266.475
Total	**21.726**	**3.401.402.544**	**139.503.972**	**3.540.906.516**

The level of investment needed on the rest of the main European network (ERIM network) appears to be quite high (about 2,9 bn €) if compared to the expected benefits (57 mn € / year), whereas on the 6 ERTMS corridors the upgrading cost are about 0,6 bn € with annual benefit of 68 mn €. This is due to two factors: high percentage of section with train limit < 750 m in the "Rest of Europe" network, and lower density of freight traffic on it with respect to ERTMS corridors.

9.2.2 Reduction of waiting times at borders

Following the same approach already applied for corridors A & E, the expected reduction on border waiting times were estimated for ERTMS corridor, as presented in Table 9-4.

Table 9-4 - Waiting times of selected border stations along ERTMS corridors and on the rest of the network

(CF: Conventional Freight – CT: Combined Transport)

Name	Country1	Country 2	ERTMS corridor	Savings		
				Pax	CF trains	CT trains
Chiasso	Switzerland	Italy	ERTMS A	0	-120	-55
Domodossola Domo II	Italy	Switzerland	ERTMS A	0	-140	-120
Emmerich	Germany	Netherlands	ERTMS A	0	0	-55
Basel CH/D	Switzerland	Germany	ERTMS A	0	-55	-40
Brennero	Italy	Austria	ERTMS B	-7	-85	-60
Kufstein	Austria	Germany	ERTMS B	0	-20	-20
Padborg/Flensburg	Germany	Denmark	ERTMS B	0	0	0

Name	Country1	Country 2	ERTMS corridor	Savings		
				Pax	CF trains	CT trains
Copenhaghen/Lernacken	Denmark	Sweden	ERTMS B	0	0	0
Thionville	France	Luxembourg	ERTMS C	0	-25	-25
Athus	Belgium	Luxembourg	ERTMS C	0	0	0
Basel CH/F	Switzerland	France	ERTMS C	0	-55	-40
Modane	France	Italy	ERTMS D	0	-205	-25
Villa Opicina	Italy	Slovenia	ERTMS D	-11	-150	-150
Hodos / Jesenice	Slovenia	Hungary	ERTMS D	-10	-60	-30
Cerbère / Portbou	France	Spain	ERTMS D	0	0	0
Sturovo	Slovakia	Hungary	ERTMS E	-5	-170	-140
Hegyeshalom	Hungary	Austria	ERTMS E	0	-50	-50
Breclav	Czech Rep.	Austria	ERTMS E	0	-24	-4
Dolní Žleb / Decin	Czech Rep.	Germany	ERTMS E	0	0	-91
Bratislava-Petržalka	Slovakia	Austria	ERTMS E	-5	-90	-30
Frankfurt (Oder)	Germany	Poland	ERTMS F	0	-150	-150
Aachen	Germany	Belgium	ERTMS F	0	-30	-30
Horka	Poland	Germany	ERTMS F	-25	-30	-30

On the basis of the above data, the time savings for ERTMS corridor B-C-D-F have been estimated following the same approach already adopted for corridor A and E.

In case the intervention on technical harmonisation at border crossing will concern the entire main European network (ERIM network), the savings on waiting time have been extrapolated as the product of the total international traffic by the ratio between the overall border waiting time saving on ERTMS corridors and the international traffic over the ERTMS corridors.

This approach is not likely to exaggerate the expected impacts, since border crossings outside the ERTMS corridors are likely to be less advanced, in terms of interoperability, than the ones on ERTMS corridors.

The following table summarizes the results at 2020 horizon.

Table 9-5 – 2020 overall saving for each corridor and the whole network (per year)

SAVINGS 2020	Passenger	Freight
CORRIDOR A	-	- 128.896
CORRIDOR B	- 2.172	- 67.042
CORRIDOR C	-	- 3.021
CORRIDOR D	- 535	- 100.458
CORRIDOR E	-	- 44.208
CORRIDOR F	- 1.673	- 40.125
TOTAL train.h	**- 4.380**	**- 383.749**
average load (pass. / train or net t / train)	500	600
TOTAL SAVING (passenger.h/y or ton.h/y) **on ERTMS corridors**	**- 2.190.000**	**- 230.249.550**
TOTAL SAVING (passenger.h/y or ton.h/y h) - **whole main European network**	**- 5.481.270**	**- 544.000.833**

9.3 Impacts of intervention on path allocation rules

9.3.1 Additional Capacity For Freight Trains

The table below summarises the likely impacts in terms of traffic in case of increase in the number of freight path by 10%.

The data are obtained as follows:

- Freight traffic impact: +10% of 2020 forecasted traffic in tkm;
- Passenger traffic effect: corridors B, C, D, F have several sections used at 85% or more (according to ERIM network utilisation maps), so the likely reduction of regional traffic is about 20% as observed for corridor A.

Table 9-6 – Additional capacity for freight trains

	Reduction of passenger traffic (million pkm / year)	Increase in freight traffic (million tkm / year)
CORRIDOR A*	-743,9	5.801,6
CORRIDOR B	-2.059,7	2.953,4
CORRIDOR C	-852,8	2.165,1
CORRIDOR D	-2.424,2	2.217,1
CORRIDOR E *	-136,9	1.356,3
CORRIDOR F	-697,1	3.255,7
Rest of Europe (ERIM network) **	-3.956,5	23.258,8
Total	**-10.871,1**	**41.008,0**

* This data correspond to the likely increase in trainkm presented in the paper on corridors A and E, converted in passenger.km and freight.km respectively by using the following load value: 120 passenger / regional train and 600 net tons / train.

** Most sections outside ERTMS corridors are not highly saturated in 2020 (according to ERIM analysis), so in most cases the additional freight traffic is likely to be accommodated without reducing regional passengers. Accordingly, only a 5% abatement is considered (instead of 20% on corridors B-C-D-F).

9.4 Impacts of intervention on path allocation and traffic management rules on train priority

9.4.1 Reduction in waiting times of freight trains

The approach applied for estimating the impact of increased freight priority on scheduled and unscheduled waiting time is the same explained for corridors A and E following the analysis of the New Opera case study. The resulting expected variations are presented hereafter.

Table 9-7 - Expected variation in freight trains waiting times

Country	Infrastructure Manager	ERTMS Corridor	Route length [km]	Average % of freight trains	Corresponding reduction of waiting time		Total reduction in waiting times (scheduled + unscheduled)
					Unscheduled (minutes / km)	Scheduled (minutes / km)	
NL	ProRail	A	103	100%	0,0010	0,0014	0,0024
CH	SBB/BLS	A	768	51%	0,0102	0,0166	0,0268
GM	DB	A	1080	53%	0,0093	0,0150	0,0243
IT	RFI	A	722	47%	0,0124	0,0203	0,0326
AU	OBB	B	110	80%	0,0026	0,0038	0,0064
DK	DSB	B	350	44%	0,0142	0,0235	0,0377
DE	DB	B	1205	71%	0,0039	0,0060	0,0099
IT	RFI	B	893	31%	0,0260	0,0446	0,0705
SW	BV	B	909	36%	0,0208	0,0352	0,0560
BE	SNCB	C	532	60%	0,0065	0,0103	0,0169
FR	RFF	C	1084	70%	0,0040	0,0062	0,0103
LU	CFL	C	59	36%	0,0206	0,0349	0,0555

Country	Infrastructure Manager	ERTMS Corridor	Route length [km]	Average % of freight trains	Corresponding reduction of waiting time		Total reduction in waiting times (scheduled + unscheduled)
					Unscheduled (minutes / km)	Scheduled (minutes / km)	
CH	SBB	C	5	68%	0,0046	0,0072	0,0118
FR	RFF	D	877	62%	0,0062	0,0098	0,0159
IT	RFI	D	644	25%	0,0352	0,0616	0,0968
SL	SZ	D	534	86%	0,0019	0,0028	0,0047
HU	MAV	D	283	44%	0,0144	0,0238	0,0382
ES	RENFE	D	535	23%	0,0381	0,0668	0,1049
AU	OBB	E	167	44,4%	0,0139	0,0231	0,0370
CZ	CD	E	828	42,9%	0,0150	0,0250	0,0400
GM	DB	E	55	64,5%	0,0054	0,0084	0,0138
HU	MAV	E	274	35,3%	0,0216	0,0366	0,0582
SK	ZSR	E	297	28,6%	0,0297	0,0514	0,0810
DE	DB	F	980	82,4%	0,0023	0,0034	0,0057
PL	PKP	F	954	76,1%	0,0031	0,0047	0,0078

The path allocation / traffic management rules giving priority to freight shall be, in principle, limited to the main network used by freight traffic. The 6 ERTMS corridor account for 28% of the network but 42% of the freight traffic is routed via them, so they are the first candidate for the application of the proposed priority rules.

As a very rough estimate, being 52,6% the share of freight traffic on the Rest of the ERIM rail network, in case priority rules are extended everywhere, the following average effects on waiting times might be expected.

	Average % of freight trains	Reduction of waiting time		Total reduction in waiting times (scheduled + unscheduled
		Unscheduled - freight (minutes / km)	Scheduled - freight (minutes / km)	
Rest of Europe (ERIM network)	55,1%	0,0084	0,0135	0,0219

However, such a generalized application of priority rules for freight is not likely to be applied, because of the strong impacts on regional passenger traffic on such a large geographic scale. <u>For this reason, at the macro level impact evaluation scale (TRANSTOOLS modelling) waiting times reduction due to priority rules are applied only on the ERTMS corridors</u>.

The resulting overall impact on annual basis is the following.

ERTMS corridor	Waiting Time saving for freight in 2020 (tons.h / year)
A	17.047.032
B	12.082.599
C	4.248.786
D	14.752.968
E	5.274.308
F	3.578.157
Total	**57.683.580**

9.4.2 Increase in waiting times of passenger trains

The estimated impacts of priority to freight on passenger trains are presented in the following table.

Table 9-8 - Expected variation in freight trains waiting times

Country	Infrastructure Manager	ERTMS Corridor	Route length [km]	Average % of freight trains	Corresponding increase of waiting time		Total increase in waiting times (scheduled + unscheduled)
					Un-scheduled (minutes / km)	Scheduled (minutes / km)	
NL	ProRail	A	103	100,0%	- 0,0217	- 0,0164	- 0,0382
CH	SBB/BLS	A	768	51,0%	- 0,0232	- 0,0395	- 0,0627
GM	DB	A	1080	53,0%	- 0,0231	- 0,0381	- 0,0612
IT	RFI	A	722	47,0%	- 0,0233	- 0,0424	- 0,0657
AU	OBB	B	110	80,0%	- 0,0223	- 0,0235	- 0,0458
DK	DSB	B	350	44,1%	- 0,0234	- 0,0447	- 0,0681
DE	DB	B	1205	71,3%	- 0,0226	- 0,0275	- 0,0500
IT	RFI	B	893	31,4%	- 0,0238	- 0,0560	- 0,0798
SW	BV	B	909	36,1%	- 0,0237	- 0,0515	- 0,0752
BE	SNCB	C	532	60,4%	- 0,0229	- 0,0334	- 0,0563
FR	RFF	C	1084	70,4%	- 0,0226	- 0,0279	- 0,0505
LU	CFL	C	59	36,2%	- 0,0236	- 0,0514	- 0,0750
CH	SBB	C	5	67,6%	- 0,0227	- 0,0293	- 0,0520
FR	RFF	D	877	61,5%	- 0,0229	- 0,0327	- 0,0556
IT	RFI	D	644	25,0%	- 0,0240	- 0,0628	- 0,0868
SL	SZ	D	534	86,3%	- 0,0221	- 0,0210	- 0,0431

Country	Infrastructure Manager	ERTMS Corridor	Route length [km]	Average % of freight trains	Corresponding increase of waiting time		Total increase in waiting times (scheduled + unscheduled)
					Un-scheduled (minutes / km)	Scheduled (minutes / km)	
HU	MAV	D	283	43,8%	- 0,0234	- 0,0449	- 0,0683
ES	RENFE	D	535	23,3%	- 0,0241	- 0,0647	- 0,0887
AU	OBB	E	167	44,4%	- 0,0234	- 0,0444	- 0,0678
CZ	CD	E	828	42,9%	- 0,0234	- 0,0456	- 0,0691
GM	DB	E	54,74	64,5%	- 0,0228	- 0,0310	- 0,0538
HU	MAV	E	273,9	35,3%	- 0,0237	- 0,0523	- 0,0759
SK	ZSR	E	297	28,6%	- 0,0239	- 0,0589	- 0,0828
DE	DB	F	980	82,4%	- 0,0223	- 0,0225	- 0,0448
PL	PKP	F	954	76,1%	- 0,0224	- 0,0252	- 0,0476

As a very rough estimate, being 55,1% the share of freight traffic on the Rest of the ERIM rail network, in case priority rules are extended everywhere, the following average effects on waiting times might be expected.

	Average % of freight trains	Corresponding increase of waiting time		Total increase in waiting times (scheduled + unscheduled
		Unscheduled - passenger (minutes / km)	Total increase in waiting times (scheduled + unscheduled	
Rest of Europe (ERIM network)	55,1%	- 0,0231	- 0,0367	- 0,0598

However, as previously stated, such a generalized application of priority rules for freight is not likely to be applied, because of the strong impacts on regional passenger traffic on such a large geographic scale. For this reason, at the macro-impact evaluation scale (i.e. in the TRANSTOOLS modelling) waiting times reduction due to priority rules are applied only on the ERTMS corridors.

The overall impact on annual basis is the following.

ERTMS corridor	Waiting Time Increase for passenger in 2020 (passenger.h / year)
A	1.229.516
B	1.002.764
C	321.295
D	1.412.750
E	237.425
F	422.606
Total	**4.626.356**

9.5 Impact of intervention on terminals

9.5.1 Increase of transhipment tracks' length

Table 9-9 - Investments needed for upgrading of transhipment track to 750 m

	Investments (€)
CORRIDOR A	40.812.000
CORRIDOR B	46.440.000
CORRIDOR C	13.500.000
CORRIDOR D	39.965.000
CORRIDOR E	37.599.000
CORRIDOR F	1.290.000
Rest of Europe	251.527.667
Total	**431.133.667**

The investments for the ERTMS corridors are estimated on the basis of the same approach applied for corridor A & E, whereas for the rest of Europe an approximate approach for investment estimate is applied:

[50% x (total ERTMS corridor terminal track investment cost) / (length of ERTMS corridors in km)] x [length of the rest of the ERIM network]

The approximation is acceptable since both terminal density and size is likely to be lower on the rest of the network, so that the ratio of average investment cost on terminal per km of corridor length is probably lower on ERTMS corridors than on the rest of the network. Besides, some terminals already take into account for ERTMS corridors also serve the rest of the network. On the other hand, average transhipment track length is likely to be lower on terminal outside ERTMS network, so that the additional length per track is probably higher.

9.5.2 Reduction of shunting costs and time

The average savings in shunting cost and time per train (to be taken into account in the macro traffic modelling) are presented in the following table

Table 9-10 - Expected reductions of shunting costs and time

Terminal location	N. operation saved per train (average at each end of the journey)	Time saving per operation (h)	Hours saved per train (average at each end of the journey)	Average cost of shunting operation (€/tr)	Shunting cost saving per train (average at each end of the journey)
CORRIDOR B	1	0,5	0,5	43	43
CORRIDOR C	1	0,5	0,5	43	43
CORRIDOR D	2	0,5	1	43	86
CORRIDOR F	2	0,5	1	43	86
OTHER TERMINALS not involved in any ERTMS corridor	2	0,5	1	43	86

The overall impacts in terms of saved shunting cost and time at 2020 horizon are presented in the following table. For the ERTMS corridors B-C-D-F, the calculation approach is the same already applied for corridors A & E (presented in Table 7-5), whereas for the rest of the network the savings have been estimated according to the ratio [average saving per tkm moved by intermodal transport] resulting from the estimate carried out for ERTMS corridors.

Table 9-11 - Impacts on terminal technical standardization by ERTMS corridor

Location of terminals	Estimated impacts in 2020 of prolonging transhipment tracks to 750 m			
	Shunting operations saved / week	Shunting operations saved / year	Savings in annual costs of shunting operations (€ / year)	Reduction of shunting time (ton.hours per year)[26]
ERTMS Corridor A	1.034	44.445	2.311.130	15.940.610
ERTMS Corridor B	1.382	71.864	3.090.152	7.123.485
ERTMS Corridor C	148	7.696	330.928	1.044.251
ERTMS Corridor D	1.106	57.512	2.473.016	10.660.802
ERTMS Corridor E	1.354	58.240	3.028.505	6.440.833
ERTMS Corridor F	96	4.992	214.656	1.111.344
Total ERTMS corridors	**5.120**	**244.749**	**11.448.387**	**42.321.326**
Rest of Europe (ERIM network)	5.528	287.458	12.360.698	45.693.870
Overall total (ERIM network)	**10.648**	**532.208**	**23.809.086**	**88.015.195**

[26] The result originates from the number of hours saved multiplied by the number of trains and the respective average tonnage.

9.5.3 Improvement of coordination between network path definition and terminal slot allocation: Reduction of waiting time at the interface main line – terminal

As for the other corridors the following time saving is expected as result of coordination between network path and terminal slot planning:

- **Long distance train: 82,5 minutes**
- **Short distance trains: 50% of the above impacts**

The overall impacts in terms of saved waiting time at terminal at 2020 horizon are presented in the following table. For the ERTMS corridors B-C-D-F, the calculation approach is the same already applied for corridors A and E, whereas for the rest of the network the savings have been estimated according to the ratio [average saving per tkm moved by intermodal transport] resulting from the estimate carried out for ERTMS corridors.

Table 9-12 - Benefits coming from terminal slot and long distance train path planning and coordination

Terminal location	Time savings in 2020 (ton.h / year)	Value of time savings in 2020 (€/year)
ERTMS Corridor A	52.525.270	51.518.934
ERTMS Corridor B	63.974.809	62.749.112
ERTMS Corridor C	3.442.551	3.376.595
ERTMS Corridor D	20.471.685	20.079.467
ERTMS Corridor E	45.399.088	44.529.284
ERTMS Corridor F	6.049.640	5.933.735
Total ERTMS corridors	**191.863.043**	**188.187.126**
Rest of Europe (ERIM network)	207.152.417	203.183.570
Overall total (ERIM network)	**399.015.461**	**391.370.696**

9.6 Micro Level Cost Benefit Analysis

The costs and benefits presented in the previous chapters may be converted in monetary values and aggregated in a overall cost-benefit analysis in order to estimate the overall impacts of Option C and Option B with respect to the baseline.

9.6.1 Results without the effect of the additional capacity for freight traffic

The following table summarises the results of the overall CBA for Options B and C with respect to the baseline (Option A); for Option C, the table does not take into account the effect of the "additional capacity for freight traffic". Overall assumptions are the same applied for corridor A & E (e.g. evaluation period 30 years 2009-2038 – basis year 2008; discount rate 5%; track length investments costs on the lines distributed over 7 years 2009-2015; transhipment track length's investments distributed over 3 years 2013-2015; traffic stable after 2020 etc.).

As for corridors A and E, intervention on extended interoperability at border crossings is considered to be applied both in option B and C, but with faster implementation in the latter case (effects starting from 2016, whereas for option B they begin in 2020).

In Option C, the intervention on path allocation rules & traffic management aiming at giving priority to freight against some types of passenger trains has been applied to ERTMS corridors only, since a generalised application is not feasible because it would imply a widespread deterioration of passenger transport speed without the possibility, for instance, to use alternative routes where freight has not the priority.

Table 9-13 – Overall cost benefit analysis results

OPTION C

Intervention area	Cost / benefit	ERTMS CORRIDOR A	ERTMS CORRIDOR E	ERTMS CORRIDORS B-C-D-F	TOTAL ERTMS CORRIDORS	REST OF THE NETWORK	ALL NETWORK
Technical harmonisation	Investment cost for prolonging the tracks	-136,5	-129,5	-258,6	**-524,6**	-2.695,0	**-3.219,6**
	Rail freight cost reduction	168,5	46,3	440,9	**655,7**	1.754,2	**2.409,9**
	Reduction of waiting time at borders	1.161,1	390,4	2.295,4	**3.846,9**	2.685,8	**6.532,7**
Path allocation rules and traffic management rules	Additional capacity for freight trains *	-	-	-	**-**	-	**-**
	Reduction in scheduled & unscheduled waiting time (Freight)	266,4	77,6	510,2	**854,2**	0,0	**854,2**
	Increase in scheduled & unscheduled waiting time (Passenger traffic)	-125,8	-24,9	-323,2	**-473,8**	0,0	**-473,8**
	Additional charges for priority freight path	-104,4	-23,2	-135,4	**-263,0**	0,0	**-263,0**
Terminals	Investment cost for prolonging the transhipment tracks	-30,5	-28,1	-75,6	**-134,1**	-187,8	**-322,0**
	Reduction of shunting costs because of longer transhipment tracks	21,5	28,2	56,9	**106,7**	115,2	**221,9**
	Reduction of shunting time because of longer transhipment tracks	156,8	62,1	286,0	**504,9**	655,4	**1.160,3**
	Reduction of waiting time because of coor-dination between network and terminal planning	519,8	407,6	885,4	**1.812,9**	1.958,0	**3.770,9**
TOTAL(MICRO-LEVEL) NET PRESENT VALUE (mn €)		1.897,1	806,6	3.682,1	**6.385,7**	4.285,8	**10.671,5**
(MICRO-LEVEL) INTERNAL RATE OF RETURN		35,5%	24,7%	35,7%	**33,4%**	13,2%	**18,7%**
(MICRO-LEVEL) BENEFIT / COST RATIO		5,8	4,9	5,6	**5,6**	2,5	**3,5**

OPTION B

Intervention area	Cost / benefit	ERTMS CORRIDOR A	ERTMS CORRIDOR E	ERTMS CORRIDORS B-C-D-F	TOTAL ERTMS CORRIDORS	REST OF THE NETWORK	ALL NETWORK
Technical harmonisation	Investment cost for prolonging the tracks	-136,5	-129,5	-258,6	**-524,6**	-2.695,0	**-3.219,6**
	Rail freight cost reduction	168,5	46,3	440,9	**655,7**	1.754,2	**2.409,9**
	Reduction of waiting time at borders	878,3	295,3	1.736,3	**2.909,8**	2.031,6	**4.941,4**
Path allocation rules and traffic management rules	Additional capacity for freight trains *	-	-	-	**-**	-	**-**
	Reduction in scheduled & unscheduled waiting time (Freight)	-	-	-	**-**	-	**-**
	Increase in scheduled & unscheduled waiting time (Passenger traffic)	-	-	-	**-**	-	**-**
	Additional charges for priority freight path	-	-	-	**-**	-	**-**
Terminals	Investment cost for prolonging the transhipment tracks	-30,5	-28,1	-75,6	**-134,1**	-187,8	**-322,0**
	Reduction of shunting costs because of longer transhipment tracks	21,5	28,2	56,9	**106,7**	115,2	**221,9**
	Reduction of shunting time because of longer transhipment tracks	156,8	62,1	286,0	**504,9**	655,4	**1.160,3**
	Reduction of waiting time because of coor-dination between network and terminal planning	-	-	-	**-**	-	**-**
TOTAL(MICRO-LEVEL) NET PRESENT VALUE (mn €)		1.058,2	274,3	2.186,0	**3.518,4**	1.673,5	**5.191,9**
(MICRO-LEVEL) INTERNAL RATE OF RETURN		22,6%	13,0%	23,3%	**21,3%**	8,5%	**12,2%**
(MICRO-LEVEL) BENEFIT / COST RATIO		7,3	2,7	7,5	**6,3**	1,6	**2,5**

* The related benefits / costs are not taken into account; see next page.

The above results confirm the ones obtained for corridors A and E:

1. Both options present a **positive Net Present Value** in case of application to ERTMS corridors only and to the whole main European rail network (ERIM network), even

without considering the further benefits at macro-level (modal shift and related change in externalities)

2. **Benefits of Option B** are lower particularly because of the lack of the intervention on coordination between network path planning and terminals slot planning, that is particularly positive in terms of monetarised impact.
3. **Option C**'s benefits due to path design and traffic management **priority rules** to the advantage of freight are considered to be to a large extent cut down because of the likely corresponding increase in infrastructure charges (set on corridors B-C-D-F at +0,10 €/trainkm). The lower that increase will be, the higher the overall positive impact.

Micro-level CBA indexes (NPV, IRR, B/C ratio) are higher in case of application of the Policy Option B & C to **ERTMS corridors only**, because the intervention of harmonising train length limit does not appear to be effective at the overall ERIM network level (NPV of the related investments offset the expected benefits in terms of cost reduction).

9.6.2 Results with the effect of the additional capacity for freight traffic

Since the effect of the "additional capacity for freight trains" is only potential (it expresses a potential additional freight traffic and the corresponding negative shift for passenger transport), it is advisable to present the CBA results for Option C with and without such impact, as in the following table[27].

[27] The results are available for "all main rail network" only, since the approach applied combines the micro and the macro level effect (see *Annex.IV – Approach for estimating cost and benefits of the additional capacity*), so that it is not possible to present the results as the addition of effects on corridors A, E, other ERTMS corridors and rest of the network as for the other micro impacts.

Table 9-14 – Overall CBA results with the effect of the additional freight capacity

Intervention area	Cost / benefit (*for the whole network*)	NPV (millions €)
Technical harmonisation	Investment cost for prolonging the tracks	-3.219,6
	Rail freight cost reduction	2.409,9
	Reduction of waiting time at borders	6.532,7
Path allocation rules and traffic management rules	Additional capacity for freight trains	1.209,3
	Reduction in scheduled & unscheduled waiting time (Freight)	854,2
	Increase in scheduled & unscheduled waiting time (Passenger traffic)	-473,8
	Additional charges for priority freight path	-263,0
Terminals	Investment cost for prolonging the transhipment tracks	-322,0
	Reduction of shunting costs because of longer transhipment tracks	221,9
	Reduction of shunting time because of longer transhipment tracks	1.160,3
	Reduction of waiting time because of coor-dination between network and terminal planning	3.770,9
TOTAL NET PRESENT VALUE		**11.880,8**
INTERNAL RATE OF RETURN		**19,7%**
BENEFIT / COST RATIO		**3,8**

The NPV might growth by a maximum of 1,2 bn € thanks to the benefits of the additional capacity; correspondingly the IRR might increases from 18,7% to 19,7% if all the potential additional traffic is actually shifted to rail from road.

10 ASSESSMENT OF ADMINISTRATIVE COSTS

Administrative costs are defined as the costs incurred by enterprises, the voluntary sector, public authorities and citizens in meeting legal obligations to provide information on their action or production, either to public authorities or to private parties. Recurring and one-off administrative costs have to be taken into account.

For each policy option, emerging administrative costs in terms of additional staff costs for implementing the proposed policy options, as well as investments needs, were calculated

10.1 One-stop-shop

The administrative costs for setting-up a dedicated One-Stop-Shop covering the whole process of international freight path allocation[28] over the corridor are supposed to be the following:

A. permanent staff wages, in charge of defining and allocating the international paths over the corridor in close cooperation with national IM;
B. travel and daily allowance for national IM representatives that will take part to the OSS management meetings;
C. office expenditures for the OSS, in particular the location and equipment of the OSS head office;
D. design and maintenance of web-based application for online research and application of international paths.

A. Permanent staff wages

The structure of OSS staff will depend on the specific tasks allocated to it. The effort required for some of the tasks (in particular those relating to the definition of the coordinated international timetable and the sale of the path) is likely to depend on the international traffic level on the corridors.

It is then assumed that a OSS will require the following type of professional figures:
- OSS director
- Joint corridor Manager
- Timetabling Manager
- Sales staff
- Secretary

The table below represents a hypothesis of the OSS staff size and costs, based on PwC knowledge and comparison with existing experiences of OSS (considering that the foreseen OSS will actually allocate 100% of international capacity, so they would require more effort than the existing ones involved in general only in the allocation of a part of the capacity available for international traffic).

[28] This body might be also part of RNE as an operative business unit.

Table 10-1 - OSS's permanent staff cost estimation

Cost element	Level	Annual salary per FTE[29]	Corridor international traffic / year					
			0 – 20 million trains.km		20 – 30 million trains.km		> 30 million trains.km	
			FTEs required	Total salary	FTEs required	Total	FTEs required	Total
OSS staff cost	Director	€ 120.000	0,5	€ 60.000	1	€ 120.000	1	€ 120.000
	Joint Corridor Manager	€ 60.000	1	€ 60.000	1	€ 60.000	1	€ 60.000
	Timetabling Manager	€ 60.000	1	€ 60.000	1	€ 60.000	2	€ 120.000
	Sales staff	€ 50.000	1	€ 50.000	2	€ 100.000	3	€ 150.000
	Secretary	€ 30.000	1	€ 30.000	2	€ 60.000	3	€ 90.000
	TOTAL		**4,5**	**€ 260.000**	**7**	**€ 400.000**	**10**	**€ 540.000**

On the basis of the above hypothesis, the 2020 expected administrative costs for OSS wages can be estimated.

Table 10-2 - OSS's permanent staff cost by each corridor estimation

ERTMS Corridor	ERIM Traffic 2020		Estimated traffic in trainkm 2020			Corresponding OSS staff costs (Euro / year)
	International freight traffic	International passengers traffic	International freight traffic*	International passengers traffic**	Total (trainkm millions)	
	(t.km millions)	(p.km millions)	(trainkm millions)	(trainkm millions)		
A	29.774	941	50	2	52	540.000
B	16.201	1.967	27	4	31	540.000
C	10.118	857	17	2	19	260.000
D	10.714	1.826	18	4	22	400.000
E	8.949	489	15	1	16	260.000
F	18.512	556	31	1	32	540.000
TOTAL	**94.268**	**6.636**	**157**	**13**	**170**	**2.540.000**

Hypothesis on average payload of international trains

* 600 net tons / train (including empty wagon traffic)

** 500 pax / train

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[29] FTE means Full Time Equivalent. With the expression FTE is indicated the person working for 8 h a day. People working for less than 8h a day are compared to that measure (e.g. a person working 6h is equal to 0,75 FTE 6/8h)

It should be considered, however, that the existing IM coordination body for proposing to the market international paths (RailNetEurope) employs in its Vienna office 14 persons (1 Secretary general, 12 managers responsible for sales, timetabling, etc. and 1 assistant). RNE staff cost might be estimated approximately € 870.000 / year (see table below).

Table 10-3 - OSS's coordination and planning staff cost

Level	Estimated average annual salary	Number of persons	Annual cost
Secretary General	€ 120.000	1	€ 120.000
Managers in charge of sales, timetabling, etc.	€ 60.000	12	€ 720.000
Assistant	€ 30.000	1	€ 30.000
Total	-	14	€ 870.000

The true additional costs for the proposed corridor OSS might be then evaluated at

OSS additional staff costs / year = € 2.540.000 - € 870.000 = **€ 1.670.000**

i.e. about 66% of the total costs previously estimated. Corridor-specific additional OSS staff costs will be then calculated as [total OSS staff costs] x 66%.

Table 10-4 - OSS's coordination and planning staff cost

ERTMS Corridor	Corresponding OSS staff costs (Euro / year)	Abatement because of re-allocation of RNE staff	Additional OSS staff costs (Euro / year)
A	540.000	66%	355.000
B	540.000	66%	355.000
C	260.000	66%	171.000
D	400.000	66%	263.000
E	260.000	66%	171.000
F	540.000	66%	355.000
TOTAL	**2.540.000**	**66%**	**1.670.000**

B. Travel costs and effort of national IM representatives attending OSS management meetings

About 3 people from each IM along the corridor will need to participate to 2 meetings per year for final timetabling coordination and overall OSS performance monitoring.

It is assumed that each delegation is composed by a Director and by two staff's people. So an overall daily wage of € 1200 for each delegation, per meeting. It is also assumed that travel and lodging expensed amount to € 600 per day and per person.

The following table summarises the resulting annual costs for travel costs and effort for national IM representatives attending OSS management meetings

Table 10-5 - Travel costs for delegates attending to the meetings

ERTMS Corridor	Number of IMs involved	People attending each OSS meeting	Number of meetings / year	Total IM represen-tatives effort: mandays / year	Total meeting attendance costs
A	6	18	2	36	36.000
B	5	15	2	30	30.000
C	4	12	2	24	24.000
D	4	12	2	24	24.000
E	5	15	2	30	30.000
F	2	6	2	12	12.000
TOTAL					**156.000**

C. Office expenditures for the OSS

The OSS head offices are supposed to be located by the headquarter of one of the corridor national IM, so no additional location cost is expected. Utilities and other office functioning expenditures (consumables, equipment location, IT assistance) might be estimated at 15.000 euro / year per OSS on average. Staff's PC are supposed to be purchased. One PC per staff is foreseen, so the number will depend on the staff size as previously estimated.

Table 10-6 – Renting costs for headquarter renting and office structure purchase

ERTMS Corridor	Head office annual cost				Head office equipment investment costs	
	Location	Office functioning costs	Total		Number of PC to be purchased	PC purchase costs*
	Euro / y	Euro / y	Euro / y			
A	-	15.000	15.000		10	20.000
B	-	15.000	15.000		10	20.000
C	-	15.000	15.000		5	10.000
D	-	15.000	15.000		7	14.000
E	-	15.000	15.000		5	10.000
F	-	15.000	15.000		10	20.000
TOTAL	-	90.000	**90.000**		47	**94.000**

* Unit cost: 2.000 Euro / PC

D. Design and maintenance of web-based application

It will be required the design (or corridor-specific customization) and implementation of a web-based application for the online application of paths by authorised applicants.

The following costs have been estimated.

- Design and implementation: € 20.000
- Maintenance: 20% of design cost = € 4.000

Based on the cost estimate of points A-B-C-D above, the total OSS annual and investments costs are the ones presented in the table below.

Table 10-7 - Total OSS annual and investments costs are the ones presented in the table below

ERTMS Corridor	Annual costs					Investment costs		
	OSS Staff costs	OSS meeting attendance costs	Head office functioning costs	Web site maintenance	Total OSS annual costs	OSS Staff's PCs	Web site design & implementation	Total
A	355.000	36.000	15.000	4.000	**410.000**	20.000	20.000	**40.000**
B	355.000	30.000	15.000	4.000	**404.000**	20.000	20.000	**40.000**
C	171.000	24.000	15.000	4.000	**214.000**	10.000	20.000	**30.000**
D	263.000	24.000	15.000	4.000	**306.000**	14.000	20.000	**34.000**
E	171.000	30.000	15.000	4.000	**220.000**	10.000	20.000	**30.000**
F	355.000	12.000	15.000	4.000	**386.000**	20.000	20.000	**40.000**
TOTAL	1.670.000	156.000	90.000	24.000	**1.940.000**	94.000	120.000	**214.000**

10.2 Transparency

The proposed action in charge of IM and terminal managers to publish a "reference document of the corridor", containing: (1) all information published in the national network statements that concern the corridor; (2) all information concerning the conditions and modalities for access to ancillary services (terminals); (3) a link to a regularly updated publication of temporary constraints/works has a cost in terms of staff dedicated to this activity.

The additional personnel costs are associated to the creation of a team in charge of collecting corridor's data collection (traffic, capacity, line availability, technical features data) and elaborating corridor reference document drafting / publication and maintenance. Data will be provided by national IM, so the work will consist only in data collection and Corridor Statement preparation.

It is assumed that the first year one person is required for this activity per each corridor, 2 in case of corridors longer than 2500 km. This person will be attached to the OSS team, so no additional support or management staff will be needed.

In the following years, the required effort will be significantly reduced because only updatings shall be included in the reference document. The required effort is likely to be reduced at 20% of the one of the first year.

Table 10-8 – Total annual costs for transparency function

ERTMS Corridor	Corridor length 2020	Staff involved in the preparation of Corridor Reference document	Total Corridor Reference Document preparation staff costs (1st year)	Total Corridor Reference Document preparation staff costs (years >1)
	km	Staff	Euro	Euro
A	2.673	2	80.000	16.000
B	3.467	2	80.000	16.000
C	1.680	1	40.000	8.000
D	2.220	1	40.000	8.000
E	1.621	1	40.000	8.000
F	1.934	1	40.000	8.000
TOTAL	**13.470**	**6**	**320.000**	**64.000**

Additionally, it is assumed that 2 people from each national IM take part in meetings twice a year, which amounts (for Corridor A) to 2 people x 4 IMs x 2 times a year = 16 mandays. The cost for this people attending is composed by the daily wage and travel expenses. For the wage it is assumed that a Manager and a member of the staff participates in the meetings. A daily wage of € 800 is assumed for each delegation, i.e. for Corridor A a total cost of € 6.400. It is assumed that travel and lodging expenses amount to € 600 per day per person. Therefore, again for Corridor A, 16 attendances to meeting x € 600 = € 9.600. Yearly, the overall cost of the IMs' delegations amounts to **€ 16.000**.

Finally, it is assumed that 1 person from each Terminal Operator (TO) take part in such meetings twice a year. Along Corridor A, there are actually 4 main terminals operators:

- Germany: Kombiterminal (Ludwigshaven), DUSS
- Switzerland: DUSS
- Italy: CEMAT, HUPAC

However, the terminal management situation is relatively dynamic, and it is not clear what will be the actors in 2020 (some countries have an evolution towards terminals managed by the main network IM, i.e. Italy and Spain, whereas in other countries national terminal operators or even specialized terminal operators managing few or just one terminal are the most common situation). Thus, it is supposed that (on average) 3 terminal operators per country shall be invited to the meetings.

In case of corridor A (4 countries), with the assumed overall daily wage of € 400,00 for each delegation, composed by 1 person only, the total cost will then be € 9.600 yearly (12 TOs x 2 times a year = 24 delegation attendances). In addition, for travel and lodging expenses, 24 attendance to meeting x € 600 = € 14.400. This adds to the previous € 9.600, thus amounting to **€ 24.000**.

The table below summarises the meeting attendance costs for all ERTMS corridors.

Table 10-9 – Total annual functioning costs for transparency function

ERTMS Corridor	Number of IMs involved	People attending each OSS meeting	Number of meetings / year	Total IM representatives effort: mandays / year	Total meeting attendance costs (IM repr.)	Number of Terminal Operators involved	Total meeting attendance costs (TO repr.)	Total meeting attendance costs
A	6	12	2	16	24.000	12	24.000	48.000
B	5	10	2	20	20.000	15	30.000	50.000
C	4	8	2	16	16.000	12	24.000	40.000
D	4	8	2	16	16.000	12	24.000	40.000
E	5	10	2	20	20.000	15	30.000	50.000
F	2	4	2	8	8.000	6	12.000	20.000
TOTAL					104.000		144.000	**248.000**

Based on the above cost estimates, the total Corridor reference document preparation costs are the ones presented in the table below.

Table 10-10 – Total annual costs for transparency document preparation

ERTMS Corridor	Annual costs (year >1)		
	Staff costs	Meeting attendance costs	Total annual costs
A	16.000	48.000	64.000
B	16.000	50.000	66.000

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ERTMS Corridor	Annual costs (year >1)		
	Staff costs	Meeting attendance costs	Total annual costs
C	8.000	40.000	48.000
D	8.000	40.000	48.000
E	8.000	50.000	58.000
F	8.000	20.000	28.000
TOTAL	**64.000**	**248.000**	**312.000**

10.3 Traffic management

Administrative costs related to the Traffic Management intervention area have been estimated according to the approach hereafter described.

An Experts Group has been identified, in charge of such issues for each corridor. It is assumed that a representative for each IM interested by the corridor will take part in this Group, as well as a Group Chairman in charge of coordination.

For Corridor A, 7 persons will be then involved (6 staff members[30] and 1 Chairman coordinating the works), meeting only once, for 1 day, with the aim of defining the "priority rules" to be published in the corridor's network statement. By assuming that an average daily fee amounts of € 800 per expert, the staff cost will amount to € 5.600 / meeting (i.e. per year). Travel expenses must also be added, assumed to be € 600 / person. Therefore, the overall travel cost for 7 people will amount to € 4.200.

Hence, the overall administrative cost, related to the implementation of the "traffic management" measure for Corridor A amount to € 9.800. The cost of such organisation, as already said, is one-off: it is only borne when the meeting takes place. For this reason, structure-related costs, such as rent and support staff have not been taken into account. Possible subsequent meetings (for variations or integrations to the "priority rules", as initially set) will have the same cost of the first one.

Similarly, administrative costs related to other corridors have been estimated. The results are hereafter presented.

Table 10-11 – Total annual costs for traffic management intervention area

ERTMS Corridor	Number of IMs involved	Number of experts involved	N. meetings / year	Total Expert Group costs
A	6	7	1	9.800
B	5	6	1	8.400
C	4	5	1	7.000
D	4	5	1	7.000

[30] There are 6 different infrastructure managers along the corridor: 4 IMs of national networks (RFI, SBB, DB Netz and Pro Rail) and 2 IMs in charge of specific parts of line: BLS (IM of the Lotscheberg line) and KeyRail (IM of the Betuweline).

ERTMS Corridor	Number of IMs involved	Number of experts involved	N. meetings / year	Total Expert Group costs
E	5	6	1	8.400
F	2	3	1	4.200
TOTAL				**44.800**

Meeting costs		
Expert daily cost	800	Euro / meeting
Travel and lodging cost	600	Euro / meeting

The application of the traffic priority rule defined by the Expert Group is not likely to generate additional administrative costs, since it requires only the integration of such criteria in the usual traffic management practice of the national IMs.

10.4 Quality of service

Concerning the estimate of the administrative costs related to the "quality of service" intervention area, a reference structure has first been identified, in charge of similar issues. Its composition in terms of FTEs has been used as benchmark, adapting the number of necessary FTEs according to the traffic registered on the corridor in the year 2020.

From UIRR's experience and from the "operations commissions" of INTERUNINT (The International Co-ordination Committee for Road-Rail CT), the structure of the organisation dedicated to quality control[31] has been studied. The model has been chosen also because Interunint is trying to involve in the process railway companies, as highlighted by the definition of administrative costs provided in the Inception Report.

The benchmark structure involves 11 persons, of which 9 FTEs[32] on quality issues. It has been calculated that 1 FTE is in charge, on average, of 2 billion ton.km for quality control activities. Therefore, through a simple proportion with the traffic expected in 2020 compared to the other corridors, it is possible to assess the necessary staff for the controls on the other corridors.

In the future, however, most IM will have dedicated staff at national level to monitor quality, in order to have an effective Performance Regime system. Corridor staff will then mainly gather collected data at national level and ensure permanent reporting on that. The real staff required may then be estimated at 20% of the one calculated according to the above mentioned ratio (rounding to closest unit)

[31] Such process takes place through the setting up of "quality groups", targeting specific parts of the rail network for the control of multimodal trains.

[32] PwC estimate, based on the assumption that one unit spends 80% of his time on quality issues.

Table 10-12 - Total annual costs for quality of service management permanent staff

ERTMS Corridor	ERIM Traffic 2020 International freight traffic (t.km millions)	Staff theoretically required for freight traffic quality control	Staff actually dedicated for corridor freight traffic quality control	Total corridor quality monitoring staff costs*
A	29.774	15	3	120.000
B	16.201	8	2	80.000
C	10.118	5	1	40.000
D	10.714	5	1	40.000
E	8.949	4	1	40.000
F	18.512	9	2	80.000
TOTAL	**94.268**	**46**	**10**	**400.000**

* Staff cost: € 40.000 / year

Manager of this activity will not be required, since this task might be taken by the OSS director or by one of the OSS manager on behalf of it.

This is the permanent staff all year round. To these costs, it is also necessary to add the costs of railway companies and of IMs affected by the corridor, supporting the central organization by attending two meetings a year. Neither a support staff nor an office are needed for such structure, since it is assumed that, for such activities, the structure relies on the office and support staff of the OSS which will be created.

Table 10-13 - Total annual costs for quality of service management staff attending to the meetings

ERTMS Corridor	Number of IMs involved	N. meetings / year	Total meeting attendance costs
A	6	2	12.000
B	5	2	10.000
C	4	2	8.000
D	4	2	8.000
E	5	2	10.000
F	2	2	4.000
TOTAL			52.000

Meeting costs		
IM staff daily cost	400	Euro / meeting
Travel and lodging cost	600	Euro / meeting

No implementation cost is expected, related to the recording, measurement and control of quality data, since local IMs are already in charge of such process for their respective sections of the corridor.

Table 10-14 - Overall administrative costs related to quality of service intervention area

ERTMS Corridor	Total corridor quality monitoring staff costs*	Total meeting attendance costs	Total costs for Quality Monitoring
A	120.000	12.000	132.000
B	80.000	10.000	90.000
C	40.000	8.000	48.000
D	40.000	8.000	48.000
E	40.000	10.000	50.000
F	80.000	4.000	84.000
TOTAL	400.000	52.000	452.000

10.5 Corridor governance

The administrative costs associated to the Corridor Governance intervention area are due to the creation of a technical round table between the Member States affected by the corridor, to discuss all the intervention areas indicated in this IA. One expert (two experts at most) is planned to take part from each Ministry or regulatory body affected by the corridor for each intervention area.

Every Member State will consequently send between 9 and 18 experts. It needs to be taken into account the fact that some intervention areas overlap each other, so each Member State are likely to send to corridor governance meetings no more than 6 to 8 experts. Following such hypothesis for Corridor A (4 affected countries), between 24 and 32 people will meet, so it is possible to assume that on average 28 people will participate to each meeting.

The implementation of the technical roundtable will determine then the following costs:

Table 10-15 - Total annual costs for Corridor Governance staff attending to the meetings

ERTMS Corridor	Number of countries	Estimated number of experts to be involved	N. meetings / year	Total meeting attendance costs
A	4	28	2	56.000
B	5	35	2	70.000
C	4	28	2	56.000
D	4	28	2	56.000
E	5	35	2	70.000
F	2	14	2	28.000
TOTAL		**168**		**336.000**

Meeting costs		
RB or Ministry daily cost	400	Euro / meeting / person
Travel and lodging cost	600	Euro / meeting / person

The estimate is based on the assumption that the Corridor Governance will meet twice a year (before the timetable's definition and after about 6 months to check and make the necessary adjustments).

10.6 Total additional administrative costs

The following table present the total administrative cost as resulting from the calculation illustrated in the previous chapters.

ERTMS Corridor	Annual cost for implementing the Rail Network GivingPriority to Freight							Investment costs
	OSS annual costs	Corridor reference document preparation	Traffic mgt Expert Group cost	Quality Monitoring Costs	Corridor Governance Group costs	Total		OSS investment costs
A	410.000	64.000	9.800	132.000	56.000	**671.800**		**40.000**
B	404.000	66.000	8.400	90.000	70.000	**638.400**		**40.000**
C	214.000	48.000	7.000	48.000	56.000	**373.000**		**30.000**
D	306.000	48.000	7.000	48.000	56.000	**465.000**		**34.000**
E	220.000	58.000	8.400	50.000	70.000	**406.400**		**30.000**
F	386.000	28.000	4.200	84.000	28.000	**530.200**		**40.000**
TOTAL	**1.940.000**	**312.000**	**44.800**	**452.000**	**336.000**	**3.084.800**		**214.000**

The average additional annual administrative cost per ton.km is 0,020 € per train.km (the values per corridor are between 0,014 and 0,027 € / train.km), as presented in the table below. A very small increase in freight train infrastructure charges (presently between 1 and 4 € / train.km) will then allow to fully recover these additional costs.

ERTMS corridor	Annual cost for implementing the Rail Network GivingPriority to Freight (Euro)	International freight traffic (t.km Millions)	Average cost per tkm (€)	Average cost per train.km* (€)
A	671.800	29.774	0,0000226	0,014
B	638.400	16.201	0,0000394	0,024
C	373.000	10.118	0,0000369	0,022
D	465.000	10.714	0,0000434	0,026
E	406.400	8.949	0,0000454	0,027
F	530.200	18.512	0,0000286	0,017
TOTAL	**3.084.800**	**94.268**	**0,0000327**	**0,020**

* Hypothesis: 600 tons / train

10.7 Saving in administrative costs due to OSSs

Both RU and IM will take benefit from the booking of international freight paths through OSS. For RUs, this will eliminate the need to approach 2 or more IMs for booking each national section of the international path, whereas IMs will be contacted only once (through the OSS they will create).

The following table summarizes the expected savings for RUs thanks to this simplification. The calculation is based on the estimate of the number of booking transactions that are likely to be eliminated thanks to the OSS.

The fact that most trains are related to regular paths (i.e. having the same route and schedule each day, or each week) is taken into account, in order not to overestimate the savings.

Corridor	A	B	C	D	E	F = C / (D * E)	G	H = (F*M/250 + F*N/48 + F*P) *G	I	J = (H/G)* I	L = J*K
	Length (km)	Number of IM	International freight traffic in 2020 (Mn tkm / year)	Average length of international freight train trip (km)	Average freight train tonnage (t / train)	Number of freight path / year	Typical number of IM involved / international path	Number of path booking transactions / year	N. booking operations saved / path	Total number of operation saved per year	Total saving (€ / year)
A	2.673	6	29.774	1.000	600	49.623	3	16.175	2	10.783	646.989
B	3.467	5	16.201	1.000	600	27.002	4	11.735	2	5.867	352.048
C	1.680	4	10.118	800	600	21.079	3	6.871	2	4.581	274.830
D	2.749	5	12.515	1.000	600	20.858	3	6.799	2	4.533	271.951
E	1.621	5	8.949	800	600	18.644	3	6.077	2	4.051	243.077
F	1.934	2	18.512	800	600	38.567	2	8.381	1	4.190	251.416
Rest of ERIM network	38.078		128.455	1.000	600	214.092	3	69.783	2	46.522	2.791.327
Total	**52.202**	**27**	**224.524**			**389.865**		**125.820**		**80.527**	**4.831.638**

M	% of regular daily paths	60%		Work hours for 1 path booking (€)	1,5
N	% of regular weekly paths	30%		Average work cost of RU* staff (€/h)	40
P	% other paths	10%	**K**	Unit Cost of 1 path booking(€)	75

D includes Liubljiana - Budapest

** or Authorised Applicant*

The RU staff hour cost (40 €) has been estimated as the ratio between the annul cost for salary and social charges (60.000 € on average) and the product of the work hours per day (7,5) and the actual worked days (estimated at 200 days / year).

Considering very low assumptions in terms of RU staffs' work hours needed for 1 path booking, in total, about 80k booking operations per year might be avoided, representing a potential annual cost reduction for RUs (and authorized applicants) of € 4,8 millions.

For IMs, the savings is more difficult to be appreciated, since they still probably will have to finalize the contractual aspects for each country leg of the paths, after that the OSSs have defined and book the international paths. Thus, the national IM effort needed for the international freight booking process will be not eliminated, even if some reduction is certainly to be expected.

The total effect in terms of administrative costs shall then take into account the additional expenditures summarized in chapters 10.6 and the above presented savings.

11 MACRO LEVEL IMPACTS

Macro level impacts are originated from the variation of the macro variables and from the traffic variation multiplied by the direct costs and the external costs of traffic.

11.1 Impacts on traffic (modal shift)

Following the methodology described in the chapters 5.3.1 and 5.3.2, the micro – level impacts due to the proposed policy options have been integrated in the Transtools modelling framework to determine the effects on the modal shift of the two case study corridors and on the overall ERIM network.

The TRANSTOOLS results for the simulation at 2020 horizon of macro modal-shift effects are the following.

Table 11-1 - Baseline traffic (Option A)

	Freight		Passenger	
	in million tonne-kilometres		in million passenger kilometres per year	
Corridor A	47.477		17.768	
Corridor E	12.099		3.889	
Overall ERIM network	398.075		81.044	

Table 11-2 – Modal shift impact of Option B (vs Option A)

	Freight	Change in % with respect to the baseline (Option A)	Passenger	Change in % with respect to the baseline (Option A)
	in million tonne-kilometres		in million passenger kilometres per year	
Corridor A	2.453	5,2%	-	0,0%
Corridor E	1	0,0%	-	0,0%
Overall ERIM network	13.428	3,4%	-	0,0%

Table 11-3 - Modal shift impact of Option C (vs Option A)

	Freight in million tonne-kilometres	Change in % with respect to the baseline (Option A)	Passenger in million passenger kilometres per year	Change in % with respect to the baseline (Option A)
Corridor A	2.883	6,1%	23-	-0,1%
Corridor E	1.795	14,8%	6,620-	-0,2%
Overall ERIM network	20.117	5,1%	74-	-0,1%

The impact at corridor level are quite close for the two options on Corridor A, whereas on Corridor E the rail freight traffic increase in Option C will be much higher. This is probably because the bigger micro-impact on this corridor is expected to be the one of the coordination of network path and terminal slot planning, that is foreseen to take place only in Option C.

For the purpose of calculating the cost and benefit analysis, traffic data are considered to be stable after 2020. For the period 2016-2020 a build-up trend has been built considering the annual growth rate.

11.2 Direct economic effect

In order to simplify the analysis, the direct economic effect has been estimated in terms of net variation of total transport costs for the users, due to the shift from road to rail of some freight traffic on one hand, and to the shift of some passenger traffic from rail to road on the other hand.

The assessment of cost savings is based on cost models as applied in European models such as TRANSTOOLS, ETIS-BASE and SPIN. Different figures are used for each option and corridor. These differences are mainly caused by the differences in the average trip distance of the shifted flows observed in the Transtools output for each option. Differences between countries have also been taken into account. Furthermore, we used the Transtools output to determine the share of intermodal transport (incl. pre/end haulage by road) and direct rail transport without pre-end haulage in the transport chains. Based on the overall transport cost, the costs per ton kilometre are derived. The following table presents these costs per ton kilometre. They present the values based on the particular transport chains that were shifted from road to rail in case of Options B or C. The values for transport via rail therefore include pre/end haulage costs for freight transport via rail. Moreover the average travel distance of these particular transport chains is an important factor that determines the cost level and cost structure.

Table 11-4 – Unit values of modal shift – direct economic effect

Freight transport			
Corridor	**Option**	**cost per ton kilometre via Rail**	**Road cost per ton kilometre**
A	B	**€ 0,051**	**€ 0,081**
A	C	**€ 0,054**	**€ 0,085**
E	B	**€ 0,103**	**€ 0,130**
E	C	**€ 0,084**	**€ 0,093**

ERIM overall	B	**€ 0,049**	**€ 0,081**
ERIM overall	C	**€ 0,054**	**€ 0,084**
Passenger transport			
Corridor	**Option**	**Rail cost per passenger kilometre**	**Road cost per passenger kilometre**
A	B	**€ 0,135**	**€ 0,261**
A	C	**€ 0,135**	**€ 0,261**
E	B	**€ 0,099**	**€ 0,189**
E	C	**€ 0,099**	**€ 0,189**
ERIM overall	B	**€ 0,129**	**€ 0,236**
ERIM overall	C	**€ 0,129**	**€ 0,236**

From the table it can for instance been seen that the costs per ton kilometre for corridor E for freight transport are much higher than the costs for corridor A and ERIM network in general. The reason is that the shifted freight flows on corridor E have a rather low travel distance compared with the observed shifted flows on other corridors. As a result there in the shifted flows on corridor E there is a much higher cost share for fixed costs for loading/unloading of the train or truck and pre- end haulage of the cargo. This causes a high cost value if expressed in ton kilometre. If there average trip distance increases the costs per ton kilometre will decrease due to the offset of these fixed costs for loading and unloading of the train (or truck).

On this basis, the following tables present the estimated savings (for freight) and additional costs (for passenger) generated by the modal shift impact previously estimated. Needless to say, the impact levels are proportional to the traffic impacts.

Table 11-5 – Direct economic effects – Option B vs A

ASSESSMENT LEVEL	COST / BENEFIT	CHANGE IN DIRECT TRANSPORT COSTS IN 2020 (€ / YEAR)		
		ERTMS CORRIDOR A	ERTMS CORRIDOR E	ALL NETWORK
MACRO LEVEL - DIRECT ECONOMIC IMPACTS	Freight	75.455.304	22.316	403.114.825
	Passenger	0	0	0

Table 11-6 – Direct economic effects – Option C vs A

ASSESSMENT LEVEL	COST / BENEFIT	CHANGE IN DIRECT TRANSPORT COSTS IN 2020 (€ / YEAR)		
		ERTMS CORRIDOR A	ERTMS CORRIDOR E	ALL NETWORK
MACRO LEVEL - DIRECT ECONOMIC IMPACTS	Freight	90.411.484	15.944.215	125.839.448
	Passenger	-2.952.164	-594.467	-4.858.500

11.3 Impacts on congestion, environment and transport safety

11.3.1 Monetary evaluation of the external costs

Impacts on congestion, environment (pollution, noise, climate change) and transport safety are directly linked to the modal shift generated by the two policy options and presented in the 11.1.

The level of the external impacts have been estimated in monetary terms using unit cost value per ton.km and passenger.km of road and rail on the basis of the guidelines given by the recent *Handbook on estimation of external cost in transport sector* (2007), prepared by the consortium led by CE Delft on behalf of DG TREN.

In deriving the evolution of the unit cost value during the time, the following aspects have been considered

- projections of GDP data and population data (the actual indicator for indexation used is in fact the per capita income).
- for the costs of climate change another indicator taken from the CE handbook report (which was based again on data of IPCC) has been used.
- for air pollution we included an additional factor in the calculations, namely a 1% reduction per year in the cost which relates to the technological improvements resulting in an reduction of emission factors has been considered.

At the network level the following unit external costs in Euro 2007 have been applied for year 2020.

Table 11-7 - External costs in eurocent per ton km or passenger km (ERIM network)

FREIGHT	Congestion	Accidents	Air pollution	Noise	Climate change	**Total**
Truck	2,17	0,03	0,22	0,09	0,22	**2,72**
Freight train	0,01	0,01	0,07	0,04	0,10	**0,23**
PASSENGER	Congestion	Accidents	Air pollution	Noise	Climate change	**Total**
Car	8,11	0,26	0,18	0,09	0,51	**9,15**
Train	0,08	0,08	0,12	0,09	0,22	**0,58**

On this basis, the following tables present the estimated external benefits (for freight) and external costs (for passenger) generated by the modal shift impact due to the two policy options. As for the direct economic impacts, the impact levels are proportional to the traffic impacts.

Table 11-8 – External effects – Option B vs A

ASSESSMENT LEVEL	**COST / BENEFIT**	**CHANGE IN EXTERNAL TRANSPORT COSTS IN 2020 (€ / YEAR)**		
		ERTMS CORRIDOR A	**ERTMS CORRIDOR E**	**ALL NETWORK**
EXTERNAL EFFECTS OF FREIGHT TRANSPORT	Congestion	7.262.181.980	1.201.977	29.004.421.071
	Accidents	24.534.399	8.121	134.279.727
	Air pollution	760.566.356	64.972	2.014.195.908
	Noise	122.671.993	40.607	671.398.636
	Climate Change	368.015.979	121.822	2.685.594.544

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EXTERNAL EFFECTS OF PASSENGER TRANSPORT	Congestion	-	-	-
	Accidents	-	-	-
	Air pollution	-	-	-
	Noise	-	-	-
	Climate Change	-	-	-

Table 11-9 – External effects – Option C vs A

ASSESSMENT LEVEL	COST / BENEFIT	CHANGE IN EXTERNAL TRANSPORT COSTS IN 2020 (€ / YEAR)		
		ERTMS CORRIDOR A	ERTMS CORRIDOR E	ALL NETWORK
EXTERNAL EFFECTS OF FREIGHT TRANSPORT	Congestion	8.533.666.233	2.656.016.126	43.453.026.055
	Accidents	28.829.953	17.946.055	201.171.417
	Air pollution	893.728.558	143.568.439	3.017.571.254
	Noise	144.149.767	89.730.275	1.005.857.085
	Climate Change	432.449.302	269.190.824	4.023.428.338
EXTERNAL EFFECTS OF PASSENGER TRANSPORT	Congestion	-200.866.490	-28.068.485	-594.035.096
	Accidents	-4.223.828	-1.191.587	-11.124.253
	Air pollution	-3.285.200	-1.191.587	-3.708.084
	Noise	0	0	0
	Climate Change	-8.682.313	-2.449.373	-22.248.505

11.3.2 Evaluation of the impacts on energy and environment (absolute value)

The modal shifts between road and rail result in different energy consumption and emissions. This chapter presents the analyses on the emissions and energy as result of the traffic analyses for ERTMS corridors A and E and the ERIM network.

The following emissions have been distinguished: CO2 , NOx , PM and SO2. These emissions are related to air quality and global warming. Furthermore the energy consumption is expressed in the amount of Joule (J) and also the “ton oil equivalent” (toe).

The most complete and state-of-the-art source for figure on energy usage and emissions is the TREMOVE database version 2.7. This source already provides estimates for the year 2020. See for more information: http://www.tremove.org/

This source was used to derive the differences in the emissions between road and rail transport for both passengers and freight. Subsequently the modal shifts have been multiplied with the difference between road and rail in order to determine the savings on emissions and energy consumption.

For the option B there is no impact on the passenger transport market, therefore only the modal shifts in the freight transport market were used for the impact on energy and emissions. For Option C there are ‘reversed modal shifts’ expected in the passenger transport market due to less local trains. Therefore for Option C the savings in the freight market and the losses in the passenger transport market have been summed in order to determine the overall energy and emission impacts.

Emissions and damages to the environment

Air pollution causes deaths and respiratory disease. Air pollution is often identified with major stationary sources, but the greatest source of emissions is mobile sources, mainly from transport vehicles such as cars and trucks. Gases such as carbon dioxide, which contribute to global warming, have recently gained recognition as pollutants by climate scientists, while they also recognize that carbon dioxide is essential for plant life through photosynthesis.

Air pollution is caused by the emission of air pollutants such as particulate matter (PM), NOx, SO2. These emissions cause:

- health problems
- acid rain

- damages to buildings
- crop losses
- costs for further damages for the ecosystem (biosphere, soil, water).

Health problems are one of the most important effects of emissions. Emissions such as particles and NOx provide problems with breathing and the respiratory system, damage to lung tissue, and premature death. Small particles penetrate deeply into sensitive parts of the lungs and can cause or worsen respiratory disease such as emphysema and bronchitis, and aggravate existing heart disease. Especially if emissions of PM, NOx, SO2 occur in highly populated areas they cause high external costs to society. For this reason there are also requirements with respect to the air quality. In particular if modal shifts take place in metropolitan or urban areas there is a relatively big contribution to the quality of life in this area.

Carbondioxide (CO2) is the most important emission related to global warming / greenhouse gas effect. It has no direct impact on health and therefore it does not make a difference where the gas is emitted. Savings of CO2 are important in light of the Kyoto protocol. The Kyoto Protocol is an agreement made under the United Nations Framework Convention on Climate Change (UNFCCC). Countries that ratify this protocol commit to reducing their emissions of carbon dioxide and five other greenhouse gases (GHG), or engaging in emissions trading if they maintain or increase emissions of these green house gases. There are targets with respect to the reduction of CO2.compared to emission levels in 1990. As of January 2008, and running through 2012, Annex I countries have to reduce their greenhouse gas emissions by a collective average of 5% below their 1990 levels (for many countries, such as the EU member states, this corresponds to some 15% below their expected greenhouse gas emissions in 2008).

Energy and emission characteristics

The following tables present the average energy and emission characteristics for road and rail per passenger-kilometre (pkm) and tonne-kilometre (tkm).

Table 11-10 - Energy and emission characteristics of passenger transport by road

Emission type:	Car Diesel	Car Petrol	Weighted average	unit
CO2	116.35	129.79	121.16	gram/pkm
NOx	0.2222	0.13127	0.1896	gram/pkm
PM	0.01602	0.01525	0.01575	gram/pkm
SO2	0.14189	0.21607	0.16845	gram/pkm
Energy consumption in GJ	0.00138	0.00159	0.00145	GJ/pkm
Energy consumption toe	0.00003	0.00004	0.000035	toe/pkm

The figures above are based on values for 1.4-2 liter cars in the year 2020.

Table 11-11 - Energy and emission characteristics of passenger transport by rail

Emission type:	Locomotive electric	Locomotive diesel	Railcar electric	Weighted average[33]	unit
CO2	13.96	41.47	38.25	24.46	gram/pkm
NOx	0.00863	0.63812	0.0273	0.06395	gram/pkm
PM	0.000305	0.04078657	0.00087	0.00364	gram/pkm
SO2	0.00397	0.090415731	0.0082	0.01214	gram/pkm
Energy consumption in GJ	0.00014	0.000468	0.000456	0.000274	GJ/pkm
Energy consumption toe	0.000003	0.000011	0.000011	0.000007	toe/pkm

Based on the share of diesel and of electric it is possible the determine the differences between road and rail vehicles. For example it can be seen that the CO_2 emission of is much lower for rail transport(between 14 and 41 gram/pkm) compared to cars (116-130 gram per pkm).

Table 11-12 - Energy and emission characteristics of freight transport by road

Emission type:	>32t truck	unit
CO2	81.989	gram/tkm
NOx	0.3732800	gram/tkm
PM	0.0115190	gram/tkm
SO2	0.0999930	gram/tkm
Energy consumption in GJ	0.0009732	GJ/tkm
Energy consumption in toe	0.0000232	toe/tkm

Table 11-13 - Energy and emission characteristics of freight transport by rail

Emission type:	Train Diesel	Train Electric	unit
CO2	48.45	25.26	gram/tkm
NOx	0.745600	0.015200	gram/tkm
PM	0.047658	0.000706	gram/tkm
SO2	0.105465	0.008660	gram/tkm
Energy consumption in GJ	0.000547	0.000269	GJ/tkm
Energy consumption toe	0.000013	0.000006	toe/tkm

For the freight trains there have been different weighted average values for the corridors. For corridor A, a 100% share of electric locomotives was assumed. For corridor E a 80% share of

[33] Weighted average determined by: 58% electric locomotives, 8% diesel locomotives and 34% railcar.

electric locomotives was assumed and for the ERIM network a 90% share of electric locomotives is taken into account.

Next by means of comparing the emission and energy characteristics, the savings due to a model shift in tonne-kilometres can be derived.

Results

The shifts of tonne-kilometres and passenger-kilometres have been estimated with the TRANSTOOLS model for the different policy/ Option B and Option C were compared with the Option A. Subsequently the changes in the absolute figures on the emissions and energy consumption have been derived.

The following table presents the reduction of emissions and energy consumption for ERTMS corridor A (Rotterdam – Genoa) .

Table 11-14 - Energy and emission consumption impacts (Corridor A)

	Option B	Option C freight transport	Option C passenger transport	Option C overall
Kton CO2	139.2	163.5	2.3-	161.3
ton NOx	878.5	1,032.3	2.9-	1,029.4
ton PM	26.5	31.2	0.3-	30.9
ton SO2	224.1	263.3	3.7-	259.6
PJ	1.7	2.0	0.0-	2.0
Ktoe	41.2	48.4	0.7-	47.7

The following table presents the reduction of emissions and energy consumption for corridor E (Dresden – Budapest).

Table 11-15 - Energy and emission consumption impacts (Corridor E)

	Option B	Option C freight transport	Option C passenger transport	Option C overall
Kton CO2	0.0	93.5	0.6-	92.8
ton NOx	0.2	380.5	0.8-	379.6
ton PM	0.0	2.6	0.1-	2.5
ton SO2	0.1	129.2	1.0-	128.1
PJ	0.0	1.2	0.0-	1.2
Ktoe	0.0	27.7	0.2-	27.5

The following table presents the reduction of emissions and energy consumption for the ERIM Network.

Table 11-16 - Energy and emission consumption impacts (ERIM network)

	Option B	Option C freight transport	Option C passenger transport	Option C overall
Kton CO2	730.6	1,094.6	7.2-	1,087.4
ton NOx	3,827.5	5,734.2	9.3-	5,724.9
ton PM	82.1	123.1	0.9-	122.2
ton SO2	1,096.4	1,642.6	11.6-	1,631.0
PJ	9.1	13.6	0.1-	13.5
Ktoe	216.3	324.1	2.1-	322.0

11.4 Employment impacts

In terms of employment, the main effect of the proposed policy Options are:

- the need of additional staff for administrative tasks, as already identified in the document on Administrative costs
- the likely reduction of the employment in the road sector, resulting from the shift of traffic to rail transport because of reduction in time and costs of the latter.

On the contrary, the modal shift impact is considered not likely to increase significantly the employment in the rail industry, since this sector, characterized historically by a relatively high job intensity, in the recent years had to become more efficient due to public budget constraints, both in the infrastructure managers and railway undertaking sides. As a result, the job intensity of rail is declining, and relatively moderate changes of the transport volumes, as the ones forecasted, are not likely to imply significant additional staff needs.

The same applies for the small reduction forecasted for rail passenger transport: no significant job impacts in the rail sectors shall be expected

11.4.1 Increase in administrative staff

The additional staff needs evaluated for ERTMS corridors are the ones for running the One-Stop-Shop, preparing and updating the Corridor Reference document, as well as monitoring the freight traffic quality.

The data have been extrapolated to the overall European main network by applying the following ratios resulting from the analysis of ERTMS corridor:

- n. administrative staff / international rail traffic (bn tkm) for the employment needs in One Stop Shops and Traffic Quality Monitoring;
- n. administrative staff / rail network length for the employment needs in Corridor Reference document preparation (permanent FTEs required).

The resulting figures have been then reduced by 60%, since an implementation for the whole European main network will certainly imply significant synergies in terms of administrative tasks.

The table below summarizes the overall impact in administrative staff employment.

Table 11-17 - Overall impact in administrative staff employment (option C)

	Additional administrative staff – **Option C** (FTE / year)			
	One Stop Shop	Preparation of Corridor Reference document **	Corridor freight traffic quality control	Total
Corridor A	10,0	0,4	3,0	13,4
Corridor E	4,5	0,2	1,0	5,7
Other ERTMS corridors	31,5	1,0	7,0	39,5
Total ERTMS corridors	**46,0**	**1,6**	**11,0**	**58,6**
ERTMS corridor 2020 international traffic (mn tkm)	94.268			
ERTMS corridor 2020 length	13.595			
N. staff / bn international tkm	0,5	0,1	0,1	0,7
N. staff / 1000 km of line	3,4	0,6	0,8	4,8
Rest of the ERIM network 2020 international traffic (mn tkm)	128.455			
Rest of the ERIM network 2020 length	38.078			
Additional needs for the rest of the main European network*	**25,0**	**1,8**	**6,0**	**32,8**
Total main European network*	**71,0**	**3,4**	**17,0**	**91,4**

* ERIM network

The ratios of the green cases are the ones used for extrapolation ERTMS data to the rest of the network

For **Option B**, according to the options' definition (cf. Inception Report), the implementation of the Corridor Reference document is not foreseen, since it requires a legislative framework. On the contrary, both OSS and Quality monitoring are likely to be implemented as in Option C.

The expected employment impact of Option B are therefore the following ones:

Table 11-18 - Overall impact in administrative staff employment (option B)

	Additional administrative staff – **Option B** (FTE / year)		
	One Stop Shop	Corridor freight traffic quality control	Total
Corridor A	10,0	3,0	13,0
Corridor E	4,5	1,0	5,5
Other ERTMS corridors	31,5	7,0	38,5
Total ERTMS corridors	**46,0**	**11,0**	**57,0**
Additional needs for the rest of the main European network	**25,0**	**6,0**	**31,0**
Total main European network	**71,0**	**17,0**	**88,0**

11.4.2 Reduction of road transport employment

Following the modal shift estimated by TRANSTOOLS as result of the implementation of the Option B and C, the expected employment impact on road transport appears relatively high in terms of number of jobs lots (especially for Corridor A), but it is relatively small if compared to the overall employment level in the sector, as shown by the table below.

Table 11-19 - Reduction of road transport employment estimates

	Employment intensity of road transport (n. employees / bn tkm)	**Option B**			**Option C**		
		Estimated reduction of road freight transport (bn tkm)	Estimated impact (reduction of road freight transport employees)	Reduction in % of road freight employees in corridor countries	Estimated reduction of road freight transport (bn tkm)	Estimated impact (reduction of road freight transport employees)	Reduction in % of road freight employees in corridor countries
Corridor A	1.688	2,4534	4.142	0,6%	2,8830	4.867	0,7%
Corridor E	1.870	0,0008	2	0,0%	1,7946	3.355	0,6%
Whole Europe	**2.235**	**13,4280**	**30.007**	**1,1%**	**20,1171**	**44.955**	**1,6%**

12 TOTAL COST BENEFIT ANALYSIS

The assumptions taken for CBA calculation are presented in the previous chapters 7-8-9-10-11.2 and 11.3.1.

12.1 Specific assumptions on administrative costs

Administrative costs due to implementing the policy outside the ERTMS corridors have been estimated using the same approach applied for them, and then abated by 60% in order to take into account the high synergies that are very likely to exist in case of an application at overall main European rail network level

Table 12-1 - Administrative cost assumptions – Option C (values in Euro)

	Administrative investment costs	Administrative costs – 1st year	Administrative costs – years >1
Total ERTMS corridors	214.000	3.340.800	3.084.800
Rest of ERIM network outside ERTMS corridors	116.800	2.011.680	1.773.700
Total ERIM network	**330.800**	**5.352.500**	**4.858.500**

For CBA calculation, investments costs are supposed to take place in 2015. The first year of implementation of the different administrative actions is considered to be 2016, so that in 2020 all supporting administrative actions will be in full operations.

In Option B, only the costs for OSS, Quality monitoring and Corridor governance are included, following the options' definition of the Inception Report.

12.2 Results

The following tables summarize the results for Option C and B. All indexes (NPV, IRR, B/C) show an highly positive socio-economic impact of the proposed policies in both options.

Option C determines better effects, especially for corridor E where the modal shift impact is significantly higher than in Option B.

Since congestion effects represent a big share of the benefits, and their existence is a bit theoretical (since there are not evaluated by an analysis based on demand – speed curves on each section, but using average values per unit of traffic that are highly approximate for monetarising this external impact), results are presented also without the effect on congestion.

The level of the overall NPV changes, but the general conclusions are however the same.

12.2.1 Option C

Table 12-2 - Cost benefits analysis result for option C

ASSESSMENT LEVEL	Cost / benefit		ERTMS CORRIDOR A	ERTMS CORRIDOR E	ALL NETWORK
MICRO-LEVEL	Technical harmonisation Path allocation and traffic mgt rules (except "additional capacity for freight") Terminals		1.897,1	806,6	10.671,5
	Additional capacity for freight trains		1.135,8	-13,3	1.209,3
ADMINISTRATIVE COSTS			-0,3	-1,6	-0,8
MACRO LEVEL - DIRECT ECONOMIC IMPACTS	Freight		846,5	149,3	5.679,0
	Passenger		-27,9	-5,6	-74,7
MACRO LEVEL - EXTERNALITIES	Freight	Congestion	83.283,3	27.183,3	455.306,7
		Accidents	281,4	183,7	2.107,9
		Air pollution	8.194,7	1.390,6	29.826,9
		Noise	1.406,8	918,4	10.539,5
		Climate Change	4.678,9	2.912,5	44.494,1
	Passenger	Congestion	-1.983,4	-289,9	-7,8
		Accidents	-41,6	-11,6	-117,1
		Air pollution	-30,4	-12,4	-36,8
		Noise	0,0	0,0	0,0
		Climate Change	-94,7	-26,7	-247,2
TOTAL NET PRESENT VALUE (mn €)			**99.546,1**	**33.183,1**	**553.103,3**
INTERNAL RATE OF RETURN			**132,7%**	**98,9%**	**86,2%**
BENEFIT / COST RATIO			**39,7**	**56,8**	**51,2**

Without congestion impacts

TOTAL NET PRESENT VALUE (mn €)	**18.246,2**	**6.289,7**	**104.051,5**
INTERNAL RATE OF RETURN	**83,0%**	**57,3%**	**49,5%**
BENEFIT / COST RATIO	**31,8**	**22,9**	**22,9**

12.2.2 Option B

Table 12-3 - Cost benefits analysis result for option B

ASSESSMENT LEVEL	Cost / benefit		ERTMS CORRIDOR A	ERTMS CORRIDOR E	ALL NETWORK
MICRO-LEVEL	Technical harmonisation Path allocation and traffic mgt rules (except "additional capacity for freight") Terminals		1.058,2	274,3	5.191,9
	Additional capacity for freight trains		0,0	0,0	0,0
ADMINISTRATIVE COSTS			0,4	-1,0	5,9
MACRO LEVEL - DIRECT ECONOMIC IMPACTS	Freight		706,5	0,2	3.806,9
	Passenger		0,0	0,0	0,0
MACRO LEVEL - EXTERNALITIES	Freight	Congestion	70.874,4	12,3	303.912,3
		Accidents	239,4	0,1	1.407,0
		Air pollution	6.973,7	0,6	19.909,1
		Noise	1.197,2	0,4	7.035,0
		Climate Change	3.981,8	1,3	29.699,4
	Passenger	Congestion	0,0	0,0	0,0
		Accidents	0,0	0,0	0,0
		Air pollution	0,0	0,0	0,0
		Noise	0,0	0,0	0,0
		Climate Change	0,0	0,0	0,0
TOTAL NET PRESENT VALUE (mn €)			**85.031,6**	**288,3**	**370.967,4**
INTERNAL RATE OF RETURN			**127,2%**	**13,3%**	**75,9%**
BENEFIT / COST RATIO			**220,0**	**6,6**	**89,3**

Without congestion impacts

TOTAL NET PRESENT VALUE (mn €)	**14.157,3**	**276,0**	**67.055,1**
INTERNAL RATE OF RETURN	**75,2%**	**13,0%**	**40,6%**
BENEFIT / COST RATIO	**41,6**	**6,6**	**23,9**

13 RISK ANALYSIS

13.1 Micro level sensitivity analyses

The sensitivity analyses (risk analyses) carried out at the macro level concern the two impact areas that appear the most significant contributors in terms of benefits, i.e.

- technical harmonization for extended interoperability at border crossing, that generates reduction of waiting time at borders;
- coordination between network paths and terminal slots planning, that produces reduction of waiting time at arrival/departure tracks for the trains before entering into the terminal (inbound trains) or after leaving the terminal before entering into the main network (outbound trains).

13.1.1 Hypotheses for the micro-level sensitivity analyses

For both sensitivity analysis, the approach is to consider that the main "risk" is that the situation will be already improved in the baseline (Option A), so that the effort of the implementation of the policy Options B & C might not produce so high benefits as estimated in the base case analysis.

For the first area (**extended interoperability at border crossing**), the "base case" analysis conducted for both options B & C has considered that in the baseline (Option A), the 2020 borders waiting time are the same as in 2007 situation, excluding the borders where new infrastructure will eliminate the border crossing (e.g. between France and Spain), where no waiting times at border are expected in Option A (so no gain is expected in Options B/C).

The sensitivity analysis considers that the 2020 waiting times in the baseline (Option A) are instead improved with respect to 2007 situation, corresponding to a maximum of 10' in the case of passengers trains, 60' in the case of conventional freight trains and 30' in the case of the combined transport trains. The baseline waiting time is then set at the minimum between such maximum levels and the 2007 level.

For the second area (**coordination between network paths and terminal slots planning**), the "base case" analysis conducted for option[34] C has considered that the 2020 average expected savings is 82,5 minutes per train at each terminal (origin and destination), as the average between likely savings observed as differences between situations of no coordination (waiting time = 120') and situation of coordination (waiting time between 30' and 45').

The sensitivity analysis considers that the 2020 baseline (Option A) waiting times at arrival / departure tracks are on average 90' instead of 120', bringing the average savings to 52,5 minutes per train at each terminal.

13.1.2 Results

The following tables summarize the results of the two sensitivity analyses for Option C and B (for the latter only the sensitivity on border waiting times).

As shown in the following paragraphs for both corridors A and E and for the whole network the total micro-level benefits are reduced, especially for the sensitivity on border waiting times, but all micro-level CBA indexes (NPV, IRR, B/C) do remain largely encouraging for the implementation of the proposed policy options.

[34] This intervention area is supposed not feasible in Option B.

Only in the case of Corridor E, the Option B CBA results of the sensitivity analysis present a NPV that is only slightly positive

13.1.3 Corridor A

Table 13-1 - Corridor A risk analysis results

	Option C			Option B	
	Base case	Sensitivity on borders waiting time*	Sensitivity on terminal waiting time**	Base case	Sensitivity on borders waiting time
Reduction of waiting time at borders	1.161,1	588,7	1.161,1	878,3	445,3
Reduction of waiting time because of coordination between network and terminal planning	519,8	519,8	330,8	-	-
Other micro-level impacts	1.351,9	1.351,9	1.351,9	179,9	179,9
MICRO-LEVEL NET PRESENT VALUE (mn €)	**3.032,8**	**2.460,4**	**2.843,8**	**1.058,2**	**625,2**
MICRO-LEVEL INTERNAL RATE OF RETURN	**43,9%**	**40,1%**	**42,9%**	**22,6%**	**18,7%**
MICRO-LEVEL BENEFIT / COST RATIO	**8,6**	**7,2**	**8,2**	**7,3**	**4,7**

* **Improved baseline (Option A)**: maximum border waiting time are set at 10' (passenger trains), 60' (conventional freight) and 30' (combined transport trains)

** **Improved baseline (Option A)**: maximum terminal waiting time on arrival/departure tracks before entering into the terminal (inbound trains) or before accessing to the main nework (outbound trains) are set at 90' (instead of 120' in the base case)

The figures presented in the table confirm that, for corridor A, the total micro-level benefits are reduced, especially in the case of the sensitivity on border waiting times (micro-level NPV -19% for Option C and -40% for Option B), while the decrease is lower in the case of the sensitivity on terminal waiting time (micro-level NPV -6% for Option C; the sensitivity is obviously not applicable to Option B).

Nevertheless, all micro-level CBA indexes (NPV, IRR, B/C) do remain largely encouraging for the implementation of the proposed policy options.

13.1.4 Corridor E

Table 13-2 - Corridor E risk analysis results

	Option C			Option B	
	Base case	Sensitivity on borders waiting time*	Sensitivity on terminal waiting time**	Base case	Sensitivity on borders waiting time
Reduction of waiting time at borders	390,4	159,5	390,4	295,3	120,7
Reduction of waiting time because of coordination between network and terminal planning	407,6	407,6	259,4	-	-
Other micro-level impacts	-4,8	-4,8	-4,8	-21,0	-21,0
MICRO-LEVEL NET PRESENT VALUE (mn €)	**793,2**	**562,4**	**645,0**	**274,2**	**99,6**
MICRO-LEVEL INTERNAL RATE OF RETURN	**24,5%**	**20,6%**	**22,1%**	**13,0%**	**8,8%**
MICRO-LEVEL BENEFIT / COST RATIO	**4,6**	**3,6**	**3,9**	**2,7**	**1,6**

* **Improved baseline (Option A)**: maximum border waiting time are set at 10' (passenger trains), 60' (conventional freight) and 30' (combined transport trains)

** **Improved baseline (Option A)**: maximum terminal waiting time on arrival/departure tracks before entering into the terminal (inbound trains) or before accessing to the main nework (outbound trains) are set at 90' (instead of 120' in the base case)

For corridor E, the reduction of micro-level benefits is more significan than in the case of corridor A, especially in the case of the sensitivity on border waiting times (micro-level NPV -29% for Option C and -64% for Option B), while the decrease is lower in the case of the sensitivity on terminal waiting time (micro-level NPV -19% for Option C).

Such reductions, however, do not change the sign of the total micro-level impact, since all micro-level CBA indexes (NPV, IRR, B/C) still show a positive effect resulting from the implementation of the proposed policy options.

13.1.5 Overall network

Table 13-3 – Overall network risk analysis results

	Option C			Option B	
	Base case	Sensitivity on borders waiting time*	Sensitivity on terminal waiting time**	Base case	Sensitivity on borders waiting time
Reduction of waiting time at borders	6.532,7	3.631,4	6.532,7	4.941,4	2.746,8
Reduction of waiting time because of coordination between network and terminal planning	3.770,9	3.770,9	2.399,7	-	-
Other micro-level impacts	1.577,2	1.577,2	1.577,2	1.372,9	1.372,9
MICRO-LEVEL NET PRESENT VALUE (mn €)	**11.880,8**	**8.979,5**	**10.509,5**	**6.314,3**	**4.119,7**
MICRO-LEVEL INTERNAL RATE OF RETURN	**19,7%**	**17,1%**	**18,6%**	**13,4%**	**11,4%**
MICRO-LEVEL BENEFIT / COST RATIO	**3,8**	**3,1**	**3,5**	**2,8**	**2,2**

* **Improved baseline (Option A)**: maximum border waiting time are set at 10' (passenger trains), 60' (conventional freight) and 30' (combined transport trains)

** **Improved baseline (Option A)**: maximum terminal waiting time on arrival/departure tracks before entering into the terminal (inbound trains) or before accessing to the main nework (outbound trains) are set at 90' (instead of 120' in the base case)

For the overall network, the reduction of micro-level benefits in the sensitivity cases is in line with the one observed for the corridors A and E. In the case of the sensitivity on border waiting times, the micro-level NPV decreases by 24% for Option C and by 35% for Option B, whereas in the case of the sensitivity on terminal waiting time, the diminution is by 12% (Option C).

As for the two corridors, despite the relatively high benefits' reduction, all micro-level CBA indexes (NPV, IRR, B/C) show a positive effect resulting from the implementation of the proposed policy options.

The significant decrease of total benefits in the two sensitivity analyses means that the overall impact of the policy options strongly depend on the implementation of the measures on waiting times at borders and terminals. The positive effect of the "Rail network giving priority to freight" policy is then extremely dependent upon the implementation of such actions.

13.2 Macro level sensitivity analyses

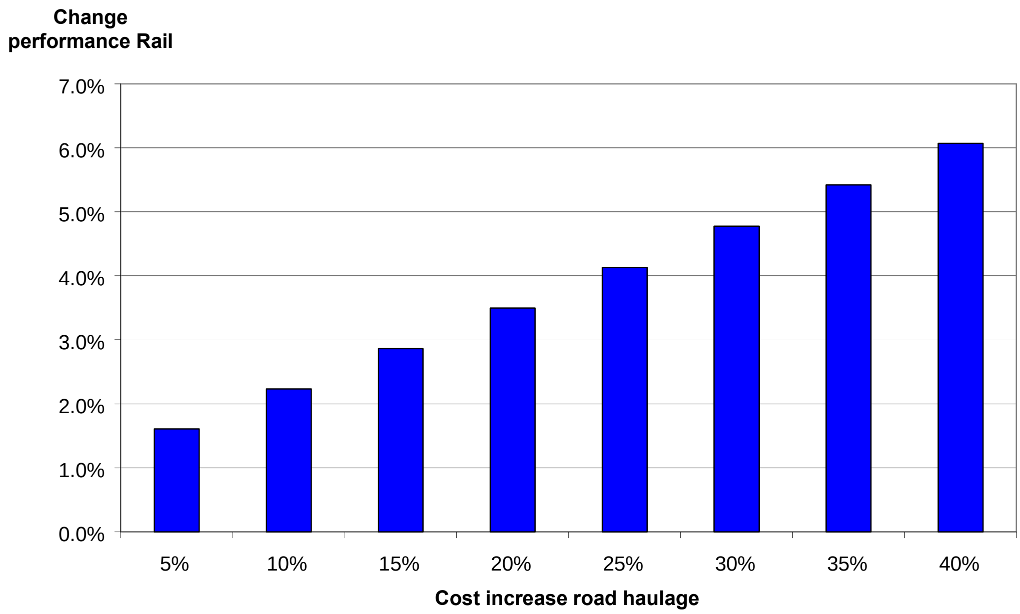
One of the main reasons of uncertainty in the impact evaluation is the future evolution of the variables that are exogenous to the rail transport, and, in particular, the attributes (time, cost) of its main competitor, the road transport. For that reason, some sensitivity analyses on road transport characteristics were carried out.

13.2.1 Hypotheses for the macro-sensitivity analyses

The sensitivity with respect to changes in the road haulage costs have been analyzed and applied on the ERIM network extrapolation results. It concerns the following scenarios:

1. Increase of fuel prices for trucks, based on 5% and 10% growth of crude oil price per year
2. Full internalisation of External Costs, resulting in a price difference increase of 2.5 eurocent per km
3. Introduction of longer and heavier vehicles in whole of Europe: 25.5 meters at 60 tons Gross Vehicle Weight

The overall cost changes per tonne-kilometre have been derived. Next the elasticities derived from Transtools model output were used to calculate the changes in modal shifts. In order to identify the elasticities the Transtools model was run with several relative cost increases. The following figure presents the found elasticity values between cost changes in road haulage and the volume of rail transport:



Subsequently an estimation was provided on the amount of tonne-kilometers that could be shifted between road and rail transport due to changes in road haulage costs. The following table presents the original values for ERIM network extrapolation.

	Amount of tonne-kilometers rail (million) in 2020 ERIM network	Change compared to option A (million)	Relative change compared to option A
Option A	398,075	-	-
Option B	411,503	13,428	+3.4%
Option C	418,193	20,117	+5.1%

The values on tonne-kilometres for rail transport as result of cost changes in road haulage were derived from the original values as presented for the ERIM Network by means of applying the right elasticity values.

13.2.2 Scenario 1: Increase of fuel prices

In the Transtools baseline scenario for year 2020, the prices for road haulage were based on the year 2007 with an average growth of 2% per annum. Considering the actual price increase, this growth rate seems to be rather modest. Converted to crude oil prices, this would mean a crude oil brent price development from 52 in year 2007 to 68 euro per barrel in the year 2020. Reality is however, that in year 2008 already prices have been observed above this estimated value for 2020, for example an average price of 85 euro (=132 USD) per barrel in June 2008.

Therefore two alternatives have been calculated based on high price increase:
1. an increase of 5% per annum: 99 Euro per barrel in 2020
2. an increase of 10% per annum: 182 Euro per barrel in 2020

The impact on the road haulage costs depends on the share of the fuel costs in the overall operational costs of a truck. The share of fuel consumption is depending on the average distance of the trip. Furthermore, the fuel price includes taxes that have to be taken into account as well.

For rail transport it is assumed in this calculation that there is no impact on the energy costs for rail transport. This could however be in some cases optimistic, because electricity generation is into some extend also linked to oil prices (for example in countries where there are power plants running on natural gas prices). Moreover, a small share of the locomotives could still be running on diesel fuels. As a result, the impacts might be seen as the upper bound of the impacts according to Transtools elasticities.

The following table presents the impact on costs for an average European country for general cargo:

Table 13-4 - Impacts of fuel increase for an average European country for general cargo

Distance	50 km	150 km	300 km	600 km
Road cost increase at 5% growth	8%	12%	13%	14%
Road cost increase at 10% growth	12%	17%	19%	21%

For this calculation it is assumed that all cost increases in road haulage will result in price increases for their clients. Experiences have shown that in practice a share of road hauliers does absorb some of the cost increase by increasing their productivity or decrease profits. However, especially since the fuel prices increased, more and more road hauliers use fuel price clauses in their contracts.

Due to the higher road haulage costs the break even point between road and rail transport will reduce, attracting a certain amount of additional cargo to the rail transport mode.

The following maximum volume increase can be expected for the ERIM network for scenario 5% annual growth of oil price:

Table 13-5 – Results of sensitivity analysis in case of + 5% fuel cost

	Shift to rail in million tonne-kilometres	Amount of tonne-kilometers rail (million) in 2020 ERIM network	Relative change of rail freight performance in %
Option A	10,897	408,973	+2.7%
Option B	10,747	422,250	+2.6%
Option C	9,870	428,063	+2.4%

The following volume increase can be expected for the ERIM network for scenario 10% annual growth of oil price:

Table 13-6 – Results of sensitivity analysis in case of + 10% fuel cost

	Shift to rail in million tonne-kilometres	Amount of tonne-kilometers rail (million) in 2020 ERIM network	Relative change of rail freight performance in %
Option A	14,423	412,498	+3.6%
Option B	13,865	425,368	+3.4%
Option C	12,503	430,696	+3.0%

13.2.3 Scenario 2: Internalisation of external costs

For this sensitivity scenario it was assumed that the external unit costs for road haulage will be internalised for the categories: congestion, noise, air pollution, accidents and climate change. The external costs for road haulage for the application on the ERIM network extrapolation are 2.72 eurocents per kilometer. Internalising these costs would result into an overall cost increase of road haulage in between 32% and 34%, depending on the average distance.

For this calculation it is assumed that all cost increases in road haulage due to internalizing of external costs will result in price increases for their clients.

For rail transport no change has been taken into account. The external costs for congestion, noise, air pollution, accidents and climate change are quite low compared to road haulage, therefore the increase of costs for rail would be much lower (5%). However, it must be remarked that not all social costs have been internalized. The infrastructure costs for rail, especially investments, are not 100% covered by rail freight transport (e.g. Betuwe route).

The following table presents the results on the estimation on the impact on rail volumes on the ERIM network taking into account the internalization of external costs:

Table 13-7 - Results of sensitivity analysis in case of internalisation of external costs

	Amount of tonne-kilometers rail (million) in 2020 ERIM network	Shift to rail in million tonne-kilometres due to scenario 2	Relative change of rail freight performance in %
Option A	418,613	20,538	+5.2%
Option B	433,265	21,762	+5.3%
Option C	439,229	21,037	+5.0%

13.2.4 Scenario 3: Longer and heavier vehicles (LHV)

Currently studies and debates are ongoing whether the maximum length and Gross Vehicle Weight of road vehicles shall be extended. Some countries in Europe already allow 25.5 metre trucks with a maximum GVW of 60 tonnes. Such trucks can carry 3 TEU per truck in stead of 2 TEU. A full European roll-out of such dimensions would result in a cost decrease for road haulage resulting in a 'reversed modal shift' from rail to road. Especially for transport characterized by high volume in m3 and low weight, the impact is large.

Calculations carried out by NEA show that the introduction of longer and heavier vehicles will result in a potential cost decrease for road hauliers of between 17% and 19% (depending on the distance).

In this calculation, it is also expected that the increase of productivity for road hauliers will result directly in lower costs for the client of the same relative change. Note that in this case the impact is much more immediate compared to the two previous scenarios.

The following table presents the estimated results in terms of impact on rail volumes on the ERIM network:

Table 13-8 - Results of sensitivity analysis in case of longer and heavier vehicles (LHV)

	Amount of tonne-kilometers rail (million) in 2020 ERIM network	Shift to road in million tonne-kilometres	Relative change of rail freight performance in %
Option A	384,663	13,413	-3.4%
Option B	397,795	13,709	-3.3%
Option C	404,314	13,878	-3.3%

The above results are inline with a recent study by TML Leuven for the European Commission "Effects of adapting the rules on weight and dimensions of heavy

commercial vehicles as established within Directive 96/53/EC". In this study the Transtools model was applied. The model results indicate a maximum impact of -3.8% on rail volume in tons due to LHV introduction. For more information on this study, see http://www.tmleuven.be/project/weightanddimensions/documents/home.htm .

14 COMPARISON OF THE OPTIONS

The following picture summarises the quantitative and qualitative effects of the two policy options.

Impact area	*Intervention area*	*Impact*	*Impact level*					
			Option B			*Option C*		
			A	E	Overall	A	E	Overall
QUALITATIVE IMPACTS	**Investment coordination**	Increasing transparency to users of rail infrastructure	Only for long terms investment			Both for medium and long term investment and maintenance works		
		Better use of infrastructure	Low			High		
	Path allocation process	Increase market opening and transparency	High			High		
	Transparency	Increasing transparency to users of rail infrastructure	No or low impact			High		
	Quality of service	Improvement of punctuality and reliability of international freight paths	Medium-to-high			Medium-to-high		
MICRO-LEVEL QUANTITATIVE IMPACTS	**Technical harmonisation**		910,3	212,0	4.131,7	1.193,2	307,1	5.723,0
	Path allocation rules and traffic management rules *		-	-	-	1.172,0	16,2	1.326,7
	Terminals		147,9	62,2	1.060,2	667,7	469,8	4.831,1
	NPV Total micro-level (€ mn)		**1.058,2**	**274,2**	**5.191,9**	**3.032,8**	**793,2**	**11.880,8**
ADMINISTRATIVE COSTS			**0,4**	**-1,0**	**5,9**	**-0,3**	**-1,6**	**-0,8**
MACRO-LEVEL QUANTITATIVE IMPACTS	**Direct economic impacts**	Freight	706,5	0,2	3.806,9	846,5	149,3	5.679,0
		Passengers	0,0	0,0	0,0	-27,9	-5,6	-74,7
	Externalities**	Freight	12.392,1	2,4	58.050,5	14.561,8	5.405,1	86.968,4
		Passengers	0,0	0,0	0,0	-166,7	-50,7	-401,2
	NPV Total macro-level (€ mn)		**13.098,6**	**2,7**	**61.857,4**	**15.213,7**	**5.498,1**	**92.171,6**
NPV Total quantitative impacts (€ mn)			**14.157,3**	**275,9**	**67.055,1**	**18.246,2**	**6.289,7**	**104.051,5**
EMPLOYMENT IMPACTS	**Additional rail administrative staff** (FTE / year)		**13,0**	**5,5**	**88,0**	**13,4**	**5,7**	**91,4**
	Reduction of road transport employment (% of total employees in road freight)		**0,6%**	**0,0%**	**1,1%**	**0,7%**	**0,6%**	**1,6%**

* Iincluding economic effect of the “additional capacity for freight trains”.

** Congestion effects non considered (as explained in chapter 12.2, the estimated congestion effects, while representing a big share of the benefits, are a bit theoretical, being not evaluated by an analysis based on demand – speed curves on each section, but using average values per unit of traffic that are highly approximate for monetarising this external impact).

The following conclusions can be drawn from the comparison of the two policy options according to the above presented assessment results:

1. In terms of qualitative impacts, higher impacts are expected for Option C in the areas where the legislative obligations are required and/or likely to be largely more effective than the voluntary approach, such as investment coordination and transparency.

2. Both options present a positive micro-level Net Present Value; benefits of Option B are lower particularly because of the lack of the intervention on additional capacity for freight, as well as on coordination between network path planning and terminals slot planning, that are particularly positive in terms of monetarised impact.
3. For both options, overall differences in administrative costs between the status-quo and options B and C are very small, because the additional expenditure for administrative staff employed in OSS, preparation of corridor reference documents and quality control are balanced by the savings in RUs' staff costs thanks to the simplification of path booking for international trains.
4. Also at the macro-level, both options have an highly positive socio-economic impact of the proposed policies. Option C determines better effects, especially for corridor E where the modal shift impact is significantly higher than in Option B.
5. Following the modal shift estimated by TRANSTOOLS as result of the implementation of the Option B and C, the expected employment impact on road transport appears relatively high in terms of number of jobs lots (especially for Corridor A), but it is relatively small if compared to the overall employment level in the sector.
6. In general terms, both the voluntary approach of Option B and the legislative approach of Option C shall be preferred to the status-quo situation of Option A, since both qualitative and quantitative effects are positive or highly positive. The difference between the two options appear to be higher (in favour of Option C) for corridor E, since the modal shift generated by option B for this corridor is very small (the relative change in rail attributes due to Option B measures is probably not sufficient to significantly modify the competitive position of rail against road for this corridor).
7. As presented in chapter 13, the risk of generating lower impacts than the one observed is mainly linked to an evolution better than expected in Option A (status-quo), in particular with respect to interoperability at border crossing and coordination between network path and terminal planning. The risk is higher for Option B in the case of corridor E, for which a better "status-quo" evolution of interoperability at border crossing may imply a NPV that is only slightly positive.

Based on the above conclusions, strengths, weaknesses, opportunities and threats of the two options are presented hereafter.

	Option B	*Option C*
STRENGTHS	▪ Small increase or even decrease in total administrative costs ▪ Positive micro and macro quantitative total effects ▪ No negative impacts on passenger traffic	▪ High impact on transparency ▪ Low increase on total administrative costs ▪ Very positive micro and macro quantitative effects
WEAKNESSES	▪ Small improvement in terms of investment and maintenance work coordination ▪ Macro-level effects very different from one corridor to another	▪ Small negative impacts on passenger traffic
OPPORTUNITIES	▪ Likely improvement in freight reliability	▪ Likely improvement in freight reliability
THREATS	▪ Positive micro-impact risk to be very low if the evolution of interoperability at border crossing is better than expected	▪ The magnitude of the impacts depends strongly on the status-quo evolution, in particular with respect to interoperability at border crossings and coordination network / terminals

15 MONITORING AND EVALUATION

As provided by the Impact Assessment guidelines of the European Commission, monitoring systems have the main function of enabling policymakers to verify to what extent the policy is achieving its set objectives.

For this purpose a set of core indicators need to be identified for the key objectives of the intervention. Such indicators must be checked against the purpose they are supposed to serve.

In compliance with the monitoring tasks provided by the Impact Assessment guidelines of the European Commission a set of core indicators has been defined for the key policy objectives set out for the creation of a rail freight network giving priority to freight.

A detailed description of the above-mentioned set of indicators is given in the following paragraph.

15.1 Proposed set of core indicators

The definition of a monitoring and evaluating system starts with the identification of the key indicators. An indicator can be defined as the measurement of an objective to be met, a resource mobilized, an effect obtained, a gouge of quality or a context variable. Within the framework of the present impact assessment analysis, an attempt has been made to define some core indicators for the main policy objectives and to outline the monitoring system envisaged.

At this stage, it seems there is no point in laying down detailed indicators and the monitoring systems detailed features for all the options identified as part of the impact assessment. This will be done, more correctly, after the political choice of the most appropriate policy option has been made, as this is the last step in the policy design process.

That being said, some core indicators for the key policy objectives (see paragraph 3.1 for "general objectives") have been identified, as it is fair to assume that these general objectives are reasonably stable across the various alternative policy options envisaged in the impact assessment.

The indicators have been identified according to the criterions adopted by the European Commission in the Impact Assessment Guidelines (the so-called "SMART" criteria):

- Specific
- Measurable
- Accepted (by staff, stakeholders);
- Realistic (closely related to the objectives to be reached);
- Time - dependent.

Furthermore, the selection of the proposed indicators have privileged indicators which are credible for non expert, unambiguous and easy to interpret; easy to monitor and robust against manipulation.

In the following table is reported the above mentioned set of indicators.

Intervention area	Micro – level impact or qualitative impact	Proposed indicator
Investment planning / heavy maintenance	(qualitative)	Existence of coordination table or memorandum of understanding on these issues among states and related IM's (existence? Y/N)
Technical harmonisation of infrastructures	Operating costs waiting times – train size	Km of rail line with crossing tracks compliant to 750 m
		Reduction (minutes) of waiting times at borders
Path allocation process	(qualitative)	Creation of the One Stop Shop (realised Y/N)
Path allocation rules	Speed – line capacity	Additional capacity for freight trains (% of additional freight trains, number of additional train.km)
		Change in regional passenger trains (% of change in regional passenger trains, variation in the number of train.km)
Traffic management rules	Punctuality	Freight trains punctuality reduction of trains delays (minutes)
		Passenger trains punctuality – (number of cancelled trains / trains moved to other lines).
	(qualitative)	Establishing priority rules in the "reference document of the corridor" (number of documents /total ERTMS corridor)
Transparency	(qualitative)	Realisation of the "corridor's reference document" (number of documents / total of ERTMS corridor)
Terminals (transhipment tracks)	Operating costs – trains size	Expenditure to standardise tracks 750 m long (€)
		Reduction of shunting costs (€)
Terminals (coordination between terminal slot and long distance train path)	Waiting times	Reduction of waiting time due to coordination between terminal slot and l/d train path (minutes)
Quality of service	(qualitative)	Creation of a structure in charge of this issue for each corridor (realised Y/N)
	(quantitative)	Punctuality level of freight trains (minutes or % within a given maximum delay)
		Transit time (minutes)
Corridor governance	(qualitative)	Creation of a structure in charge of this issue for each corridor (realised Y/N)

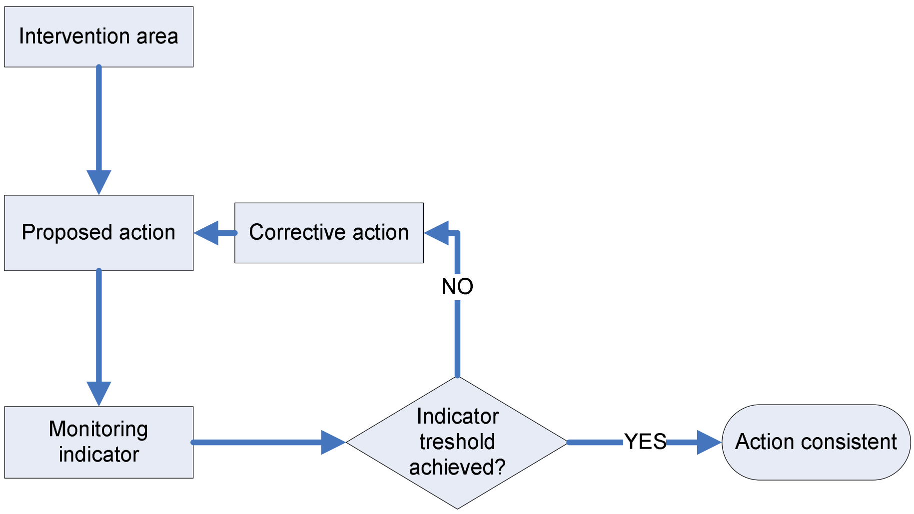
15.2 Monitoring process proposed for the identified set of core indicators

Specific processes have to be set up in order to quantify each of the indicators identified in the set described in the previous paragraph.

Each process has to enable an evaluation of the effectiveness of the implemented actions, through the comparison between the expected impact and the real impact recorded by the monitoring system, in order to verify whether the implemented actions are having impact consistent with the estimates of the Impact Assessment exercise.

The following picture is going to illustrate the proposed method for implementing the monitoring process:

Figure 15-1 - Proposed monitoring process



The comparison is going to be made through the definition of specific thresholds over the estimated values, so that if the value of the indicators recorded by the monitoring system is lower than the threshold it is supposed that the action has not met its objective, otherwise the action is believed to be consistent with its objective and effective in terms of its capacity of producing the estimated impact.

The following table shows some examples for the comparison of the values recorded by the monitoring system and the estimated values.

Indicator	Value recorded by the monitoring system	Threshold	Action effectiveness
% of rail lines with crossing tracks compliant to 750 m train length (or more)	80%	100%	NO
	100%		YES

Indicator	Value recorded by the monitoring system	Target	Action effectiveness
Creation of the One Stop Shop (realised Y/N)	NO	YES	NO
	YES		YES

In the second case, it would be possible also to develop a more complex indicator not base on a simple yes / no assessment.

Indicator	Value recorded by the monitoring system	Target	Action effectiveness
Number of international freight paths sold through the OSS	50%	80%	NO
	90%		YES

As outlined above, the monitoring process has to enable, for each of the monitoring system's indicators, a timely and realistic evaluation of the effectiveness of the implemented actions in terms of capability of generating impact levels near to those estimated through the Impact Assessment exercise.

Corrective actions have to be specified for each indicator in case that the impact level is not within its threshold, in order to enhance the overall success of the implemented actions.

The monitoring process could be, of course, even improved through the implementation of a tailorized information system with specific functions in order to allow each of the actor involved in the production and evaluation of the monitoring indicators to see its own set as well as to send "warning" messages to those responsible of the corrective actions in case the threshold has not been met.

Such enhancements would of course produce a separate impact on administrative costs to be evaluated separately.

ANNEX I – BASELINE SCENARIO DESCRIPTION OF CORRIDORS

In the methodology adopted, the baseline scenario is the current situation defined as the status of the rail freight corridors as at the end of 2007. An extensive data collection has been done in order to gather the information indicated in the Table 5-1. Currently some data are still missing because stored in ERIM database and will be added to the baseline scenario as soon a as the database will be available.

Variables subjected to changes, such as traffic and investments, have been updated to 2015 as indicated by option A (projection of the baseline scenario to the year 2015, taking into account the effects produced by the actions described in the Tasks Specification[35]).

Hereinafter are presented the fiches illustrating the status of the six ERTMS corridors.

Corridor A

Corridor Main Information	
Corridor	A
TEN-T network	Y
Overall length	2.548 km
Countries	4 (Italy, Switzerland, Germany and Netherland)
Infrastructure Managers	5 (RFI, SBB - BLS, DB Netz, and ProRail - KeyRail)

Traffic data	**2005**	**2015**
International traffic (Million of t km)	17.047	23.013
International traffic density (Million of t km / km)	6,69	9,03
Pax traffic (Million of passenger km)	13.112	15.914
Pax traffic density (Million of t km / km)	5,15	6,25
Share of freight traffic on total corridor traffic	68%	70%
Share of international freight traffic on total freight corridor traffic	62%	63%

Technical harmonisation						
			Upgrading investments			
	Sections length (km)	**%age of sections**	**N/A**	**N**	**Y (upgrade for all sections)**	**Y (upgrade for some sections only)**
Track gauge different from 1435 mm		0%	X			
Max train limit 600 m		73%				X

[35] 1. 1st railway package (directives 2001/14 and 2001/12); 2. TEN-T programme; 3. cooperation between Member States (MS) and infrastructure managers (IM) within the framework of ERTMS corridors; 4. deployment of the TAF TSI.

Technical harmonisation						
	Sections length (km)	**%age of sections**	**Upgrading investments**			
			N/A	**N**	**Y (upgrade for all sections)**	**Y (upgrade for some sections only)**
or more						
Max train limit 750 m or more		To be estimated				X
Loading gauge Gabarit GB or bigger		79%				X
Loading gauge Gabarit GC or bigger		To be estimated				X
Axle load up to 22,5 t or higher		99%				X
Rail line with at least two tracks		To be estimated				X

Foreseen investments				
Section	**Description**	**Start date**	**End date**	**Type of investment**
Genoa – Milan / Novara – Swiss border	New and upgraded line	2010	2013	TEN-T Priority Project
Mornago C. – Luino – Gallarate	Cross tracks lengthen to 600 mt	12/2006		
Italian part of the corridor	Line upgrades with upway and subway for rail crossing	12/2006		
Domodossola Station (DOMO II)	Multi system catenary line activation on 6 tracks		03/2008	-
Genova – Milano – Chiasso	New line	2010	2013	TEN-T Priority Project
Alessandria – Novara – Sempione	Upgraded line	2010	2013	TEN-T Priority Project
Basel – Karlsruhe	Upgraded line	2010 (In some sections close to Basel works ongoing)		TEN-T Priority Project
Frankfurt/M-Mannheim	New line	2010	2013	TEN-T Priority Project
Duisburg- Emmerich	Upgraded line	Works ongoing		TEN-T Priority

Foreseen investments				
Section	**Description**	**Start date**	**End date**	**Type of investment**
				Project
"Iron Rhine" Rheidt – Antwerp – cross border section	Upgraded line	2010	2013	TEN-T Priority Project
Betuwe line	New line	1998	2007	TEN-T Priority Project
ERTMS implementation	Traffic management technology	2006	2012 (*)	
(*) 2015 on Oberhausen - Mannheim sections				

One Stop Shop

Currently the One Stop Shop (OSS) lists the available paths on the next timetable according to the what is published on the Rail Net Europe website. Path are proposed only for cross-border section, not for the entire journey.

Then a feasibility study is done on request, in case the RU or the authorised applicant asks for a path longer than the border section.

The indication hereinafter are referred to the available paths for freight trains.

Only the sections present in the path catalogue are listed in the table. offers train paths only for cross-border sections of the line. In the national section path will be then allocated taking into account the booked path on the cross border section.

Section	**Daily Train Paths Available**							**Notes**			
Section (length of each section*)	Sun	Mon	Tue	Wed	Thu	Fri	Sat	Country	Max train length m	Ma x tonnage T	Loading Gauge
Basel-Domodossola and vv	124	129	139	139	139	139	138	CH/I	(Double traction) North South: max 2000to / 700m via LBS max 1400to / 700m via Scheitelstrecke (Berg) + 400 to in line service via Bergstrecke North South: max 1400to / 700m via LBS und Bergstrecke		P 80/405 C 80/405 NT 70/396

One Stop Shop

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Section	**Daily Train Paths Available**							**Notes**			
Section (length of each section*)	Sun	Mon	Tue	Wed	Thu	Fri	Sat	Country	Max train length m	Ma x tonnage T	Loading Gauge
Basel-Luino-Chiasso and vv	231	232	232	232	232	230	228	CH/I	700	1700	600
Offenbach-Basel and vv	67	164	173	175	161	115	72	D/CH	600	1300	P/C 50/ P/C 1380
Kijfoek-Grenze-Emmerich and vv	48	59	87	93	96	96	78	NL	700	1600	P/C 70, P/C 400
								D	600	1600	Mbr 56 P 90 km/h
Kijfoek-Venlo-Viersen and vv	21	25	52	50	50	51	39	NL	700	1500	P/C 70, P/C 400
								D	580	1600	P/C 70, P/C 400
Montz-Aachen-Gremberg and vv	12	21	40	42	39	36	24	BE/D	700	1700	P/C 70 P/C400
*	To be calculated with ERIM database										

Border stations		
Name	**Transit time (minutes)**	
	Conventional Freight	*Combined Transport*
Domodossola (DOMO II)	145	125
Chiasso	125	60

Border stations		
Name	**Transit time (minutes)**	
Basel	60	45
Venlo	60	60
Emmerich	60	60

Main terminals and ports	
Combined Transport Inland Terminals	*Ports*
▪ Milano - Certosa - Desio - Greco Pirelli - Segrate - Smistamento ▪ Novara - Boschetto - CIM ▪ Basel Wolf ▪ Mannheim Hadelshafen ▪ Köln Eifeltor ▪ Duisburg Rurhort Hafen (DUSS)	▪ Genoa ▪ Rotterdam

Corridor governance						
Existing coordination tables among IMs			**Existing coordination tables among MS**			
Interoperability			*Coordinated investments*			Limited investment coordination
ERTMS Deployment	☑ YES	☐ NO	TEN-T priority project	☑ YES	☐ NO	
Letter of intent signed 3rd March 2006			The following sections are part of the TEN-T Priority project 24 (Lyon – Genova – Basel – Duisburg – Rotterdam – Antwerpen): - Genoa – Milan / Novara – Swiss border - Genova – Milano – Chiasso - Alessandria – Novara – Sempione - Basel – Karlsruhe - Frankfurt/M-Mannheim			

Corridor governance						
Existing coordination tables among IMs			**Existing coordination tables among MS**			
			- “Iron Rhine” Rheidt – Antwerp – cross border section			
Path Planning			*Foreseen joint cross-border investment*			
One Stop Shop	☑ YES	☐ NO	☐ YES	☑ NO	-	
Coordinated path planning	☑ Cross border section	☐ All section	*Coordinated Heavy Maintenance*			No heavy maintenance coordination
			☐ YES	☑ NO	-	

Corridor Map

Corridor B

Corridor Main Information	
Corridor	B
TEN-T network	Y
Overall length	3.467

Corridor Main Information	
Countries	5 (Italy, Austria, Germany, Denmark and Sweden)
Infrastructure Managers	7 (RFI,OBB-Gysev, DB Netz, Bane Danemark, BanVerket-ScandLines)

Traffic data	**2005**	**2015**
International traffic (Million of t km)	11.102	14.988
International traffic density (Million of t km / km)	3,20	4,32
Pax traffic (Million of passenger km)	17.277	21.004
Pax traffic density (Million of t km / km)	4,98	6,06
Share of freight traffic on total corridor traffic	54%	56%
Share of international freight traffic on total freight corridor traffic	55%	56%

Technical harmonisation						
	Sections length (km)	**%age of sections**	**Upgrading investments**			
			N/A	**N**	**Y (upgrade for all sections)**	**Y (upgrade for some sections only)**
Track gauge different from 1435 mm		0%	X			
Max train limit 600 m or more		87%				X
Max train limit 750 m or more		To be estimated				X
Loading gauge Gabarit GB or bigger		97%				X
Loading gauge Gabarit GC or bigger		To be estimated				X
Axle load up to 22,5 t or higher		97%				X
Rail line with at least two tracks	3.167	91%				X

Foreseen investments				
Section	**Description**	**Start date**	**End date**	**Type of investment**
Whole RFI network extension	Europtirails implementation E.P.R. implementation			
New RFI online catalogue of available national and international train paths (linked to ASTER-IF)	Ongoing			
Naples - Verona	New line		2007	TEN-T

Foreseen investments				
Section	**Description**	**Start date**	**End date**	**Type of investment**
				Priority Project
	(On going works between Florence and Bologna)			
Verona Q.E.	Terminal 3rd module realisation	12/2007	11/2008	
Fortezza Verona	Upgraded line (to PC/80 profile, new traffic management system)	2008	2015	TEN-T Priority Project
Brenner Tunnel	New line	2010	2013	TEN-T Priority Project
Kufstein - Innsbruck	New line	2010	2013	TEN-T Priority Project
Munchen-Kufstein (depending on completion Brenner tunnel)	Upgraded line	After 2013		TEN-T Priority Project
Nurnberg - Munchen	Upgraded line		Completed	TEN-T Priority Project
Hannover-Hamburg/Bremen	Upgraded line	2010	2013	TEN-T Priority Project
Puttgarden - Hamburg	Upgraded line	Works ongoing		TEN-T Priority Project
Copenhagen-Roedby	Upgraded line	2010	2013	TEN-T Priority Project
Fehmarn Belt fixed rail-road link	Rail-Road (bridge)	2010	2013	TEN-T Priority Project
Nordic Triangle- Rail upgrade -Swedish sections	Upgraded line Some sections to be opened 2010-2013		Completed	TEN-T Priority Project
Railway tunnels : Malmö and Stockholm (Citytunnels and Citybanan)	Upgraded line		Completed	TEN-T Priority Project
Milano Bologna	New line	On Going works		TEN-T Priority Project

One Stop Shop

Currently the One Stop Shop (OSS) lists the available paths on the next timetable according to the what is published on the Rail Net Europe website. Path are proposed only for cross-border section, not for the entire journey.

Then a feasibility study is done on request, in case the RU or the authorised applicant asks for a path longer than the border section.

The indication hereinafter are referred to the available paths for freight trains.

Only the sections present in the path catalogue are listed in the table. offers train paths only for cross-border sections of the line. In the national section path will be then allocated taking into account the booked path on the cross border section.

Section	**Daily Train Paths Available**							**Notes**			
Section (length of each section*)	Sun	Mon	Tue	Wed	Thu	Fri	Sat	Country	Max train length m	Ma x tonnage T	Loading Gauge
Domegliara - Brenner - Kufstein - Worgl - Kufstein - Trudering and vv	129	157	166	165	166	165	157	I/A/DE	540 N/S (550 S/N)	1560 N/S (1200 S/N)	P/C 70/400
Maschen - Eidelstedt - Flensburg and vv	248	255	259	260	260	253	260	DE	650	1600	P/C 70/400
Padborg - Kolding - Nyborg – Ringsted - Höje Taastrup - Peberholm and vv	248	255	259	260	260	253	260	DK	835	1800	EA Load x 0.65 MZ Load x 0.45
Peberholm - Malmö - Hässleholm - Nässjö – Hallsberg and vv	248	255	259	260	260	253	260	S	580	1200	A
Domegliara - Brenner - Kufstein - Worgl - Kufstein - Trudering and vv	129	157	166	165	166	165	157	I/A/DE	540 N/S (550 S/N)	1560 N/S (1200 S/N)	P/C 70/400
Maschen - Eidelstedt - Flensburg and vv	248	255	259	260	260	253	260	DE	650	1600	P/C 70/400

One Stop Shop

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The indication hereinafter are referred to the available paths for freight trains.

Only the sections present in the path catalogue are listed in the table. offers train paths only for cross-border sections of the line. In the national section path will be then allocated taking into account the booked path on the cross border section.

Section	**Daily Train Paths Available**							**Notes**			
Section (length of each section*)	Sun	Mon	Tue	Wed	Thu	Fri	Sat	Country	Max train length m	Ma x tonnage T	Loading Gauge

** to be calculated with ERIM DB*

Border stations

Name	**Transit time (minutes)**	
	Conventional Freight	*Combined Transport*
Brennero	90	65
Kufstein	25	25
Padborg/Flensburg	n/a	n/a
Copenhaghen/Lernacken	n/a	n/a

Main terminals and ports

Combined Transport Inland Terminals	*Ports*
Bologna Interporto	Naples
Verona Q.E.	Hamburg
Munchen Riem	Malmo - Copenhagen
Nuremberg – Hafen and Hgb	
Hannover Linden and Linden hafen	
Hamburg Billewerder	

Corridor governance

Existing coordination tables among IMs			**Existing coordination tables among MS**			
Interoperability			*Coordinated investments*			Good investment coordination
ERTMS Deployment	☐ YES	☑ NO	TEN-T priority project	☑ YES	☐ NO	

<table>
<tr><th colspan="7">Corridor governance</th></tr>
<tr><th colspan="3">Existing coordination tables among IMs</th><th colspan="4">Existing coordination tables among MS</th></tr>
<tr><td colspan="3">Letter of intent not signed</td><td colspan="3">The following sections are part of theese TEN-T Priority projects:
1 (Rail axis Berlin – Verona – Milano – Bologna – Naples – Messina - Palermo)
11 (Oresund link)
20 (Fernham Belt railways axis):
- Fortezza Verona;
- Brenner Tunnel;
- Kufstein – Innsbruck;
- Munchen-Kufstein (depending on completion Brenner tunnel);
- Nurnberg – Munchen;
- Hannover-Hamburg/Bremen;
- Puttgarden – Hamburg;
- Copenhagen-Roedby;
- Fehmarn Belt fixed rail-road link;
- Nordic Triangle- Rail upgrade -Swedish sections;
- Railway tunnels : Malmö and Stockholm (Citytunnels and Citybanan).</td><td rowspan="3"></td></tr>
<tr><td colspan="3">Path Planning</td><td colspan="3">Foreseen joint cross-border investment</td></tr>
<tr><td>One Stop Shop</td><td>☑ YES</td><td>☐ NO</td><td>☑ YES</td><td>☐ NO</td><td>(*)</td></tr>
<tr><td rowspan="2">Coordinated path planning</td><td rowspan="2">☑ Cross border sections</td><td rowspan="2">☐ All sections</td><td colspan="3">Coordinated Heavy Maintenance</td><td rowspan="2">No heavy maintenance coordination</td></tr>
<tr><td>☐ YES</td><td>☑ NO</td><td>-</td></tr>
<tr><td colspan="7">(*) A memorandum of understanding about the expected investments for the Brenner tunnel realisation has been signed by Austrian and Italian government.</td></tr>
</table>

Corridor Map

Corridor C

Corridor Main Information	
Corridor	C
TEN-T network	Y
Overall length	1.680
Countries	4 (Switzerland, France, Luxembourg, Belgium)
Infrastructure Managers	4 (SBB, RFF, CFL and Infrabel)

Traffic data	2005	2015
International traffic (Million of t km)	6.281	8.479
International traffic density (Million of t km / km)	3,74	5,05
Pax traffic (Million of passenger km)	6.150	7.485
Pax traffic density (Million of t km / km)	3,66	4,46
Share of freight traffic on total corridor traffic	68%	70%
Share of international freight traffic on total freight corridor traffic	47%	49%

Technical harmonisation						
	Sections length (km)	**%age of sections**	**Upgrading investments**			
			N/A	**N**	**Y (upgrade for all sections)**	**Y (upgrade for some sections only)**
Track gauge different from 1435 mm		0%	X			
Max train limit 600 m or more		100%				X
Max train limit 750 m or more		To be estimated				X
Loading gauge Gabarit GB or bigger		98%				X
Loading gauge Gabarit GC or bigger		To be estimated				X
Axle load up to 22,5 t or higher		100%				X
Rail line with at least two tracks		To be estimated				X

Foreseen investments				
Section	**Description**	**Start date**	**End date**	**Type of investment**
Brussels-Luxembourg-Strasbourg (Belgium section)	Eurocaprail project (Rail upgrade)	2007	2012	TEN-T Priority Project
Belgium section C5	ETCS implementation	2008	2014	
Brussels-Luxembourg-Strasbourg (Luxembourg section)	Eurocaprail project (Rail upgrade)	2007	2012	TEN-T Priority Project
Luxembourg – Metz – Baudrecourt	High speed railway axis east		2007	TEN-T Priority Project
Luxembourg section C5	ETCS implementation	2008	2010	
France section C5 (Mont Saint Martin – Dijion)	ETCS implementation	2008	2014	
France section C5 (Thionville - Basel)	ETCS implementation	2008	2010	

One Stop Shop

Currently the One Stop Shop (OSS) lists the available paths on the next timetable according to the what is published on the Rail Net Europe website. Path are proposed only for cross-border section, not for the entire journey.

Then a feasibility study is done on request, in case the RU or the authorised applicant asks for a path longer than the border section.

The indication hereinafter are referred to the available paths for freight trains.

Only the sections present in the path catalogue are listed in the table. offers train paths only for cross-border sections of the line. In the national section path will be then allocated taking into account the booked path on the cross border section.

Section	**Daily Train Paths Available**							**Notes**			
Section (length of each section)	Sun	Mon	Tue	Wed	Thu	Fri	Sat	Country	Max train length m	Ma x tonnage T	Loading Gauge
Antwerpen – Ronet – Bettembourg – Mont Saint Martin and vv *(length to be calculated with ERIM DB)*	55	95	120	120	120	120	121	BE	600	1100	22,5 T/ GB
								LUX	700	2000	22,5 T/ GB
								FR	700	1800	22,5 T/ GB
Antwerpen – Basel and vv	2	12	20	20	20	19	12	BE	600	2000	22,5 T/ GB
								LUX	700	2000	22,5 T/ GB
								F	700	1800	22,5 T/ GB
								CH	700	1800	22,5 T/ GB
Antwerpen – Lyon and vv	1	7	10	11	11	11	9	BE	600	2000	22,5 T/ GB
								F	700	1800	22,5 T/ GB
Emmerich – Kijifoek – Antwerpen and vv	27	76	85	85	85	85	96	NL	600	1600	P/C 70 P/C 400

One Stop Shop

Currently the One Stop Shop (OSS) lists the available paths on the next timetable according to the what is published on the Rail Net Europe website. Path are proposed only for cross-border section, not for the entire journey.

Then a feasibility study is done on request, in case the RU or the authorised applicant asks for a path longer than the border section.

The indication hereinafter are referred to the available paths for freight trains.

Only the sections present in the path catalogue are listed in the table. offers train paths only for cross-border sections of the line. In the national section path will be then allocated taking into account the booked path on the cross border section.

Section	**Daily Train Paths Available**							**Notes**			
Section (length of each section)	Sun	Mon	Tue	Wed	Thu	Fri	Sat	Country	Max train length m	Ma x tonnage T	Loading Gauge
								BE	600	1100	22,5 T/ GB
Rotterdam – Antwerpen – Lyon Miramas and vv	4	11	13	13	13	12	7	NL	600	1600	P/C 70 P/C 400
								BE	600	2000	22,5 T/ GB
								F	700	1800	22,5 T/ GB
Rotterdam – Antwerpen – Lyon and vv	5	6	6	6	6	0	4	NL	600	1600	P/C 70 P/C 400
								BE	600	1800	22,5 T/ GB
								F	700	1800	22,5 T/ GB

Border stations

Name	**Transit time (minutes)**	
	Conventional Freight	*Combined Transport*
Athus	0	0
Thionville	30	30
Basel	60	45

Main terminals and ports	
Combined Transport Inland Terminals	*Ports*
▪ Antwerpen ▪ Basel ▪ Lyon	

Corridor governance						
Existing coordination tables among IMs			**Existing coordination tables among MS**			
Interoperability			*Coordinated investments*			
ERTMS Deployment	☑ YES	☐ NO	TEN-T priority project	☑ YES	☐ NO	
Letter of intent signed 9th June 2006			The following sections are part of the TEN-T Priority project 4 (High speed railway east) and 28 (Eurocaprail on the Brussels-Luxembourg-Strasbourg railway axis): - Brussels-Luxembourg-Strasbourg (Belgium section); - Brussels-Luxembourg-Strasbourg (Luxembourg section); - Luxembourg – Metz – Baudrecourt.			Limited investment coordination
Path Planning			*Foreseen joint cross-border investment (*)*			
One Stop Shop	☑ YES	☐ NO	☐ YES	☑ NO	-	
Coordinated path planning	☑ Cross border sections	☐ All sections	*Coordinated Heavy Maintenance*			No heavy maintenance coordination
			☐ YES	☑ NO	-	
(*) The unique cross border section part of the TEN-T PP (PP 4) has been terminated in 2007.						

Corridor Map

Corridor D

Corridor Main Information	
Corridor	D
TEN-T network	Y
Overall length	2.220
Countries	4 (Spain, France, Italy and Slovenia)
Infrastructure Managers	4 (Adif, RFF, RFI and SZ)

Traffic data	2005	2015
International traffic (Million of t km)	5.681	7.669
International traffic density (Million of t km / km)	2,56	3,45
Pax traffic (Million of passenger km)	12.487	15.173
Pax traffic density (Million of t km / km)	5,62	6,83
Share of freight traffic on total corridor traffic	47%	49%
Share of international freight traffic on total freight corridor traffic	52%	53%

Technical harmonisation						
	Sections length (km)	%age of sections	Upgrading investments			
			N/A	N	Y (upgrade for all sections)	Y (upgrade for some sections only)
Track gauge different from 1435 mm		24%		?		
Max train limit 600 m or more		58%				X
Max train limit 750 m or more		To be estimated				X
Loading gauge Gabarit GB or bigger		73%				X
Loading gauge Gabarit GC or bigger		To be estimated				X
Axle load up to 22,5 t or higher		100%				X
Rail line with at least two tracks		To be estimated				X

Foreseen investments				
Section	Description	Start date	End date	Type of investment
Madrid - Levante and Mediterranean	New line	2001	2020	TEN-T Priority Project
Lyon-St Jean de Maurienne (2010 for the first phase (Chartreuse tunnel))	New line	2007	2015	TEN-T Priority Project
Tunnel du Mont-Cenis	Rail (tunnel)	2004	2018	TEN-T Priority Project
Bussoleno-Turin	New line	2002	2011	TEN-T Priority Project
Turin-Venice	New line	2002	2011	TEN-T Priority Project
Venezia - Ronchi sud-Trieste – Divaga	New line	2002	2015	TEN-T Priority Project
Venezia-Trieste	New line	2008	2015	TEN-T Priority Project
Koper-Divaca-Ljubljana	New line	2005	2012	TEN-T Priority

Foreseen investments				
Section	**Description**	**Start date**	**End date**	**Type of investment**
				Project
Divaca-Koper	Upgraded line	2005	2012	TEN-T Priority Project

One Stop Shop

Currently the One Stop Shop (OSS) lists the available paths on the next timetable according to the what is published on the Rail Net Europe website. Path are proposed only for cross-border section, not for the entire journey.

Then a feasibility study is done on request, in case the RU or the authorised applicant asks for a path longer than the border section.

The indication hereinafter are referred to the available paths for freight trains.

Only the sections present in the path catalogue are listed in the table. offers train paths only for cross-border sections of the line. In the national section path will be then allocated taking into account the booked path on the cross border section.

Section	**Daily Train Paths Available**							**Notes**			
Section (length of each section)	Sun	Mon	Tue	Wed	Thu	Fri	Sat	Country	Max train length m	Ma x tonnage T	Loading Gauge
Tarragona – Port Bou – Perpignan and vv	2	2	2	2	2	2	1	SP	450	22,5 t/axle	-
								F	-	-	-
Perpignan – Lyon and vv	41	44	44	44	44	44	42	F	-	1800	-
Lyon – Modane (faisceaux)	107	107	107	107	106	85	91	F	-	1600	-
Modane (faisceaux) – Torino Orbassano	153	153	153	153	153	153	153	I	550	1150	-
Padova - Villa Opicina and vv	103	103	103	103	103	103	103	I	550	1600	-
Villa Opicina – Lublijana and vv	47	47	47	47	47	47	47	I	-	-	-
								SI	-	-	-
Lublijiana – Zagreb and vv	38	38	38	38	38	38	38	SI	570	1600	-
								HR	570	1600	-

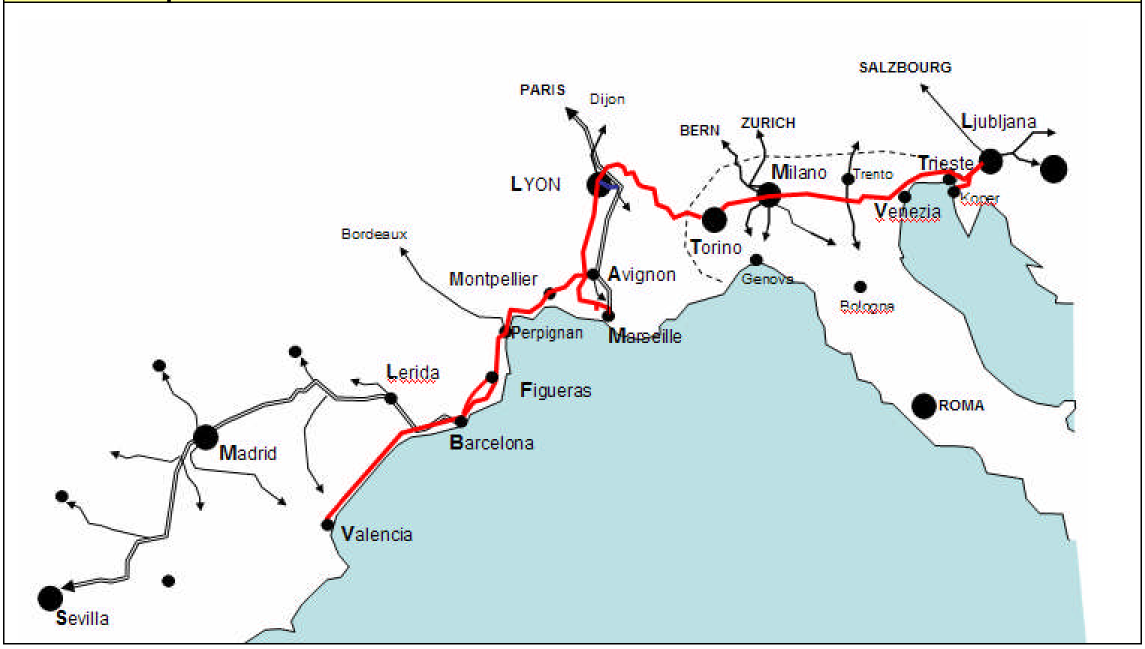
Border stations		
Name	**Transit time (minutes)**	
	Conventional Freight	*Combined Transport*
Port Bou	360	420
Cerbere	360	420
Modane	210	55
Villa Opicina	180	180
Hodos	90	65

Main terminals and ports	
Combined Transport Inland Terminals	*Ports*

▪ Barcelona Granollers
▪ Lyon Venieusseux
▪ Torino Orbassano
▪ Novara
  - CIM
  - Boscehtto
▪ Milano
  - Greco Pirelli
  - Segrate
  - Certosa
  - Smistamento
  - Desio
▪ Brescia
▪ Verona
  - Quadrante Europa
  - Porta Nuova
  - Sommacampagna
▪ Padova
  - Terminal Container FS
  - Nuovo Terminal Container
▪ Lublijiana Moste
	▪ Valencia
	▪ Barcelona
	▪ Marseille
	▪ Trieste
	▪ Koper

Corridor governance						
Existing coordination tables among IMs			**Existing coordination tables among MS**			
Interoperability			*Coordinated investments*			
ERTMS Deployment	☑ YES	☐ NO	TEN-T priority project	☑ YES	☐ NO	
Letter of intent signed 12th December 2006			The following sections are part of the TEN-T Priority project 6 (Railway axis Lyon-Trieste-Koper-Ljubljiana-Budapest-Ukranian-Border) 3 (High-speed railway axis of south-west europe) and 19 (High speed interoperability in Iberian Peninsula): - Madrid - Levante and Mediterranean; - Lyon-St Jean de Maurienne (2010 for the first phase (Chartreuse tunnel)); - Tunnel du Mont-Cenis; - Bussoleno-Turin; - Turin-Venice; - Venezia - Ronchi sud - Trieste – Divaga; - Venezia-Trieste; - Koper-Divaca-Ljubljana; - Divaca-Koper.			Good investment coordination
Path Planning			*Foreseen joint cross-border investment (*)*			
One Stop Shop	☑ YES	☐ NO	☑ YES	☑ NO	-	
			Coordinated Heavy Maintenance			No heavy maintenance coordination
Coordinated path planning	☑ Cross border sections	☐ All sections	☐ YES	☑ NO	-	
(*) Cross border memorandum of understanding have been signed between Italy and France, Italy and Slovenia. Also regarding the cross border section between Spain and France coordination exist.						

Corridor Map



Corridor E

Corridor Main Information	
Corridor	E
TEN-T network	Y
Overall length	1.621
Countries	5 (Hungary, Slovakia, Austria, Czech Republic and Germany)
Infrastructure Managers	5 (MAV, ZSR, OBB, SZDC and DB Netz)

Traffic data	2005	2015
International traffic (Million of t km)	6.880	9.018
International traffic density (Million of t km / km)	4,12	5,56
Pax traffic (Million of passenger km)	2.978	3.627
Pax traffic density (Million of t km / km)	1,84	2,24
Share of freight traffic on total corridor traffic	75%	77%
Share of international freight traffic on total freight corridor traffic	75%	75%

Technical harmonisation						
			Upgrading investments			
	Sections length (km)	%age of sections	N/A	N	Y (upgrade for all sections)	Y (upgrade for some sections only)
Track gauge different from 1435 mm		0%	X			
Max train limit 600 m or more		94%				X
Max train limit 750 m or more		To be estimated				X
Loading gauge Gabarit GB or bigger		100%				X
Loading gauge Gabarit GC or bigger		To be estimated				X
Axle load up to 22,5 t or higher		89%				X
Rail line with at least two tracks		To be estimated				X

Foreseen investments				
Section	**Description**	**Start date**	**End date**	**Type of investment**
Budapest-Sopron-Wien - railway upgrading (Hungarian side)	Upgraded line	2005	2011	TEN-T Priority Project
Budapest-Sopron-Wien - railway upgrading (Austrian side)	Upgraded line	2004	2019	TEN-T Priority Project
Breclav-Prague-(Nürnberg, with Nürnberg-Prague as cross-border section)	Upgraded line	2005	2016	TEN-T Priority Project
CZ border Schirnding-Marktredwitz-Nurnberg	Upgraded line	2012	2015	TEN-T Priority Project
Prag-(border to Linz) (Czech side)	Upgraded line	2005	2016	TEN-T Priority Project
(border to Prag)-Linz (Austrian side)	Upgraded line	2006	2017	TEN-T Priority Project

One Stop Shop

Currently the One Stop Shop (OSS) lists the available paths on the next timetable according to the what is published on the Rail Net Europe website. Path are proposed only for cross-border section, not for the entire journey.

Then a feasibility study is done on request, in case the RU or the authorised applicant asks for a path longer than the border section.

The indication hereinafter are referred to the available paths for freight trains.

Only the sections present in the path catalogue are listed in the table. offers train paths only for cross-border sections of the line. In the national section path will be then allocated taking into account the booked path on the cross border section.

Section	**Daily Train Paths Available**							**Notes**			
Section (length of each section)	Sun	Mon	Tue	Wed	Thu	Fri	Sat	Country	Max train length m	Max tonnage T	Loading Gauge
Dolni Zleb / Decin – Brno – Kuty and vv	218	218	220	220	220	220	220	CZ	600	1600	P/C70 P/C 400
Kuty – Stúrovo and vv	218	218	220	220	220	220	220	SK	650	2000	P/C70 P/C 400

One Stop Shop

Currently the One Stop Shop (OSS) lists the available paths on the next timetable according to the what is published on the Rail Net Europe website. Path are proposed only for cross-border section, not for the entire journey.

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The indication hereinafter are referred to the available paths for freight trains.

Only the sections present in the path catalogue are listed in the table. offers train paths only for cross-border sections of the line. In the national section path will be then allocated taking into account the booked path on the cross border section.

Section	**Daily Train Paths Available**							**Notes**			
Section (length of each section)	Sun	Mon	Tue	Wed	Thu	Fri	Sat	Country	Max train length m	Ma x tonnage T	Loading Gauge
Rajka – Komárom – Stúrovo – Budapest and vv	218	218	220	220	220	220	220	HU	650	2000	-

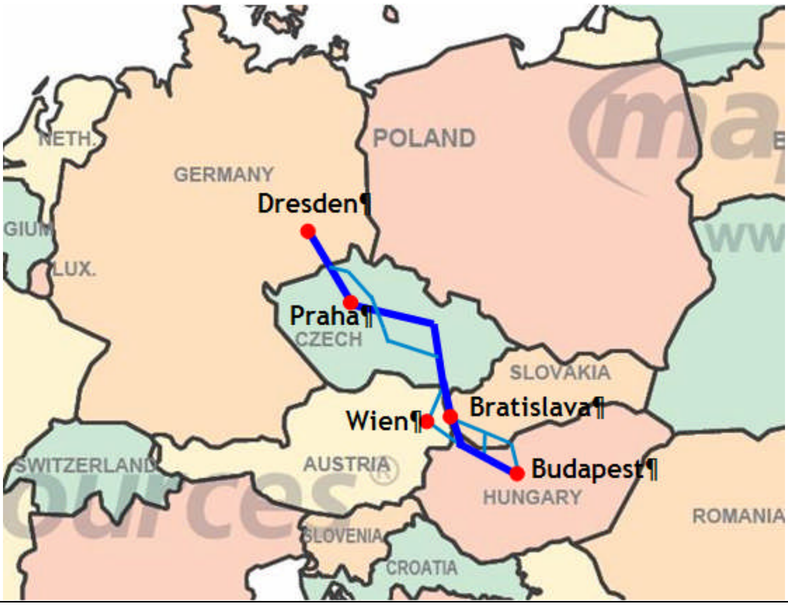
Border stations

Name	**Transit time (minutes)**	
	Conventional Freight	*Combined Transport*
Dolni Zleb / Děčín	25	121
Břeclav	54	34
Bratislava - Petrzalka	120	60
Štúrovo	200	170
Hegyeshalom	80	80

Main terminals and ports

Combined Transport Inland Terminals	*Ports*
▪ Praha Uhrineves ▪ Praha Zizkov ▪ Praha Melnik Labe ▪ Bratislava Uns ▪ Bratislava Palenisko ▪ Wien Nordwest/Inzersdorf ▪ Budapest Bilk Kombiterminál	

Corridor governance						
Existing coordination tables among IMs			**Existing coordination tables among MS**			
Interoperability			*Coordinated investments*			Limited investment coordination
ERTMS Deployment	☑ YES	☐ NO	TEN-T priority project	☑ YES	☐ NO	
Letter of intent signed in May 2007 by Germany, Czech Republic, Austria, Slovak Republic and Hungary.			The following sections are part of the TEN-T Priority project 22 (Railway axis Athina-Sofia-Budapest-Wien-Praha-Nüremberg-Dreden): - Budapest-Sopron-Wien - railway upgrading (Hungarian side) - Budapest-Sopron-Wien - railway upgrading (Austrian side) - Breclav-Prague-(Nürnberg, with Nürnberg-Prague as cross-border section) - CZ border Schirnding-Marktredwitz-Nurnberg - Prag-(border to Linz) (Czech side) - (border to Prag)-Linz (Austrian side).			
Path Planning			*Foreseen joint cross-border investment*			
One Stop Shop	☑ YES	☐ NO	☐ YES	☑ NO	-	
Coordinated path planning	☑ Cross border sections	☐ All sections	*Coordinated Heavy Maintenance*			No heavy maintenance coordination
			☐ YES	☑ NO	-	

Corridor Map


Corridor F

Corridor Main Information	
Corridor	F
TEN-T network	N
Overall length	1.934
Countries	2 (Germany and Poland)
Infrastructure Managers	2 (DB Netz and PKP)

Traffic data	2005	2015
International traffic (Million of t km)	14.826	20.015
International traffic density (Million of t km / km)	7,67	10,35
Pax traffic (Million of passenger km)	5,386	6.546
Pax traffic density (Million of t km / km)	2,78	3,38
Share of freight traffic on total corridor traffic	83%	84%
Share of international freight traffic on total freight corridor traffic	57%	58%

Technical harmonisation						
	Sections length (km)	**%age of sections**	**Upgrading investments**			
			N/A	**N**	**Y (upgrade for all sections)**	**Y (upgrade for some sections only)**
Track gauge different from 1435 mm		0%	X			
Max train limit 600 m or more		84%				X
Max train limit 750 m or more		N				X
Loading gauge Gabarit GB or bigger		100%				X
Loading gauge Gabarit GC or bigger		To be estimated				X
Axle load up to 22,5 t or higher		77%				X
Rail line with at least two tracks		To be estimated				X

Foreseen investments				
Section	**Description**	**Start date**	**End date**	**Type of investment**
Hannover - Minden	Upgraded line		2020	-
Knappenrode – Horka	Upgraded line		2020	-
Berlin – Frankfurt Oder	Upgraded line		2020	-
Aachen – Belgian border	Upgraded line		2020	-
Polish section	New line (tunnel construction)		2020	-

One Stop Shop

Currently the One Stop Shop (OSS) lists the available paths on the next timetable according to the what is published on the Rail Net Europe website. Path are proposed only for cross-border section, not for the entire journey.

Then a feasibility study is done on request, in case the RU or the authorised applicant asks for a path longer than the border section.

The indication hereinafter are referred to the available paths for freight trains.

Only the sections present in the path catalogue are listed in the table. offers train paths only for cross-border sections of the line. In the national section path will be then allocated taking into account the booked path on the cross border section.

Section	**Daily Train Paths Available**							**Notes**			
Section (length of each section)	Sun	Mon	Tue	Wed	Thu	Fri	Sat	Country	Max train length m	Max tonnage T	Loading Gauge
Aachen-Montzen and vv	19	29	62	61	57	58	41	BE	700	1700	P/C70 P/C 400
								D	700	1700	P/C70 P/C 400
Horka-Węgliniec and vv	69	69	69	69	69	69	69	D	500	1500	P/C70 P/C 400
								PL	600	1500	-
Köpenick-Oderbrücke-Rzepin and vv	218	50	46	50	49	49	46	D	600	1900	Mbr 72 P
								PL	600	1300	74
									600	3300	71

Border stations

Name	**Transit time (minutes)**	
	Conventional Freight	*Combined Transport*
Frankfurt (Oder)	180	180
Horka / Węgliniec	-	-
Aachen	60	60

Main terminals and ports	
Combined Transport Inland Terminals	*Ports*
▪ Poznam Gadki ▪ Warszawa Pruskow ▪ Warszawa Kolsped Terminal Kontenerowy ▪ Duisburg Ruhrort Hafen Duss ▪ Hannover Linden ▪ Hannover Linden Hafen	

Corridor governance						
Existing coordination tables among IMs			**Existing coordination tables among MS**			
Interoperability			*Coordinated investments*			Limited investment coordination
ERTMS Deployment	☐ YES	☑ NO	TEN-T priority project	☐ YES	☑ NO	
Letter of intent not yet signed.			No sections of the corridor are part of the TEN-T Priority projects.			
Path Planning			*Foreseen joint cross-border investment*			
One Stop Shop	☑ YES	☐ NO	☐ YES	☑ NO	-	
Coordinated path planning	☑ Cross border sections	☐ All sections	*Coordinated Heavy Maintenance*			No heavy maintenance coordination
			☐ YES	☑ NO	-	

Corridor Map

ANNEX II - MACROECONOMIC REFERENCE SCENARIO

Macroeconomic Reference Scenario: Average annual growth rates per country per sector in the period 2007-2015 (%) (derived from PRIMES model outputs)

Country / Region	EU27 / EFTA /Candidate	Basis Year	Target Year	Time period	GDP	GDP/capita	Agriculture	Industry	BasicMetals	Metal Products	Chemicals	Chemicals Other	Mining	Construction	Energy	Private Consumption	Food Consumption	Residence Construction
AT	EU27	2007	2015	8	2,0	1,8	1,6	2,4	1,3	3,6	2,9	3,2	1,7	1,5	2,0	1,9	1,8	1,5
BE	EU27	2007	2015	8	2,1	1,9	0,6	1,6	0,2	1,7	2,3	1,6	1,0	1,4	0,4	1,8	1,6	1,4
BG	EU27	2007	2015	8	3,7	4,8	2,0	3,6	3,6	3,6	3,6	3,6	-0,5	3,7	3,7	3,7	3,7	3,7
CY	EU27	2007	2015	8	3,8	2,6	2,2	3,1	0,0	0,0	2,4	0,6	4,0	4,5	3,5	4,0	3,2	3,7
CZ	EU27	2007	2015	8	3,6	3,8	0,5	4,0	1,3	1,7	3,3	2,6	4,0	2,9	0,5	3,9	4,2	4,8
DE	EU27	2007	2015	8	1,6	1,6	1,1	1,7	1,2	2,2	2,1	1,9	0,7	0,0	0,8	1,4	1,3	0,7
DK	EU27	2007	2015	8	1,6	1,4	0,6	1,1	1,1	3,3	1,6	1,8	0,5	1,4	0,5	1,6	1,4	1,4
EE	EU27	2007	2015	8	4,9	5,5	-0,1	6,1	0,1	1,4	7,2	7,6	5,3	6,6	4,5	5,1	3,8	4,5
ES	EU27	2007	2015	8	2,8	2,2	0,9	2,7	1,0	2,5	4,0	4,5	2,7	3,4	2,1	2,8	2,5	3,0
FI	EU27	2007	2015	8	2,1	1,9	0,5	2,1	1,6	1,3	1,0	0,8	1,0	1,3	1,6	1,9	2,1	1,3
FR	EU27	2007	2015	8	2,1	1,8	-0,3	2,1	0,9	2,3	2,4	2,2	1,2	1,2	1,8	1,9	1,6	1,2
GR	EU27	2007	2015	8	3,5	3,3	0,8	2,5	3,8	1,7	3,5	3,4	3,1	3,9	1,3	3,0	3,2	3,0
HU	EU27	2007	2015	8	3,5	3,8	3,4	3,2	1,5	3,0	2,2	0,9	3,8	6,1	-0,8	4,1	2,1	5,4
IE	EU27	2007	2015	8	4,2	3,1	0,7	4,4	0,0	2,2	5,1	2,1	3,2	4,6	1,9	3,4	5,2	3,7
IT	EU27	2007	2015	8	1,8	1,7	0,8	1,7	1,0	0,8	2,9	2,0	0,8	1,0	1,4	1,9	2,8	1,0
LT	EU27	2007	2015	8	5,7	6,2	1,2	6,9	2,0	2,0	6,4	5,0	7,7	7,4	5,3	5,9	4,5	7,4
LU	EU27	2007	2015	8	5,0	4,1	-0,7	4,7	1,1	4,7	7,3	6,7	3,0	5,0	3,0	4,4	5,5	5,0
LV	EU27	2007	2015	8	6,3	6,9	1,9	7,5	2,0	2,0	12,1	12,6	6,9	7,3	2,4	6,4	8,8	7,8
MT	EU27	2007	2015	8	3,8	2,6	2,2	3,1	0,0	0,0	2,4	0,6	4,0	4,5	3,5	4,0	3,2	3,7
NL	EU27	2007	2015	8	1,7	1,3	0,1	1,1	0,7	1,1	1,6	1,5	0,5	1,0	0,7	1,7	1,3	1,0
PL	EU27	2007	2015	8	4,3	4,5	3,2	5,0	1,0	2,2	6,3	7,1	5,3	3,2	0,2	4,3	5,2	5,3
PT	EU27	2007	2015	8	2,1	1,8	2,1	1,4	-1,4	2,0	1,7	1,8	1,6	0,6	1,1	2,2	1,4	1,2
RO	EU27	2007	2015	8	4,6	5,0	2,4	4,3	4,3	4,3	4,3	4,3	-0,4	4,6	4,6	4,6	4,6	4,6
SE	EU27	2007	2015	8	2,4	2,0	1,4	3,1	1,1	1,8	4,0	1,4	2,6	2,5	0,5	2,1	2,5	2,5
SI	EU27	2007	2015	8	3,0	2,9	-0,2	3,3	2,1	3,6	3,9	3,0	4,0	3,2	0,4	2,8	3,3	3,2
SK	EU27	2007	2015	8	4,5	4,6	3,0	5,1	2,8	3,9	2,4	4,8	6,1	4,7	0,4	4,0	3,5	4,7
UK	EU27	2007	2015	8	2,6	2,2	0,2	1,2	-0,3	0,8	2,0	-0,3	0,9	2,8	-0,4	2,6	1,4	2,8
CH	EFTA	2007	2015	8	2,1	2,1	0,5	2,3	2,1	2,1	2,6	2,6	2,9	1,2	2,1	2,1	1,1	2,5
IS	EFTA	2007	2015	8	1,9	1,8	0,3	2,8	1,6	1,6	1,9	1,9	7,4	0,8	2,6	1,4	1,1	0,6

Country / Region	EU27 / EFTA /Candidate	Basis Year	Target Year	Time period	GDP	GDP/capita	Agriculture	Industry	BasicMetals	Metal Products	Chemicals	Chemicals Other	Mining	Construction	Energy	Private Consumption	Food Consumption	Residence Construction
NO	EFTA	2007	2015	8	2,3	2,0	0,2	2,1	2,6	3,3	3,2	3,2	4,2	0,7	1,9	2,4	1,8	1,4
HR	Candidate	2007	2015	8	3,4	3,4	1,7	1,0	1,0	1,0	1,0	1,0	1,3	3,4	3,4	3,4	3,4	3,4
MK	Candidate	2007	2015	8	4,7	4,1	0,1	3,8	3,8	3,8	3,8	3,8	-1,0	4,7	4,7	4,7	4,7	4,7
TR	Candidate	2007	2015	8	4,7	3,6	3,3	4,7	4,7	4,7	3,8	3,8	4,7	3,7	3,9	4,3	4,3	2,2
AL		2007	2015	8	7,2	6,3	3,3	9,9	9,9	9,9	9,9	9,9	3,4	7,2	7,2	7,2	7,2	7,2
Australia/N.Zeeland		2007	2015	8	3,5	3,5	2,0	2,2	2,2	2,2	2,2	2,2	2,2	2,2	2,2	3,5	3,5	3,5
BA		2007	2015	8	4,5	3,3	2,6	3,4	3,4	3,4	3,4	3,4	0,3	4,5	4,5	4,5	4,5	4,5
BY		2007	2015	8	3,2	3,2	-3,2	4,0	4,0	4,0	4,0	4,0	-7,4	3,2	3,2	3,2	3,2	3,2
Central/South America		2007	2015	8	2,9	2,9	2,5	2,7	2,7	2,7	2,7	2,7	2,7	2,7	2,7	2,9	2,9	2,9
DZ		2007	2015	8	2,6	2,6	3,2	1,3	1,3	1,3	1,3	1,3	1,3	1,3	1,3	2,6	2,6	2,6
EG		2007	2015	8	2,6	2,6	3,2	1,3	1,3	1,3	1,3	1,3	1,3	1,3	1,3	2,6	2,6	2,6
Far East Asia		2007	2015	8	4,0	4,0	3,0	6,7	6,7	6,7	6,7	6,7	6,7	6,7	6,7	4,0	4,0	4,0
Georgia/Armenia/Azerbaijan		2007	2015	8	4,8	4,8	1,7	4,4	4,4	4,4	4,4	4,4	1,1	4,8	4,8	4,8	4,8	4,8
IL		2007	2015	8	4,0	4,0	3,0	6,7	6,7	6,7	6,7	6,7	6,7	6,7	6,7	4,0	4,0	4,0
JP		2007	2015	8	1,5	1,5	-1,1	2,5	1,1	3,3	3,5	3,5	-2,0	2,1	1,8	2,2	0,4	1,8
LB		2007	2015	8	4,0	4,0	3,0	6,7	6,7	6,7	6,7	6,7	6,7	6,7	6,7	4,0	4,0	4,0
LI		2007	2015	8	3,7	3,4	0,0	3,6	1,6	3,9	3,3	3,3	6,0	3,2	1,7	3,8	7,1	5,7
LY		2007	2015	8	2,6	2,6	3,2	1,3	1,3	1,3	1,3	1,3	1,3	1,3	1,3	2,6	2,6	2,6
MA		2007	2015	8	2,6	2,6	3,2	1,3	1,3	1,3	1,3	1,3	1,3	1,3	1,3	2,6	2,6	2,6
MD		2007	2015	8	4,1	4,1	-2,1	2,9	2,9	2,9	2,9	2,9	1,1	4,1	4,1	4,1	4,1	4,1
Rest Africa		2007	2015	8	2,0	2,0	2,1	0,9	0,9	0,9	0,9	0,9	0,9	0,9	0,9	2,0	2,0	2,0
Rest Asia		2007	2015	8	4,0	4,0	3,0	6,7	6,7	6,7	6,7	6,7	6,7	6,7	6,7	4,0	4,0	4,0
Rest Europe		2007	2015	8	3,7	3,4	0,0	3,6	1,6	3,9	3,3	3,3	6,0	3,2	1,7	3,8	7,1	5,7
Rest North America		2007	2015	8	2,3	1,9	0,8	2,3	2,2	3,4	2,8	2,8	2,1	1,8	1,1	2,3	0,9	1,3
Rest World		2007	2015	8	2,2	2,2	1,7	1,6	1,6	1,6	1,6	1,6	1,6	1,6	1,6	2,2	2,2	2,2
RU		2007	2015	8	3,0	3,0	-2,6	5,6	5,6	5,6	5,6	5,6	0,1	3,0	3,0	3,0	3,0	3,0
SY		2007	2015	8	4,0	4,0	3,0	6,7	6,7	6,7	6,7	6,7	6,7	6,7	6,7	4,0	4,0	4,0
TN		2007	2015	8	2,6	2,6	3,2	1,3	1,3	1,3	1,3	1,3	1,3	1,3	1,3	2,6	2,6	2,6
UA		2007	2015	8	3,7	3,7	-1,5	6,4	6,4	6,4	6,4	6,4	1,4	3,7	3,7	3,7	3,7	3,7
USA		2007	2015	8	2,4	1,7	1,8	2,0	1,6	2,3	2,4	2,4	-1,3	1,8	2,4	4,9	3,5	5,1
YU		2007	2015	8	3,4	3,4	0,7	2,8	2,8	2,8	2,8	2,8	1,6	3,4	3,4	3,4	3,4	3,4

ANNEX III – METHODOLOGICAL APPROACH FOR ESTIMATING RAIL FREIGHT OPERATING COST IMPACT OF THE HARMONIZED TRAIN LENGTH

The increase of the train length allows a better productivity of rail freight, so that the cost per tkm is reduced.

Given the following cost element of rail transport

	LD	LM	WD	WL	DR	EN	CH	OH
Cost element	Depreciation cost of the locomotive	Maintenance cost of the locomotive	Depreciation cost of 1 wagon	Maintenance cost of 1 wagon	Driver cost	Energy cost	Access charge	Average overhead (administrative costs etc.)
Unit of measure	€ / loco.km	€ / loco.km	€ / wagon.km	€ / wagon.km	€ / h	€ / trkm	€ / trkm	€ / trkm

the cost per tonne.km is then the following:

Rail cost (€ / tkm) = Train cost (€ / tkm) / Train payload PL (t) =

$$\frac{LD + LM + n_{wag} \cdot (WD + WL) + \frac{DR}{s} + EN + CH + OH}{PL} \quad [1]$$

where

n_{wag} = number of wagons

s = train commercial speed

TA_{wag} = tare of 1 wagon

W_{loco} = locomotive weight

PL = train payload in tons = n_{wag} x average payload[36] of 1 wagon (PL_{wag})

In case the train length is increased, supposing that no additional locomotive is required, the average cost per tkm will be reduced because only some of the cost elements in function [1] will increase, i.e. those (wagons costs and energy) depending on the number of wagon n_{wag}, so that the denominator of function [1] grows more than the numerator.

The above function will be calculated for the three typical train types T (SW: single wagon train, FT: full trainload, IM: intermodal train) in the situation before intervention (train length limit < target standard, e.g. 750 m) and after intervention (train length limit = target standard), so that the % reduction (CR_T) in unit rail freight costs per tkm of the train type T will be estimated.

[36] Net tonnage transported by 1 train.

The **average reduction in rail cost** ARC_T will be then calculated as the product of CR_T by the number of train actually taking benefits of the increase in train length (% long trains = LT_T) per train type, since no all trains are set at the maximum length, as already explained.

The hypothesis is that the ARC_T is entirely transferred to the market, so that the transport prices (net of terminal operation feeding, marshalling, etc.) will be reduced by the same percentage ($ARC_T = RP_T$, the latter representing the expected **transport price reduction** for goods moved by train type T).

Finally, the type of freight moved by each train type T (SW, FT or IM) will be defined, so that the expected reduction level of train prices RP_T can be assigned to each category of goods.

Data for the impact estimation and sources

a. Unit cost factors per type of train (LD, LM, WD, WL, DR, EN, CH, OH):

- Corridor A: *ERIM WP2 – Business oriented analysis of Genoa – Rotterdam corridor* (a benchmarking on the mentioned cost item has been carried out for France, Germany, Switzerland, Luxembourg, Belgium, Netherlands and Italy; the collected data have been reviewed by RUs). For France and Italy data will be checked also against the information collected by PwC for the economic study on Lyon – Turin railway link.

  NB. For the purpose of this study, focused on international traffic, only the cost parameters that are typically "national" (i.e. driver costs, energy and rail access charges) will be distinguished by country, for the other cost elements the average among ERIM values for corridor A countries will be considered

- Corridor E: country-specific values will be modified with respects to the Corridor A ones by multiplying the ERIM value for a reference country (e.g. Germany) by:
  - for driver cost, the ratio between average RU personnel cost of the country j (on Corridor E) and the one of the reference country, as emerging from UIC statistics;
  - for energy and access charges, the ratio between average IM revenue per trainkm of the country j (on Corridor E) and the one of the reference country, as emerging from UIC statistics.

b. Train technical parameters:

- Locomotive weight (W_{loco}) and length (L_{loco}): actual data of a typical freight locomotive;
- Wagon tare (TA_{wag}), average payload (PL_{wag}) and length (L_{wag}): average data on a sample of typical freight wagons (per type of train); the payload will take into account of maximum payload and usual load factor as analysed in previous studies (ERIM WP2, Recordit, ecc.);
- Number of wagon per train (n_{wag}): the maximum value will be set at (section train length constraint – L_{loco}) / (TA_{wag} + PL_{wag}).

c. Section with train length constraint < 750 m

- ERIM data supplied by PwC

d. % of trains set at maximum speed (i.e. taking benefits of the train length increase)

- Analysis of data on the freight train at Modane crossing (used by PwC for the studies on the Lyon – Turin railway link)

Need of improving wagon coupling and braking system

The increase of train length from 550/600 m to 750 m may require an improvement of the coupling and braking systems, since both will be affected by higher efforts.

The increase of wagon purchasing costs (impacting on wagon depreciation cost, WD) may be roughly estimated at 15%; a more in-depth analysis will be carried out to confirm this figure by consulting the scientific experts of the University of Rome La Sapienza.

Increase of WD will be integrated in the above approach, in order to have a complete view on impacts on RU costs.

ANNEX IV – APPROACH FOR ESTIMATING COST AND BENEFITS OF THE ADDITIONAL CAPACITY

In chapter 7.2.1 the expected impacts of capacity increase by 10% has been estimated. n order to calculate the likely potential benefits and cost of such increase, the following approach has been applied:

1. transformation of the effects from additional freight trainkm and reduction in regional passenger trainkm to additional tons km and reduction of passenger km;
2. for the reduction of regional passenger km, the following hypotheses are applied:
   a. 50% of the lost capacity will generate shift to road
   b. 50% will be absorbed by timetable restructuring, increase in load factor and using of other routes.
3. comparison with the expected macro effect (modal shift) in terms of additional tons km and reduction of passenger km
4. if the potential rail freight traffic due to additional capacity is higher than the expected additional rail traffic due to macro-level modal shift, the difference will be calculated and converted in potential additional benefits (both in terms of reduced external and internal costs);
5. similarly, the difference between the reduction in regional passenger traffic due to lower capacity and the reduction of same traffic due to macro-level modal shift is calculated and converted in potential additional costs (both in terms of higher external and internal costs).

The following tables present 2020 results of such approach for corridor A:

	Variation in rail capacity in 2020	Average load factor	Potential traffic variation traffic in 2020	Estimated modal shift effect in 2020 Option C *(TRANSTOOLS)*	Potential additional modal shift Option C
	(trainkm / y)	(t/train or pass/train)	(tkm or pass.km)	(tkm or pass.km)	(tkm or pass.km)
freight traffic	9.669.261	600	5.801.556.750	2.882.995.349	2.918.561.401
regional passenger traffic	-6.199.537	120	-371.972.235	-23.465.711	-348.506.524

	External costs per traffic unit (€ / 100 tkm or € / 100 pkm)		**External costs impact of additional capacity**	Average internal costs per traffic unit (€ / 100 tkm or € / 100 pkm)		**Internal costs impact of additional capacity**	**Total impacts of additional capacity**
	ROAD	RAIL	**(€)**	ROAD	RAIL	**(€)**	**(€)**
freight traffic	3,73	0,25	**101.565.937**	8,52	5,38	**91.526.845**	**193.092.782**
regional passenger traffic	9,90	0,63	**-32.236.853**	26,10	13,52	**-43.844.760**	**-76.081.614**
		Total effect	**69.329.083**			**47.682.085**	**117.011.168**

The following tables present 2020 results of such approach for corridor E:

	Variation in rail capacity in 2020	Average load factor	Potential traffic variation traffic in 2020	Estimated modal shift effect in 2020 Option C *(TRANSTOOLS)*	Potential additional modal shift Option C
	(trainkm / y)	(t/train or pass/train)	(tkm or pass.km)	(tkm or pass.km)	(tkm or pass.km)
freight traffic	2.260.550	600	1.356.330.000	1.794.605.490	0
regional passenger traffic	-273.700	120	-16.422.000	-6.619.926	-9.802.074

For this corridor, the additional traffic due to increased rail capacity is lower than the estimated modal shift effect in 2020, so that no further benefits are expected. On the contrary, the reduction of regional passenger traffic is higher than the one due to macro-level modal shift effect, so the related external and internal costs shall be taken into account.

The rail freight traffic increase due to modal shift would require a 13% increase of the capacity, so 3% more than the supposed augmentation. It has been considered that this small difference may be absorbed by the additional capacity brought by increased train length and by capacity savings obtained from timetable restructuring, so that no additional capacity needs have been considered for the impacts on passenger traffic.

	External costs per traffic unit (€ / 100 tkm or € / 100 pkm)		**External costs impact of additional capacity**	Average internal costs per traffic unit (€ / 100 tkm or € / 100 pkm)		**Internal costs impact of additional capacity**	**Total impacts of additional capacity**
	ROAD	RAIL	**(€)**	ROAD	RAIL	**(€)**	**(€)**
freight traffic	2,10	0,34	**0**	9,28	8,39	**0**	**0**
regional passenger traffic	5,55	0,58	**-487.163**	18,86	9,88	**-880.222**	**-1.367.385**
		Total effect	**-487.163**			**-880.222**	**-1.367.385**

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ANNEX V – TRAFFIC RESULT CORRIDOR A, E AND OVERALL NETWORK

Table 1 ***Result performance Option B - Option A:***

	Freight in million tonne-kilometres	Change in %	**Passenger** in million passenger kilometres per year	Change in %
Corridor A	2.453	5,2%	-	0,0%
Corridor E	1	0,0%	-	0,0%
Overall ERIM network	13.428	3,4%	-	0,0%

Table 2 ***Result performance Option C- Option A:***

	Freight in million tonne-kilometres	Change in%	**Passenger** in million passenger kilometres per year	Change in %
Corridor A	2.883	6,1%	23-	-0,1%
Corridor E	1.795	14,8%	7-	-0,2%
Overall ERIM network	20.117	5,1%	74-	-0,1%

Table 3 ***Overall figures optino A***

	Freight in million tonne-kilometres		**Passenger kilometres** in million passenger kilometres per year	
Corridor A	47.477		17.768	
Corridor E	12.099		3.889	
Overall ERIM network	398.075		81.044	

ANNEX VI –CBA METHODOLOGY DESCRIPTION

Quantitative micro – level impacts

Investment cost for prolonging tracks

- *Calculation of annual values*:
    - *A/E Corridor*: see paragraph 7.1.1 (Harmonized train length)
    - *Whole Network*: see paragraph 9.1 (Proposed approach)
- *Annual evolution*: Costs are equally distributed over a 7 years period (2009-2015)
- *Resulting NPV*:

	Corridor A	Corridor E	Overall network
NPV	-€ 136.508.815	-€ 129.536.235	-€ 2.694.990.868

Rail freight cost reduction due to increased train length

- *Calculation of annual values*:

1. [Average absolute cost reduction (see chapter 7.5)] x [Ex – ante cost per t km (for each rail route where train length is foreseen)] = [average cost reduction €/t km]
2. [Average cost reduction (€/t km)] x [Total traffic on corridor] x [percentage of trains affected by cost reduction] = [rail cost reduction]

Example (step 2):

Hypo				
Saving	IM	0,0011	€ / tkm	A
	SW	0,0034	€ / tkm	B
Traffic	International	2.013	tonn kms	20%
	National	2.020	tonn kms	100%
	Total	12.886	Millions tkm	
of which	IM (60%)	7.732	Millions tkm	C
of which	SW (20%)	2.577	Millions tkm	D
	Total 2020 savings	**17.582.504**	**€ / year**	**(AxC)+(BxD)**

- *A/E Corridor*: See paragraph 7.1.1 (Harmonized train length) and paragraph 7.5 (Cost benefits Analysis micro level)
- *Whole Network*: see paragraph 9.2.1 (Decrease of rail freight operating costs)

- *Annual evolution*: This cost reduction is expected to be achieved every year from 2016 (the prolonging of trains will be finished in 2015).
- *Resulting NPV*:

	Corridor A	Corridor E	Overall network
NPV	€ 168.547.246	€ 46.295.453	€ 1.754.183.973

Reduction of waiting times at borders

- *Calculation of annual values*:
    - *A/E Corridor*: see paragraph 7.1.2

      [(2020 option A waiting times at borders) – (2020 "Optimum time" at borders considering improved interoperability)] x (traffic at selected border stations)

    - *Other ERTMS corridors*: as for corridor A and E
    - *Whole Network*: see paragraph 9.2.2 (Proposed approach)

      (Total international traffic on network) x [(overall border waiting time on ERTMS corridor / traffic over ERTMS corridor)]

- *Annual evolution*: annual freight traffic growth rate up to 2020 (+3,5% each year), moreover the results are monetized according to time value as indicated in the Handbook on estimation of external costs in transport sector (2007).
- *Resulting NPV*:

	Corridor A	Corridor E	Overall network
NPV (Option C)	€ 1.161.118.691	€ 390.383.779	€ 2.685.798.035
NPV (Option B)	€ 878.275.954	€ 295.288.233	€ 2.031.550.995
In Option B the benefits arising from this measure are considered starting only after 2020, while in option C they're considered starting from 2016.			

Additional capacity for freight trains

The information on theoretical capacity and traffic mix (number of trains per type) in 2020 obtained from UIC (ERIM database) is very aggregated, since only average values per each country over the corridor has been supplied. As a consequence of this it has been agreed with DG TREN that two alternative scenarios should have been considered, with an increase of +10% and +30% respectively.

Within the Cost Benefit Analysis only the 10% increase scenario has been considered.

For the results of the calculation of the impact of the additional capacity see *Annex IV– Approach for estimating cost and benefits of the additional capacity*.

Moreover only in Option C economic impacts are expected because the proposed measure can be achieved only through a legislative process.

As shown in table 9 – 14 of the Final Report the overall impact of the additional capacity for freight trains amounts to € 1.209,3 millions.

Reduction in waiting times of freight trains

- *Calculation of annual values*:
    - *A/E Corridor*: See paragraph 7.3.1 (Reduction in waiting times of freight trains). The calculation of the reduction of waiting times of freight trains has been calculated through the extrapolation of the results of the showcase line Béning (France) – Ludwigshafen (Germany) provided in the New Opera Study. The Study provides an estimate of the impact in terms of reduction of freight trains waiting times due to a change in train freight priority.

The estimation worked out within the New Opera case study show that the lower is the % of freight paths the higher is the expected reduction in waiting times after an increase of freight trains priority. This reflects the fact that an high share of freight traffic implies that there is not a lot of time to be saved by giving them priority to the few passenger trains. On the basis of such a relationship it has been possible to extrapolate to all of the sections of the A/E Corridor the following exponential correlation formula:

1. *For scheduled waiting times*:

$$y = 0{,}2167e^{-5{,}0394x}$$

2. *For unscheduled waiting times*:

$$y = 0{,}1156e^{-4{,}7583x}$$

Where:

1. "y" is the reduction in waiting times on a specific section due to an increase in freight trains priority, which is function of;
2. "x" representing the % of freight paths on that section.

The economic benefit has been calculated by multiplying, for each year the following factors:

1. time savings (calculated through the application of the formula described above);
2. expected freight traffic volume at the year 2020 (train/km);
3. a load factor of 600 tons per freight train;
4. a value of time of 1,22 €/t.h[37].

- *Annual evolution*: economic benefit annual values vary on the basis of the growth in the value of time (see footnote 37).
- *Whole Network*: the above described calculation formulas, derived on the basis of the New Opera results, have been applied to all sections for the extrapolation of impacts to the whole network.

	Option	Corridor A	Corridor E	Overall network
NPV	B	0	0	0
	C	€ 266.447.845	€ 77.626.366	€ 854.231.097

Only in Option C benefits are expected because the proposed measure can be achieved only through a legislative process.

Increase in waiting times of passenger trains

- *Calculation of annual values*:
  - *A/E Corridor*: See paragraph 7.3.1 (Reduction in waiting times of freight trains). The calculation of the increase of waiting times of passenger trains has been calculated through the same approach applied for the calculation of the reduction of waiting times in freight trains, which

[37] Value of time as at year 2005, indexed for the following years of analysis at 1% (expected annual growth rate of GDP / head)

means by extrapolating the results of the showcase line Béning (France) – Ludwigshafen (Germany). The estimation worked out within the New Opera case study show that the lower is the % of freight paths the higher is the expected increase in waiting times of passenger trains after an increase of freight trains priority. This reflects the fact that an high share of freight traffic implies that there is not a lot of passenger traffic to be affected by giving freight trains an higher priority. On the basis of such a relationship it has been possible to extrapolate to all of the sections of the A/E Corridor the following exponential correlation formula:

1. *For scheduled waiting times*:

$$y = 0{,}00982e^{-1{,}7877x}$$

2. *For unscheduled waiting times*:

$$y = 0{,}00248e^{-0{,}1315x}$$

Where:

1. "y" is the increase in passenger trains waiting times on a specific section due to an higher priority for freight trains, which is function of;
2. "x" representing the % of freight paths on that section.

The economic benefit has been calculated by multiplying, for each year the following factors:

1. time increase (calculated through the application of the formula described above);
2. 30% of the expected national and international passenger trains/km at the year 2020 (train/km);
3. a load factor of 120 passenger per passenger train;
4. a value of time of 9,02[38] €/pax.h.

- *Annual evolution*: economic costs annual values vary on the basis of the growth in the value of time (see footnote 38).
- *Whole Network*: the above described calculation formulas, derived on the basis of the New Opera results, have been applied to all sections for the extrapolation of impacts to the whole network.

	Option	Corridor A	Corridor E	Overall network
NPV	B	-	-	-
	C	- € 125.780.691	- € 24.854.946	- € 473.846.825

Only in Option C benefits are expected because the proposed measure can be put in place only through a legislative process.

Additional charges for priority freight path

- *Calculation of annual values*:
  - *A/E Corridor*: see paragraph 7.5

    [Traffic on selected ERTMS corridor] x [("Express" path price) – (Standard path price)][39]

[38] Value of time as at year 2005, indexed for the following years of analysis at 1% (expected annual growth rate of GDP / head)

- o *Other ERTMS corridors*: as for corridor A and E
- o *Whole Network*: no calculation performed for the whole network.

- *Annual evolution*: constant values
- *Resulting NPV*:

	Corridor A	Corridor E	Overall network
NPV (Option C)	-€ 104.432.666	-€ 23.192.362	-
NPV (Option B)	€ 0	€ 0	-
Only in Option C benefits are expected because only through a legislative process the proposed measure can be achieved.			

Investment costs for prolonging the transhipment tracks

- *Calculation of annual values*:
  - o *A/E Corridor*: see paragraph 7.4.1
  - o *Other ERTMS corridors*: as for corridor A and E
  - o *Whole Network*: [(Upgrading costs for transhipment tracks prolongement) / (km of rail network of ERTMS corridor)] x (km of network composing the "Rest of network")
- *Annual evolution*: costs are equally split over three years (2013-2015) assuming that the realisation of tracks takes into account three years
- *Resulting NPV*:

	Corridor A	Corridor E	Overall network
NPV	-€ 30.478.713	-€ 28.079.220	-€ 187.842.781

[39] The cost benefit calculation has shown that only an increase by 6% is acceptable in order not to annul the direct benefits in freight travel time obtained by the time reduction.

Reduction of shunting costs because of longer transhipment tracks

- *Calculation of annual values*:
    - *A/E Corridor*: see paragraph 7.4.2

    [Nb. of saved transhipment operation due to 750 m tracks] x [2020 CT services] x [% of services having benefits from enlargement] x [cost of shunting operation]

Average transhipment tracks length (baseline)	% of trains taking benefit of track length extension
<= 400 m	100 %
Between 400 m and 500 m	50 %
> 500 m	20%

    - *Other ERTMS corridors*: as for corridor A and E
    - *Whole Network*: [(Cost savings due to transhipment tracks prolongement) / (Intermodal traffic on the corridor)] x [(Total traffic on the network)x (%age of intermodal traffic)]
- *Annual evolution*: from 2016 to 2020 is considered an evolution in the n. of services from and to the terminals based on a specific growth rate estimated in TEMA for intermodal traffic to/from each traffic area
- *Resulting NPV*:

	Corridor A	Corridor E	Overall network
NPV	€ 21.548.744	€ 28.212.885	€ 115.193.048

Time savings because of longer transhipment tracks

- *Calculation of annual values*:
    - *A/E Corridor*: see paragraph 7.4.2
    - [2020 CT services] x [% of services having benefits from enlargement] x [cost of shunting operation] x [Average time saving] x [Value of time]

    Where average time saving = Nb. of avoidable shunting operations (per train) * 30’

Average transhipment tracks length (baseline)	% of trains taking benefit of track length extension
<= 400 m	100 %
Between 400 m and 500 m	50 %
> 500 m	20%

    - *Other ERTMS corridors*: as for corridor A and E
    - *Whole Network*: [(Time savings due to transhipment tracks prolongement) / (Intermodal traffic on the corridor)] x [(Total traffic on the network) x (% of intermodal traffic)]
- *Annual evolution*: according to time value as indicated in the Handbook on estimation of external costs in transport sector (2007); moreover 2016 to 2020 is considered an evolution in the n. of services from and to the terminals based on a specific growth rate estimated in TEMA for intermodal traffic to/from each traffic area
- *Resulting NPV*:

	Corridor A	Corridor E	Overall network

NPV	€ 156.801.717	€ 62.058.217	€ 655.401.644

Time savings because of terminal slot and train path coordination

- *Calculation of annual values*:
  - *A/E Corridor*: see paragraph 7.4.2
  - [Average time saving per train at each terminal] x [traffic in tons at selected terminals] x [cost of transhipment operation] x [Value of time]

  Where maximum time savings = 82,5’ for long distance services and 50% for short distance services (short distance services are calculated at 30% of total traffic)

Average transhipment tracks length (baseline)	% of trains taking benefit of track length extension
<= 400 m	100 %
Between 400 m and 500 m	50 %
> 500 m	20%

  - *Other ERTMS corridors*: as for corridor A and E
  - *Whole Network*: [(Time savings due to transhipment tracks prolongement) / (Intermodal traffic on the corridor)] x [(Total traffic on the network) x (%age of intermodal traffic)]
- *Annual evolution*: according to time value as indicated in the Handbook on estimation of external costs in transport sector (2007); moreover from 2016 to 2020 is considered an evolution in the number of services from and to the terminals according to a specific growth rate estimated in TEMA for the intermodal traffic to/from each traffic area.
- *Resulting NPV*:

	Corridor A	Corridor E	Overall network
NPV (Option C)	€ 519.813.229	€ 407.644.276	€ 1.958.023.862
NPV (Option B)	€ 0	€ 0	-
Only in Option C benefits are expected because only through a legislative process the proposed measure can be achieved.			

Quantitative macro – level impacts

Impacts on traffic (modal shift)

- *A/E Corridor*: in order to determine the modal shift from road to rail generated by the proposed interventions on the rail freight network, and in particular for Corridors A and E, it has been assumed that the improved conditions of the rail freight transport in the post intervention scenario should lead to a variation in the variables affecting the transport demand. As a consequence, in order to quantify, the modal shift on the two case studies corridors, the following variables have been taken into account (see paragraph 5.3.1, 5.3.2):
    1. reduction of rail freight price;
    2. reduction of border station waiting times due to improved interoperability;
    3. reduction of terminal related waiting times (reduction of shunting operations / coordination between terminal operations in the rail path planning);
    4. reduction of the average journey times.
- *Whole Network*: in order to determine modal shift on the overall network the same process has been reiterated taking into account the total estimated traffic on the network at the year 2020.

Direct economic effect

- *A/E Corridor*: as indicated in paragraph 11.2., the direct economic effect has been estimated in terms of net variation of total transport costs for the users, due to the shift from road to rail of some freight traffic on one hand, and to the shift of some passenger traffic from rail to road on the other hand.

  [Direct economic effect] = [traffic (with modal shift – Tab 11.1/11.2)] x [variation of total transport costs Tab 11.4]
- *Whole Network*: in order to determine the direct economic effect on the overall network the same process has been reiterated taking into account the total estimated traffic on the network at the year 2020.

		Corridor A (mn €)	**Corridor E (mn €)**	**Overall network (mn €)**
NPV (Option C)	Freight	846,5	149,3	5.679,0
	Passenger	-27,9	-5,6	-74,7
NPV (Option B)	Freight	706,5	0,2	3.806,9
	Passenger	0,0	0,0	0,0
For the option B there is no impact on the passenger transport market, therefore only the modal shifts in the freight transport market were used for the impact. For Option C there are 'reversed modal shifts' expected in the passenger transport market due to less local trains.				

Impact on congestion, environment and safety

- *A/E Corridor*: as indicated in paragraph 11.3, the impacts on congestion, environment (pollution, noise, climate change) and transport safety are directly linked to the modal shift. The level of the external impacts have been estimated in monetary terms using unit cost value per ton.km and passenger.km of road and rail on the basis of the guidelines given by the recent Handbook on estimation of external cost in transport sector (2007), prepared by the consortium led by CE Delft on behalf of DG TREN.

  [External impact] = [traffic (with modal shift – Tab 11.1/11.2)] x [Δ of unitary external costs road vs. rail – Tab. from 11.7 to 11.13]

- *Whole Network*: in order to determine the impact on congestion, environment and safety on the overall network the same process has been reiterated taking into account the total estimated traffic on the network at the year 2020.

		Corridor A (mn €)	Corridor E (mn €)	Overall network (mn €)
NPV (Option C)	Freight	97.845,10	32.588,50	542.275,10
	Passenger	-2.150,10	-340,60	-408,90
NPV (Option B)	Freight	83.266,50	14,70	361.962,80
	Passenger	0	0	0
For the option B there is no impact on the passenger transport market, therefore only the modal shifts in the freight transport market were used for the impact. For Option C there are 'reversed modal shifts' expected in the passenger transport market due to less local trains.				

Employment impacts

- *A/E Corridor*: In terms of employment, the main effect of the proposed policy Options are the need of additional staff for administrative tasks and the likely reduction of the employment in the road sector, resulting from the shift of traffic to rail transport because of reduction in time and costs of the latter[40].

$$job\_effects = f\left(OSS\_staff; Corridor\_ref\_doc\_staff; freight\_traffic\_quality\_monitoring\_staff\right)$$

See paragraph 11.4

- *Whole Network*: The data have been extrapolated to the overall European main network by applying the following ratios: n. administrative staff / international rail traffic (bn tkm) for the employment needs in One Stop Shops and Traffic Quality Monitoring and n. administrative staff / rail network length for the employment needs in Corridor Reference document preparation (permanent FTEs required)[41].

[40] The modal shift impact do not increase the employment in the rail industry (sector characterised by relative job intensity)

[41] The resulting figures have been then reduced by 60%, since an implementation for the whole European main network will certainly imply significant synergies in terms of administrative tasks.

		Corridor A (FTE/year)	Corridor E (FTE/year)	Total main European network (FTE/year)
Option C	One Stop Shop	10	4,5	71
	Corridor freight traffic quality control	3	1	17
	Preparation of Corridor Reference document	0,4	0,2	3,4
Option B	One Stop Shop	10	4,5	71
	Corridor freight traffic quality control	3	1	17

For **Option B**, according to the options' definition (cf. Inception Report), the implementation of the Corridor Reference document is not foreseen, since it requires a legislative framework. On the contrary, both OSS and Quality monitoring are likely to be implemented as in Option C.

NPV Calculation methodology

The net present value of each impact has been calculated using the following formula:

$$NPV = \sum_{i=1}^{n} \frac{values_i}{(1+rate)^i}$$

TAs an example, the results for one specific intervention area (waiting time at borders) are indicated in the table hereinafter showing for each year the expected benefit and the net present value of each year at the basis year (2008).

Year	Benefits arising from reduced waiting times at BS	Net present value arising from reduced waiting times at BS (basis year:2009)
2009	-	-
2010	-	-
2011	-	-
2012	-	-
2013	-	-
2014	-	-
2015	-	-
2016	110.634.847	74.882.019
2017	111.741.196	72.029.371
2018	112.858.608	69.285.395
2019	113.987.194	66.645.951
2020	115.127.066	64.107.058
2021	116.278.336	61.664.884
2022	117.441.120	59.315.746
2023	118.615.531	57.056.098
2024	119.801.686	54.882.533
2025	120.999.703	52.791.770
2026	122.209.700	50.780.655
2027	123.431.797	48.846.153
2028	124.666.115	46.985.348
2029	125.912.776	45.195.430
2030	127.171.904	43.473.699
2031	128.443.623	41.817.558
2032	129.728.059	40.224.508
2033	131.025.340	38.692.146
2034	132.335.593	37.218.159
2035	133.658.949	35.800.325
2036	134.995.539	34.436.503
2037	136.345.494	33.124.636
2038	137.708.949	31.862.745
Total benefits	**2.845.119.123**	
Discount rate	**5,00%**	
NPV (2009-2038)	**€ 1.161.118.691**	**€ 1.161.118.691**