FR

ANNEXE 10

ANALYSE QUANTITATIVE DES IMPACTS OPERATIONNELS SUR LE CORRIDOR A

1. IMPACTS OF INTERVENTION ON TECHNICAL HARMONISATION

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.

Country code	Point_1	Point_2	Corridor ertms	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

Country code	Point_1	Point_2	Corridor ertms	Overall route length [km]	Maximum train length [m]
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

Section with maximum train length < 750 m (Corridor A)

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

- traffic between Milan area and the north via Simplon (limit 500 m) or via Luino (600 m)
- traffic between Novara area and the north via Simplon (limit 575 m) or via Luino (600 m);
- 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. 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 have been obtained

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	Simplon	500	28,83%	20%	**5,77%**	23,53%	50%	**11,76%**

Milan area and the north	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)

Cost savings due to harmonized train 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 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%.

	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

Allocation of the goods category per type of train

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.

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

Hypothesis on section upgrading cost (PwC elaboration on various sources[1])

The average values between maximum and minimum cost per km have been taken, since no details are available about the geography of each section. For upgrading not included in the table (from 355 to 750 m), the double of the upgrading from 500 to 750 m has been taken into account.

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	

[1] E.g. J.P. Baumgartner, *Prices and costs in the railway sector*, Ecole Polytechnique Fédérale de Lausanne, 2001.

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**

Estimate of section upgrading costs

1.2. Reduction of waiting times at borders

This impact mainly concerns railway undertakings due to the improved operational speed at the 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.

Current 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

Future waiting times

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
Total savings	**0**	**-315**	**-270**

Current and future waiting time at ERTMS corridor A border stations

An overall saving on this corridor of 315' (conventional freight trains) or 270' (intermodal trains) is expected for trains crossing all borders in case an improved interoperability takes place.

2. IMPACTS OF INTERVENTION ON PATH ALLOCATION RULES

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.

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*

Capacity and traffic information (Corridor A)

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.

a) 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;

b) 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;

c) 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:

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

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

Equivalence between freight and passenger paths

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).

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.*

Additional freight paths and cancelled passenger paths – scenario freight paths +10%

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.*

Additional freight paths and cancelled passenger paths – scenario freight paths +30%

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

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

3. IMPACTS OF INTERVENTION ON PATH ALLOCATION AND TRAFFIC MANAGEMENT RULES ON TRAIN PRIORITY

3.1. Reduction in waiting times of freight trains

Interventions on traffic management rules should be taken in order to respond to the need for a sufficient priority to freight trains in case of infrastructure congestion.

Furthermore, binding financial compensation schemes exist for the customers of passenger trains and not of 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.

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 high priority freight train delays due to disruptions on passenger traffic.

Unfortunately, information on waiting times 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 corridor Béning (France) – Ludwigshafen (Germany) and, in particular, to the following segments:

– Ludwigshafen – Neustadt;

– Kaiserslauten – Homburg;

– Saarbrucken – Béning.

For each of the above listed sections, two different scenarios have been elaborated in order to evaluate the reduction of waiting times following an intervention consisting in an increase of freight paths priority.

The two scenarios differ for the ETCS level, which is “2” in scenario 2 and “3” in scenario 3.

By means of the Impact Assessment, the first scenario is assumed to be the current situation and the second one, with the ETCS level “3” in place, is the baseline situation at the year 2020.

In both cases a reduction in waiting times is expected to occur as a consequence of the change of priority in freight paths, and this reduction is expected to be higher in scenario 2 than in scenario 3.

The following table summarises the information provided by the New Opera case study in the two scenarios for the examined sections.

Length (km)	Segment	Expected reduction in scheduled waiting times (min/km)		Freight traffic density	Direction
		Scenario 2	Scenario 3		
28,195	LUDWIGSHAFEN - NEUSTADT	0,211030325	0,141514453	25,8%	E/W
28,195	NEUSTADT - LUDWIGSHAFEN	0,182301827	0,090086895	25,8%	W/E
31,937	KAISERSLAUTEN - HOMBURG	0,041018255	0,01502959	34,8%	E/W
31,937	HOMBURG -KAISERSLAUTEN	0,036008392	0,016595172	34,8%	W/E
18	SAARBRUCKEN - BENING	0,063333333	0,018888889	61,5%	E/W
18	BENING - SAARBRUCKEN	0,017222222	0,007777778	61,5%	W/E

Length (km)	Segment	Expected reduction in unscheduled waiting times (min/km)		Freight traffic density	Direction
		Scenario 2	Scenario 3		
28,195	LUDWIGSHAFEN - NEUSTADT	0,089732222	0,063486434	25,8%	E/W
28,195	NEUSTADT - LUDWIGSHAFEN	0,091860259	0,063486434	25,8%	W/E
31,937	KAISERSLAUTEN - HOMBURG	0,021918151	0,009393493	34,8%	E/W
31,937	HOMBURG -KAISERSLAUTEN	0,020352569	0,00970661	34,8%	W/E
18	SAARBRUCKEN - BENING	0,032777778	0,011666667	61,5%	E/W
18	BENING - SAARBRUCKEN	0,011111111	0,00500000	61,5%	W/E

Expected reduction in waiting times due to the increase of freight trains priority

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:

d) Route length;

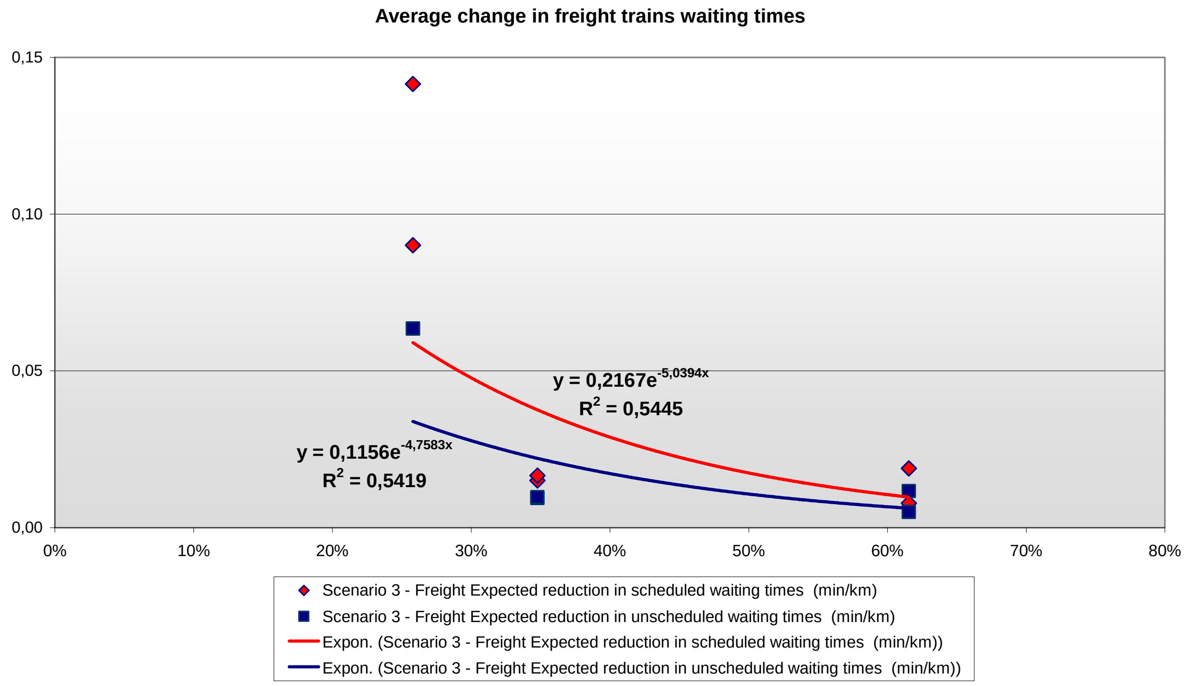
e) % of freight trains (on the basis of the passenger / freight traffic mix of each section).

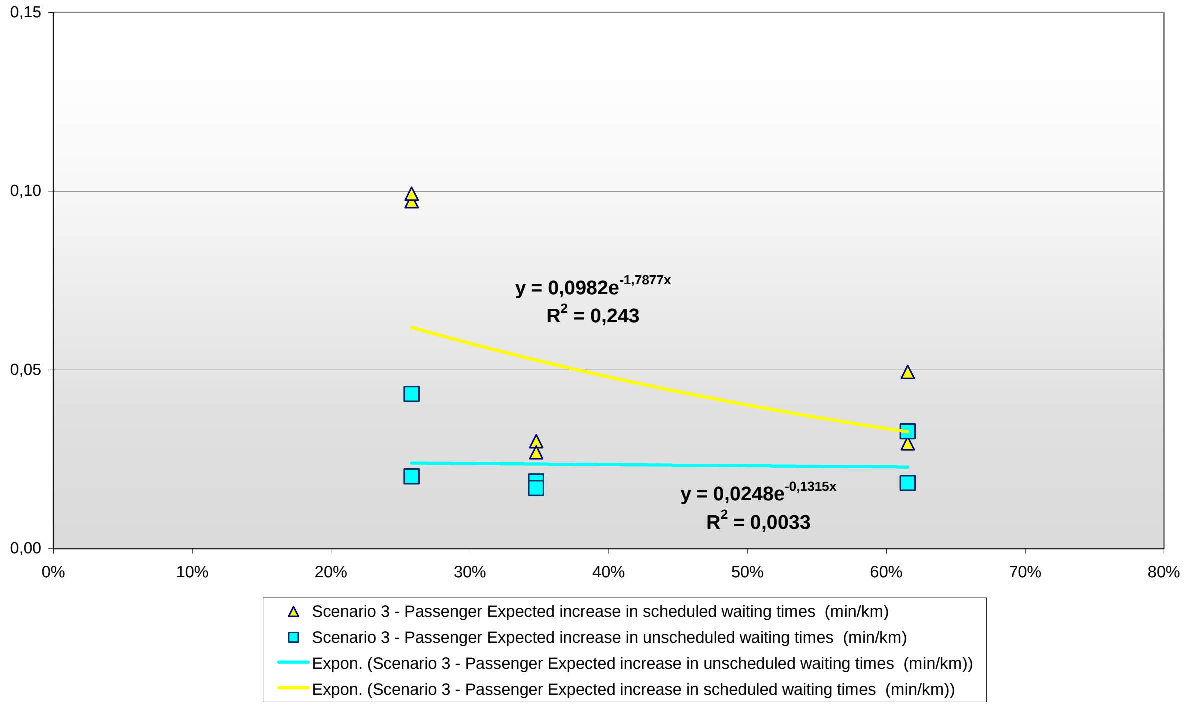
Obviously, the reference values from the New Opera case study will be the ones of scenario "2" or "3", depending on the ETCS in place in each section (level 2 or 3).

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 have been approximated through exponential functions, as shown in the following graphs. The so-obtained exponential functions have been used to calculate the estimated average change in waiting times for freight and for passengers on the section of the four countries of the corridors.





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

EXPECTED VARIATION IN FREIGHT TRAINS WAITING TIMES									
					Average variation of waiting times (Scenario 3 New Opera)			Corresponding variation of waiting time	
Country	Infrastructure Manager	ERTMS Corridor	Route length [km]	Average % of freight trains (Scenario 2 New Opera) = x	Unscheduled (minutes / km)	Scheduled (minutes / km)	% of freight trains on the examined section	Unscheduled - freight (minutes / km)	Scheduled - freight (minutes / km)
NL	ProRail	A	103	89%	0,0271	0,048315	40,71%	0,0017	0,0024
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

EXPECTED VARIATION IN PASSENGER TRAINS WAITING TIMES									
Country	Infrastructure Manager	ERTMS Corridor	Route length [km]	Average % of freight trains (Scenario 2 New Opera) = x	Average variation of waiting times (Scenario 3 New Opera)		% of freight trains on the examined section	Corresponding variation of waiting time	
					Unscheduled (minutes / km)	Scheduled (minutes / km)		Unscheduled - freight (minutes / km)	Scheduled - freight (minutes / km)
NL	ProRail	A	103	89%	-0,0250	-0,05539	59,29%	-0,0221	-0,0200
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

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[2] (the German rail Infrastructure Manager) a "**Güterwerkerhrs – Express – Trasse**" (i.e. Express Freight Path) **costs the 65% more than the standard one**.

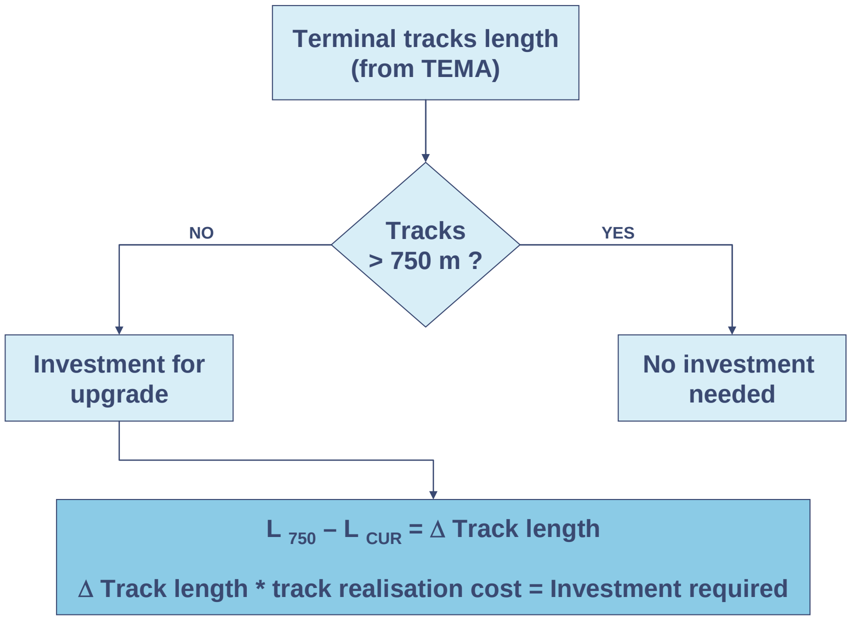
All the freight trains using this type of path are likely to be charged of an extra cost (about +65% of the basis cost) connected to the quality of the path and the corresponding level of service that can be offered.

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

4. IMPACT OF INTERVENTION ON TERMINALS

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.



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 serve trains of a length of 750 m. This way, the train does not have to be split in several parts (each corresponding to the length of the transshipment track), thus ensuring time and cost savings, due to the lower shunting[3] operations to load and unload the train.

Next, the value of such length was multiplied by an hypothetical realization cost of a linear meter[4], 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.

3 The term "shunting" refers to all the operations related to the moving of wagons inside terminals. Such operation is normally performed with manoeuvring locomotives.

4 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.).

Terminal with average transhipment track lenght < 600 mt

	Terminal	Tracks n and length		Average lenght	Meters of tracks necessary to accomodate trains 750 m long	
		3	620	620	130	390
Germany	Ludwigshafen KTL	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 lenght > 600 mt

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

Tracks to be realized in the terminal of ERTMS corridor A

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**.

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[5], 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 hypothesis is considered

Average transhipment track length (baseline)	% of trains taking benefit of track length extension
<= 400 m	100%

[5] 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.

Between 400 and 500 m	50%
> 500 m	20%

The number of shunting operation that are likely to be saved are presented in the following table

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%	82
Italy	Milano Certosa	3	1130	377	2	1	24	24	11,6%	66	100%	66
Italy	Milano Smistamento	4	1860	465	2	1	48	48	11,6%	132	50%	66
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

Savings in shun ting operations due to the increased tracks length

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 including 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 traffic flows:

- Intermodal flows to/from Milan area or Busto Arsizio

- Intermodal flows to/from Basel
- Intermodal flows to/from the following German areas: Ludwisghafen, Koeln, Duisburg, Mannheim.

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" [6] of tracks accessing the terminal. Moreover, the overall capacity of the railway system is improved.

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

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

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.

[6] 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).

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) =

$$\frac{LD + LM + n_{wag} \cdot (WD + WL) + \frac{DR}{s} + EN + CH + OH}{PL} \qquad [1]$$

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[7] 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.

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.

[7] Net tonnage transported by 1 train.

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. <u>% of trains set at maximum speed (i.e. taking benefits of the train length increase)</u>

- o Analysis of data on the freight train at Modane crossing (used by PwC for the studies on the Lyon – Turin railway link)

<u>Need of improving wagon coupling and braking system</u>

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.

ANNEXE 11

SCÉNARIO DE RÉFÉRENCE 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**	**2020**
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						
	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		94%				X
Max train limit 750 m or more		-				X
Loading gauge Gabarit GB		100%				X

or bigger						
Loading gauge Gabarit GC or bigger		-				X
Axle load up to 22,5 t or higher		89%				X
Rail line with at least two tracks		-				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.

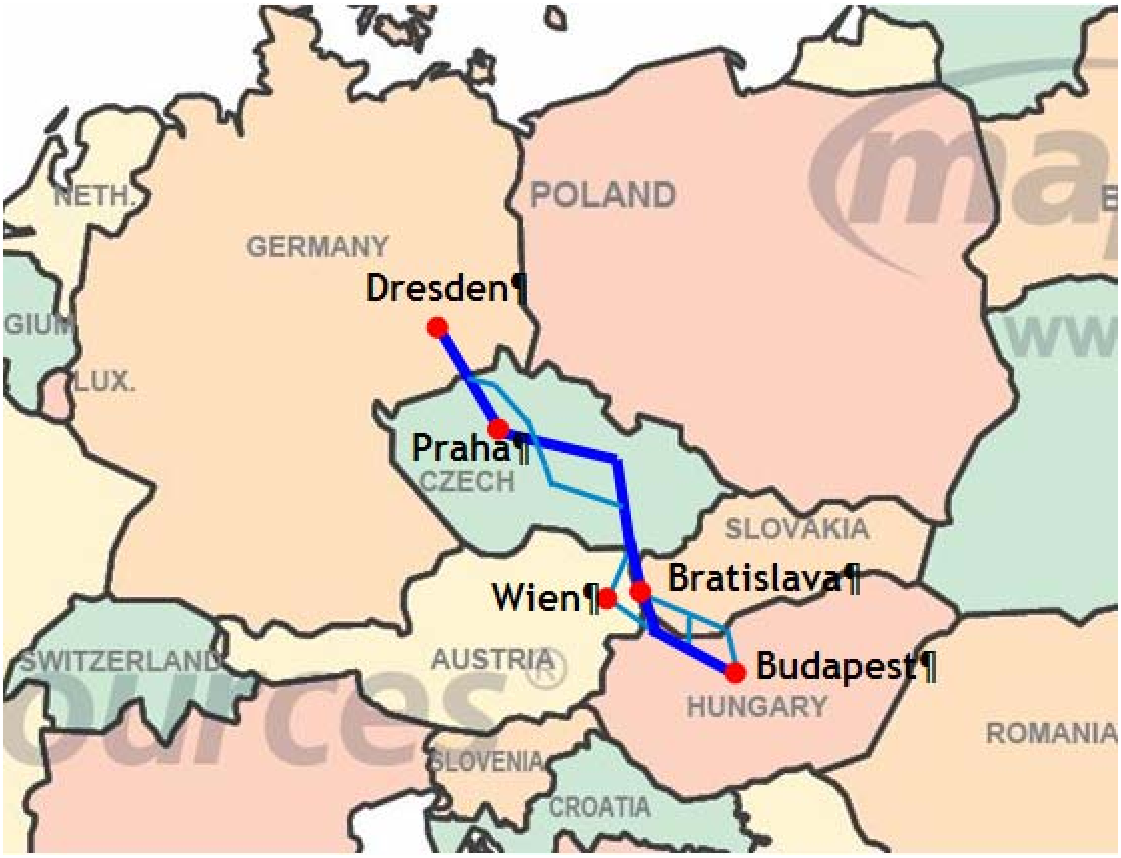
Only the sections present in the path catalogue are listed in the table. offers train paths only for cross-border sections of the line. In the national section path will be then allocated taking into account the booked path on the cross border section.

Section	**Daily Train Paths Available**							**Notes**			
Section (length of each section)	Sun	Mon	Tue	Wed	Thu	Fri	Sat	Country	Max train length m	Ma x 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
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	

<table>
<tr><td colspan="7">Corridor governance</td></tr>
<tr><td colspan="3">Existing coordination tables among IMs</td><td colspan="4">Existing coordination tables among MS</td></tr>
<tr><td colspan="3">Interoperability</td><td colspan="3">Coordinated investments</td><td rowspan="5">Limited investment coordination</td></tr>
<tr><td>ERTMS Deployment</td><td>☑ YES</td><td>☐ NO</td><td>TEN-T priority project</td><td>☑ YES</td><td>☐ NO</td></tr>
<tr><td colspan="3">Letter of intent signed in May 2007 by Germany, Czech Republic, Austria, Slovak Republic and Hungary.</td><td colspan="3">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).</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>
</table>

Corridor Map


ANNEXE 12

ANALYSE QUANTITATIVE DES IMPACTS OPERATIONNELS SUR LE CORRIDOR E

IMPACTS OF INTERVENTION ON TECHNICAL HARMONISATION

4.4. 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.

Country	Point_1	Point_2	Corridor ertms	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

Country	Point_1	Point_2	Corridor ertms	Overall route length [km]	Maximum train length [m]
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

Section with maximum train length < 750 m (Corridor A)

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

The change in rail operating costs per tkm on the above mentioned flows has been estimated according to the approach explained in the annex. The change in rail operating costs has been calculated considering average value of the cost factors among the corridor E 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 have been obtained

Traffic flow	Max train length (m)	Intermodal trains **			Single wagon trains **		
		Expected reduction in	% of train set at naxinu	Average reduction in	Expected reduction in	% of train set at naxinu	Average reduction in

		train cost per tkn (%)	n length *	train costs per tkn (%)	train cost per tkn (%)	n length *	train costs per tkn (%)
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)

Cost savings due to harmonized train 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 following table (already presented for corridor A) 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 Dresden Area and Austria (3,30%+6,27%)/2 = 4,78%.

	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

Allocation of the goods category per type of train

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.

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

Hypothesis on section upgrading cost (PwC elaboration on various sources[8])

The average values between maximum and minimum cost per km have been taken, since no details are available about the geography of each section. For upgrading not included in the table (from 355 to 750 m), the double of the upgrading from 500 to 750 m has been taken into account.

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	

[8] E.g. J.P. Baumgartner, *Prices and costs in the railway sector*, Ecole Polytechnique Fédérale de Lausanne, 2001.

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**

Estimate of section upgrading costs

4.5. Reduction of waiting times at borders

This impact mainly concerns railway undertakings due to the improved operational speed at the 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.

Current waiting times

Name	Country 1	Country 2	Pax trains	CF trains	CT trains
Bratislava-Petržalka	Slovakia	Austria	10	120	60
Breclav	Czech Rep.	Austria	3	54	34
Dolní Žleb / Decin	Czech Rep.	Germany	2	25	121
Hegyeshalom	Hungary	Austria	3	80	80
Sturovo	Slovakia	Hungary	10	200	170

Future waiting times

Name	Country 1	Country 2	Pax trains	CF trains	CT trains
Bratislava-Petržalka	Slovakia	Austria	5	30	30
Breclav	Czech Rep.	Austria	3	30	30
Dolní Žleb / Decin	Czech Rep.	Germany	2	25	30
Hegyeshalom	Hungary	Austria	3	30	30
Sturovo	Slovakia	Hungary	5	30	30

Differential

Name	Country 1	Country 2	Pax trains	CF trains	CT trains
Bratislava-Petržalka	Slovakia	Austria	-5	-90	-30
Breclav	Czech Rep.	Austria	0	-24	-4
Dolní Žleb / Decin	Czech Rep.	Germany	0	0	-91
Hegyeshalom	Hungary	Austria	0	-50	-50
Sturovo	Slovakia	Hungary	-5	-170	-140

Current and future waiting time at ERTMS corridor A border stations

An overall saving on this corridor of 10' (passenger trains) or 334' (conventional freight trains) or 315' (intermodal trains) is expected for trains crossing all borders in case an improved interoperability takes place.

5. IMPACTS OF INTERVENTION ON PATH ALLOCATION RULES

5.1. 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.

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

Capacity and traffic information (Corridor E)

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.

f) 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;

g) 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;

h) 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:

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

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

Equivalence between freight and passenger paths

The following results 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.

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

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	**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

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

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).

	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**

6. IMPACTS OF INTERVENTION ON PATH ALLOCATION AND TRAFFIC MANAGEMENT RULES ON TRAIN PRIORITY

6.1. 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.

EXPECTED VARIATION IN FREIGHT TRAINS WAITING TIMES									
Country	Infrastructure Manager	ERTMS Corridor	Route length [km]	Average % of freight trains	Average variation of waiting times (Scenario 3 New Opera)		% of freight trains on the examined section = w	Corresponding variation of waiting time	
					Unscheduled (minutes / km)	Scheduled (minutes / km)		Unscheduled - freight (minutes / km)	Scheduled - freight (minutes / km)
AU	OBB	E	167	44,4%	0,027123273	0,048315	40,71%	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

EXPECTED VARIATION IN PASSENGER TRAINS WAITING TIMES									
Country	Infrastructure Manager	ERTMS Corridor	Route length [km]	Average % of freight trains	Average variation of waiting times (Scenario 3 New Opera)		% of freight trains on the examined section	Corresponding variation of waiting time	
					Unscheduled (minutes / km)	Scheduled (minutes / km)		Unscheduled - freight (minutes / km)	Scheduled - freight (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%	-0,025048803	-0,05539	59%	-0,0228	-0,0310
HU	MAV	E	274	35,3%				-0,0237	-0,0523
SK	ZSR	E	297	28,6%				-0,0239	-0,0589

6.2. 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[9] (the German rail Infrastructure Manager) a "**Güterwerkerhrs – Express – Trasse**" (i.e. Express Freight Path) **costs the 65% more than the standard one**.

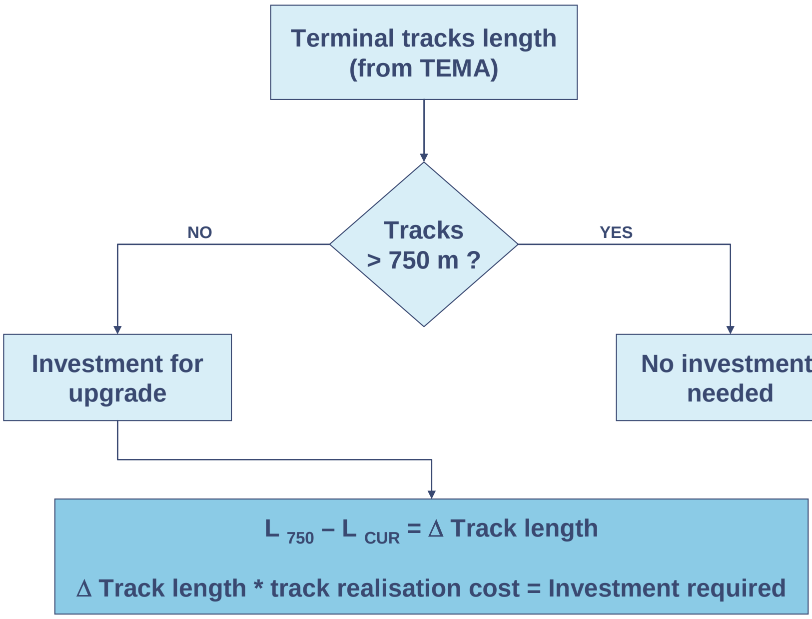
All the freight trains using this type of path are likely to be charged of an extra cost (about +65% of the basis cost) connected to the quality of the path and the corresponding level of service that can be offered.

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

7. IMPACT OF INTERVENTION ON TERMINALS

7.1. 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.



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 serve trains of a length of 750 m. This way, the train does not have to be split in several parts (each corresponding to the length of the transshipment track), thus ensuring time and cost savings, due to the lower shunting[10] operations to load and unload the train.

Next, the value of such length was multiplied by an hypothetical realization cost of a linear meter[11], 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.

10 The term "shunting" refers to all the operations related to the moving of wagons inside terminals. Such operation is normally performed with manoeuvring locomotives.

11 The following parameter have been used 3.000,00 Euro * meter of tracks realised. This cost takes into account all the procedures necessary to build up the tracks (to be verified).

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	Praha Uhrineves	8	580	580	170	1360
		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	Budapest Bilk Kombiterminál	4	750	750	750 m ready	0
		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

Tracks to be realized in the terminal of ERTMS corridor A

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**.

7.2. 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[12], 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.

Terminal Name	N tracks and overall length		Average length	Nb of shunting operations necessary to tranship the train	Δ 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

Savings in shun ting operations due to the increased tracks length

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 **1.1** only about 20% of intermodal trains are likely to be set at maximum length, but more than 20% of the

[12] 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.

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

7.3. 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" [13] of tracks accessing the terminal. Moreover, the overall capacity of the railway system is improved.

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

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

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

[13] 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).

estimated time saving, obtainable in every terminal deciding to implement the coordination procedures in the allocation of the terminal slot and the railway path.

ANNEXE 13

CALCUL DES COÛTS ADMINISTRATIFS

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

7.4. One-stop-shop

The administrative costs for setting-up a dedicated One-Stop-Shop covering the whole process of international freight path allocation[14] 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).

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

OSS's permanent staff cost estimation

Cost element	Level	Annual salary per FTE	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.

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

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).

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%.

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.

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 headquarters 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 is supposed to be purchased. One PC per staff is foreseen, so the number will depend on the staff size as previously estimated.

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.

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**

7.5. 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 updating shall be included in the reference document. The required effort is likely to be reduced at 20% of the one of the first year.

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.

Total annual functioning costs for transparency function

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 (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.

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
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**

7.6. 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[15] 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.

[15] 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).

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

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
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 Exert 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.

7.7. 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[16] 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[17] on quality issues. It has been calculated that 1 FTE is in charge, on average, of 2 billion ton.km for quality control

[16] Such process takes place through the setting up of "quality groups", targeting specific parts of the rail network for the control of multimodal trains.
[17] PwC estimate, based on the assumption that one unit spends 80% of his time on quality issues.

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 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)

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 is 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.

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.

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**

7.8. 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:

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 is will meet twice a year (before the timetable's definition and after about 6 months to check and make the necessary adjustments).

7.9. Total additional administrative costs

The following table presents 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

7.10. 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** Length (km)	**B** Number of IM	**C** International freight traffic in 2020 (Mn tkm / year)	**D** Average length of international freight train trip (km)	**E** Average freight train tonnage (t / train)	**F = C / (D * E)** Number of freight path / year	**G** Typical number of IM involved / international path	**H = (F*M/250 + F*N/48 + F*P) *G** Number of path booking transactions / year	**I** N. booking operations saved / path	**J = (H/G)* I** Total number of operation saved per year	**L = J*K** 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 and the above presented savings.

Annexe 14

Hypothèses relatives au scenario de référence pour le calcul des impacts sociétaux

Objectives

- The Transtools models will be 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 share %, will be provided as output of Transtools.

- In addition the external effects will be calculated. The externalities will be calculated based on the output of Transtools (vehicle kilometres). External costs values will be estimated with the values from the "Handbook on estimation of external costs in the transport sector" (CE Delft, 2008 as part of IMPACT).

Assumptions

- Similar exogenous and endogenous reference framework to the one used in the Reference Scenario of the Trans-Tools project will be applied for the **period 2000-2020.**

- The starting points for the basis year will be 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- see remark below);

  - 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- see later on in this note).

- The socio-economic growth rates are derived from Eurostat data and the outputs of the **PRIMES model** (DG-TREN). Projections have been recalculated to reflect the expected growth from 2007 onwards. (for the specific average annual growth rates per country per sector: see Annex I of the Inception Report)

- 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 are used to define a reference growth rate for oil price and, consequently for fuel price. In the recent STEPs research project[18] , 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.

- 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. The criteria chosen is to include:
  - projects for which some money has been already spent and whose completion expected before 2020;
  - projects sections already started and whose completion is expected before of 2010.The list of TEN projects and their details.

Some additional specific details

The next tables present some information on the level of detail of the macro-analysis,

Table 1 - 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

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

Measuring units	Values Tonnes Ton-km Number of vehicles/vessels Vehicle-km/vessel-km TEU TEU-km
Most recent base year	2006

Table 2 -Attributes 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)

Teble 3- Attributes 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	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

Table 4 - TEN projects for the baseline 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	Partial
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	Partial
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	No
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	partial
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	partial
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	No
P17	Railway axis Paris-Strasbourg-Stuttgart-Vienna-Bratislava	2015	36,554	9,475	No
P18	Rhine/Meuse-Main-Danube inland waterway axis	2019	7,914	848	No

Project code	Project name	Completion year	Total cost	Investments up to 2004	Included in Reference Scenario
P19	High-speed rail interoperability on the Iberian peninsula	2020	106,136	9,353	No
P20	Fehmarn Belt railway axis	2015	17,091	4	No
P22	Railway axis Athina-Sofia-Budapest-Vienna-Prague-Nürnberg/Dresden	2017	62,605	0	No
P23	Railway axis Gdansk-Warsaw-Brno/Bratislava-Vienna	2015	24,303	3,406	No
P24	Railway axis Lyon/Genoa-Basel-Duisburg-Rotterdam/Antwerp	2018	69,727	4,473	No
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	Partial
P27	Rail Baltica axis Warsaw-Kaunas-Riga-Tallinn-Helsinki	2018	5,600	0	No
P28	Eurocaprail on the Brussels-Luxembourg-Strasbourg railway axis	2013	7,962	0	No
P29	Railway axis if the Ionian/Adriatic intermodal corridor	2014	8,561	0	No
P30	Inland waterway Seine-Scheldt	2016	5,312	69	No

Table 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[1]	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 No No No Yes No No No Yes Yes Yes Yes Yes Yes No

TEN projects	**Subprojects**	**Deadline after 2004 revision**[1]	**Implementation in reference scenario**
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 Yes Yes Yes Yes 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 Yes Yes No Yes No Yes Yes No No
4. High-speed train east	1. Paris-Baudrecourt 2. Metz-Luxembourg 3. Saarbrucken-Mannheim	1. 2007 2. 2007 3. 2007	Yes Yes Yes
5. Conventional rail/combined transport: Betuwe line	1. Port Railway line 2. A15 line	1. 2007 2. 2007	Yes 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	No No No No No No No
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 Yes Yes Yes
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	No No Yes No Yes Yes No
9. Conventional rail link Cork–Dublin–Belfast–Larne,Stranraer	1. UK sections 2. Republic of Ireland sections	1. 2001 (f) 2. 2001 (f)	Yes 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 Yes

TEN projects	**Subprojects**	**Deadline after 2004 revision[1]**	**Implementation in reference scenario**
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	No No Yes No No
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	No No No
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	No No No No No
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	No No No No No
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	No No No No No
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	No No No No
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	No No No No
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	No No No No No
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	No No No

TEN projects	Subprojects	Deadline after 2004 revision[1]	Implementation in reference scenario
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	No No No No No No
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 Yes 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	No No No 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	No No No
28. Eurocaprail on the Bruxelles-Luxembourg-Strasbourg railway axis	1. Bruxelles-Luxembourg-Strasbourg	1. 1:2012	No
29. Railway axis on the Ionian/Adriatic intermodal corridor	1. Kozani-Kalambaka-Igoumenitsa 2. Ioannina-Antirrio-Rio-Kalamata	1. 2012 2. 2014	No No
30. Inland waterways Seine-Scheldt	1. Navigability improvements Deulemont-Gent 2. Compiègne-Cambrai	1&2: (2012-2014-2016)	No

ANNEXE 15

TRADUCTION DES RÉSULTATS OBTENUS AU NIVEAU OPÉRATIONNEL EN DONNÉES POUR LE CALCUL DES IMPACTS SOCIÉTAUX

Most of the micro-effects evaluated 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):

The following impacts of interventions have been transferred into Transtools:

Intervention		Option B	Option C
Technical Harmonisation			
	Train Length	X	X
	Waiting times at border	X	X
Path Allocation and TMS			
	Reduced waiting times		X
Terminals			
	Shunting costs	X	X
	Co-ordination		X

In Transtools it is possible to change:

- Transport times / speeds in the network
- Transport costs

By changing cost and time attributes, the Transtools software calculates transport ttimes and transport costs. Together with the distance of transport, the "impedance" for each mode is calculated based on: distance between OD, transport time and transport costs for each mode of transport. The impedance value on OD-level for each NSTR or traveller group in the demand matrix is an important indicator to determine the mode choice (road, rail, etc.).

As a result, by changing transport speeds and transport costs, new impedances are calculated and subsequently the impact on modal split is derived for passenger and freight transport.

7.11. Technical Harmonisation

7.11.1. Longer trains

The micro-analyses indicates provided the following reduction of freight train costs per tkm in %:

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%**

These costs have been transferred to flows on origin-destination level in order to make an estimate of the costs changes on Origing-Destination level and taking into account the distribution between Intermodal Trains and Single Wagon trains.

The following table presents the aggregated figures related to the cost change (both options B and C):

NSTR	NL - IT	D - IT	CH- IT	IT-IT
9	**-1,28%**	**-2,23%**	**-2,87%**	**-6,38%**
8	**-0,85%**	**-1,49%**	**-1,91%**	**-4,25%**
5	**-0,85%**	**-1,49%**	**-1,91%**	**-4,25%**
1	**-1,69%**	**-2,96%**	**-3,81%**	**-8,46%**

7.11.2. *Reduced waiting times at borders*

The next tabel presents the results obtained in the micro analyses.

Current 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

Future waiting times

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
Total savings	**0**	**-315**	**-270**

Current and future waiting time at ERTMS corridor A border stations

These figures have been used to determine the impact on the links in the network used by Transtools software. Furthermore, the waiting times not only do also have an impact on the costs, since the occupation of wagons and locomotives can increase (more roundtrips per year). As a result there is also a cost impact.

The following table presents the aggregated results on the cost tarriff:

Intermodal transport:

Saving in %	NL	D	CH	IT
NL	**0,00%**	**-4,13%**	**-3,56%**	**-5,78%**
D	**-4,13%**	**0,00%**	**-3,10%**	**-8,64%**
CH	**-3,56%**	**-3,10%**	**0,00%**	**-15,28%**
IT	**-5,78%**	**-8,64%**	**-15,28%**	**0,00%**

Conventional transport:

Saving in %	NL	D	CH	IT
NL	**0,00%**	**0,00%**	**-2,06%**	**-5,85%**
D	**0,00%**	**0,00%**	**-4,26%**	**-12,53%**

CH	**-2,06%**	**-4,26%**	**0,00%**	**-22,70%**
IT	**-5,85%**	**-12,53%**	**-22,70%**	**0,00%**

Furthermore, there has been made a conversion into NSTR freight types in order to match the input variables of Transtools software.

7.12. Impacts of intervention on path allocation and traffic managementr rules on train priority

This intervention only is relevant for option C.

The micro analyses provides values on the expected reduction of waiting times.

The following figures have been presented in the micro analyses:

EXPECTED VARIATION IN FREIGHT TRAINS WAITING TIMES									
				Average % of freight trains (Scenario 2 New Opera) = x	**Average variation of waiting times (Scenario 3 New Opera)**		**% of freight trains on the examined section**	**Corresponding variation of waiting time**	
Country	**Infrastructure Manager**	**ERTMS Corridor**	**Route length [km]**		**Unscheduled (minutes / km)**	**Scheduled (minutes / km)**		**Unscheduled - freight (minutes / km)**	**Scheduled - freight (minutes / km)**
NL	ProRail	A	103	89%	0,0271	0,048315	40,71%	0,0017	0,0024
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

This resulted in the following factors of speeds in the railnetwork of trains:

	Increase in speed (%)	**Factor**
NL	**0,36%**	**1,0036**
D	**2,30%**	**1,0230**
CH	**2,04%**	**1,0204**
IT	**2,89%**	**1,0289**

For freight trains the increased speeds result in higher productivity. As a result there is an impact also on the costprice of transport.

The following table presents the aggregated results on cost price changes of country-country level:

	NL	**D**	**CH**	**IT**

NL	**0,16%**	**0,38%**	**0,44%**	**0,51%**
D	**0,38%**	**0,52%**	**0,51%**	**0,75%**
CH	**0,44%**	**0,51%**	**0,53%**	**0,78%**
IT	**0,51%**	**0,75%**	**0,78%**	**1,33%**

Results for passenger trains:

<table>
<tr><th colspan="11">EXPECTED VARIATION IN PASSENGER TRAINS WAITING TIMES</th></tr>
<tr><th rowspan="2">Country</th><th rowspan="2">Infrastructure Manager</th><th rowspan="2">ERTMS Corridor</th><th rowspan="2">Route length [km]</th><th rowspan="2">Average % of freight trains
(Scenario 2 New Opera) = x</th><th colspan="2">Average variation of waiting times (Scenario 3 New Opera)</th><th rowspan="2">% of freight trains on the examined section</th><th colspan="2">Corresponding variation of waiting time</th></tr>
<tr><th>Unscheduled (minutes / km)</th><th>Scheduled (minutes / km)</th><th>Unscheduled - freight (minutes / km)</th><th>Scheduled - freight (minutes / km)</th></tr>
<tr><td>NL</td><td>ProRail</td><td>A</td><td>103</td><td>89%</td><td rowspan="4">-0,0250</td><td rowspan="4">-0,05539</td><td rowspan="4">59,29%</td><td>-0,0221</td><td>-0,0200</td></tr>
<tr><td>SZ</td><td>SBB/BLS</td><td>A</td><td>768</td><td>51%</td><td>-0,0232</td><td>-0,0395</td></tr>
<tr><td>GM</td><td>DB</td><td>A</td><td>1080</td><td>53%</td><td>-0,0231</td><td>-0,0381</td></tr>
<tr><td>IT</td><td>RFI</td><td>A</td><td>722</td><td>47%</td><td>-0,0233</td><td>-0,0424</td></tr>
</table>

	Increase in speed (%)	Factor speed passenger trains
NL	**-3,85%**	**0,9615**
D	**-7,32%**	**0,9268**
CH	**-7,08%**	**0,9292**
IT	**-7,82%**	**0,9218**

For passenger trains no impact is assumed on the ticket price value as input for Transtools. The eventual impact on ticket price will also depend on the modal shift and loss of market share of rail. As a result, ex post the change of ticket price could be evaluated. Moreover, there is usually a political involvement (e.g. MoT) in the decision to increase or decrease train tickets for passengers.

7.13. Impact on intervention on terminals

7.13.1. Reduction of shunting costs

This impact only relates to intermodal transport. The shuinting cost reduction applies for both Options B and C, while the co-ordination only applies for Option C.

The micro analyes provides information on the reduction of shunting costs and reports a figure of maximum 170 euro per (long) train for specific terminals and some time savings. These figure has been used to estimate the average saving for intermodal cargo flows on various origin destinations relations on the corridor.

The following table presents the results on aggregated level:

Saving in %	NL	D	CH	IT
NL	0,00%	0,50%	0,25%	0,21%
D	0,50%	0,77%	1,03%	0,90%
CH	0,25%	1,03%	1,67%	2,33%
IT	0,21%	0,90%	2,33%	2,50%

Next these figures have been applied for NSTR groups that have a lot of intermodal transport (weighted average).

7.13.2. Improvement of co-ordination between path definition and terminal slot allocation

This intervention is only valid for Option C. The micro analyses estimates an average saving of 82.5 minutes of time in the transport chain at each terminal. This time saving has been translated into higher average door-to-door speeds for the transport chain. Translated to transport speeds in Transtools this implicates an increase of approximately 7 to 11% for the NSTR classes that have a lot of intermodal cargo. As a result the transport speeds on the links have been increased with this figure.

Furthermore there is a cost saving due to higher productivity of wagons. On short distances the savings will be higher compared to long distances. The following table presents the aggregated results related to the price reduction of transport.

Saving in %	NL	D	CH	IT
NL	-3,44%	-1,43%	-1,00%	-0,97%
D	-1,43%	-1,32%	-1,48%	1,81%
CH	-1,00%	-1,48%	-2,87%	-2,74%
IT	-0,97%	-1,81%	-2,74%	-4,30%

7.14. Summarizing figures Corridor A

For corridor A, option B the following cost prices factors were found:

Cost tarif factor

NSTR 1

	NL	D	CH	IT
NL	1,00	1,00	0,98	0,94
D	1,00	1,00	0,96	0,87
CH	0,98	0,96	1,00	0,77
IT	0,94	0,87	0,77	1,00

NSTR 2

	NL	D	CH	IT
NL	1,00	1,00	0,98	0,94
D	1,00	1,00	0,96	0,87
CH	0,98	0,96	1,00	0,77
IT	0,94	0,87	0,77	1,00

NSTR 3

	NL	D	CH	IT
NL	1,00	1,00	0,98	0,94
D	1,00	1,00	0,96	0,87
CH	0,98	0,96	1,00	0,77
IT	0,94	0,87	0,77	1,00

NSTR 4

	NL	D	CH	IT
NL	1,00	1,00	0,98	0,94
D	1,00	1,00	0,96	0,87

CH	**0,98**	**0,96**	**1,00**	**0,77**
IT	**0,94**	**0,87**	**0,77**	**1,00**

NSTR 5

	NL	**D**	**CH**	**IT**
NL	**1,00**	**0,98**	**0,97**	**0,94**
D	**0,98**	**1,00**	**0,96**	**0,88**
CH	**0,97**	**0,96**	**0,99**	**0,79**
IT	**0,93**	**0,87**	**0,78**	**0,95**

NSTR 6

	NL	**D**	**CH**	**IT**
NL	**1,00**	**1,00**	**0,98**	**0,94**
D	**1,00**	**1,00**	**0,96**	**0,87**
CH	**0,98**	**0,96**	**1,00**	**0,77**
IT	**0,94**	**0,87**	**0,77**	**1,00**

NSTR 7

	NL	D	CH	IT
NL	1,00	1,00	0,98	0,94
D	1,00	1,00	0,96	0,87
CH	0,98	0,96	1,00	0,77
IT	0,94	0,87	0,77	1,00

NSTR 8

	NL	D	CH	IT
NL	1,00	0,98	0,97	0,94
D	0,98	1,00	0,96	0,89
CH	0,97	0,96	0,99	0,80
IT	0,93	0,87	0,78	0,92

NSTR 9

	NL	D	CH	IT
NL	1,00	0,98	0,97	0,94
D	0,98	1,00	0,96	0,89
CH	0,97	0,96	0,99	0,80
IT	0,93	0,87	0,78	0,92

The following speed factors were used:

NSTR	NL	D	CH	IT
1	1,000	1,000	1,000	1,000
2	1,000	1,000	1,000	1,000
3	1,000	1,000	1,000	1,000
4	1,000	1,000	1,000	1,000
5	1,023	1,023	1,023	1,023
6	1,000	1,000	1,000	1,000

7	**1,000**	**1,000**	**1,000**	**1,000**
8	**1,036**	**1,036**	**1,036**	**1,036**
9	**1,036**	**1,036**	**1,036**	**1,036**

For corridor A, option C the following cost prices factors were found:

Cost tarif factor

NSTR 1

	NL	D	CH	IT
NL	1,00	1,00	0,98	0,94
D	1,00	0,99	0,95	0,87
CH	0,98	0,95	0,99	0,77
IT	0,94	0,87	0,77	0,99

NSTR 2

	NL	D	CH	IT
NL	1,00	1,00	0,98	0,94
D	1,00	0,99	0,95	0,87
CH	0,98	0,95	0,99	0,77
IT	0,94	0,87	0,77	0,99

NSTR 3

	NL	D	CH	IT
NL	1,00	1,00	0,98	0,94
D	1,00	0,99	0,95	0,87
CH	0,98	0,95	0,99	0,77
IT	0,94	0,87	0,77	0,99

NSTR 4

	NL	D	CH	IT
NL	1,00	1,00	0,98	0,94
D	1,00	0,99	0,95	0,87
CH	0,98	0,95	0,99	0,77

IT	**0,94**	**0,87**	**0,77**	**0,99**

NSTR 5

	NL	**D**	**CH**	**IT**
NL	**0,99**	**0,98**	**0,97**	**0,93**
D	**0,98**	**0,99**	**0,95**	**0,88**
CH	**0,97**	**0,95**	**0,98**	**0,78**
IT	**0,93**	**0,86**	**0,76**	**0,92**

NSTR 6

	NL	**D**	**CH**	**IT**
NL	**1,00**	**1,00**	**0,98**	**0,94**
D	**1,00**	**0,99**	**0,95**	**0,87**
CH	**0,98**	**0,95**	**0,99**	**0,77**
IT	**0,94**	**0,87**	**0,77**	**0,99**

NSTR 7

	NL	**D**	**CH**	**IT**
NL	**1,00**	**1,00**	**0,98**	**0,94**
D	**1,00**	**0,99**	**0,95**	**0,87**
CH	**0,98**	**0,95**	**0,99**	**0,77**
IT	**0,94**	**0,87**	**0,77**	**0,99**

NSTR 8

	NL	D	CH	IT
NL	0,98	0,97	0,96	0,93
D	0,97	0,98	0,95	0,89
CH	0,96	0,95	0,97	0,78
IT	0,92	0,86	0,76	0,89

NSTR 9

	NL	D	CH	IT
NL	0,98	0,97	0,96	0,93
D	0,97	0,98	0,95	0,89
CH	0,96	0,95	0,97	0,78
IT	0,92	0,86	0,76	0,89

The following speed factors were used:

NSTR	NL	D	CH	IT
1	1,004	1,023	1,020	1,029
2	1,004	1,023	1,020	1,029
3	1,004	1,023	1,020	1,029
4	1,004	1,023	1,020	1,029
5	1,102	1,123	1,120	1,129
6	1,004	1,023	1,020	1,029
7	1,004	1,023	1,020	1,029
8	1,153	1,176	1,173	1,183
9	1,153	1,176	1,173	1,183

Speed factor for passenger trains:

NL	0,96
D	0,93
CH	0,93

IT	**0,92**

7.15. Summarizing figures Corridor E

For corridor E, option B the following cost prices factors were found:

Cost tarif factor

NSTR 1

	D	**CZ**	**SK**	**A**	**HU**
D	**1,00**	**1,00**	**1,00**	**0,93**	**0,91**
CZ	**1,00**	**1,00**	**1,00**	**0,97**	**0,96**
SK	**1,00**	**1,00**	**1,00**	**0,92**	**0,82**
A	**0,93**	**0,97**	**0,92**	**1,00**	**0,92**
HU	**0,91**	**0,96**	**0,68**	**0,92**	**1,00**

NSTR 2

	D	**CZ**	**SK**	**A**	**HU**
D	**1,00**	**1,00**	**1,00**	**0,93**	**0,91**
CZ	**1,00**	**1,00**	**1,00**	**0,97**	**0,96**
SK	**1,00**	**1,00**	**1,00**	**0,92**	**0,82**
A	**0,93**	**0,97**	**0,92**	**1,00**	**0,92**
HU	**0,91**	**0,96**	**0,68**	**0,92**	**1,00**

NSTR 3

	D	**CZ**	**SK**	**A**	**HU**
D	**1,00**	**1,00**	**1,00**	**0,93**	**0,91**
CZ	**1,00**	**1,00**	**1,00**	**0,97**	**0,96**
SK	**1,00**	**1,00**	**1,00**	**0,92**	**0,82**
A	**0,93**	**0,97**	**0,92**	**1,00**	**0,92**
HU	**0,91**	**0,96**	**0,68**	**0,92**	**1,00**

NSTR 4

	D	CZ	SK	A	HU
D	1,00	1,00	1,00	0,93	0,91
CZ	1,00	1,00	1,00	0,97	0,96
SK	1,00	1,00	1,00	0,92	0,82
A	0,93	0,97	0,92	1,00	0,92
HU	0,91	0,96	0,68	0,92	1,00

NSTR 5

	D	CZ	SK	A	HU
D	1,00	0,91	0,96	0,89	0,87
CZ	0,91	0,98	0,98	0,96	0,95
SK	0,96	0,98	0,98	0,91	0,81
A	0,89	0,96	0,91	0,98	0,91
HU	0,87	0,95	0,68	0,91	1,00

NSTR 6

	D	CZ	SK	A	HU
D	1,00	1,00	1,00	0,93	0,91
CZ	1,00	1,00	1,00	0,97	0,96
SK	1,00	1,00	1,00	0,92	0,82
A	0,93	0,97	0,92	1,00	0,92
HU	0,91	0,96	0,68	0,92	1,00

	D	CZ	SK	A	HU
D	1,00	1,00	1,00	0,93	0,91
CZ	1,00	1,00	1,00	0,97	0,96
SK	1,00	1,00	1,00	0,92	0,82
A	0,93	0,97	0,92	1,00	0,92
HU	0,91	0,96	0,68	0,92	1,00

NSTR 8

	D	CZ	SK	A	HU
D	1,00	0,87	0,94	0,88	0,86
CZ	0,87	0,98	0,97	0,96	0,94
SK	0,94	0,97	0,98	0,92	0,81
A	0,88	0,96	0,92	0,97	0,91
HU	0,86	0,94	0,69	0,91	0,99

NSTR 9

	D	CZ	SK	A	HU
D	1,00	0,87	0,94	0,87	0,85
CZ	0,87	0,97	0,96	0,95	0,94
SK	0,94	0,96	0,97	0,91	0,80
A	0,87	0,95	0,91	0,97	0,91
HU	0,85	0,94	0,68	0,91	0,99

Speed factor:

NSTR	D	CZ	SK	A	HU
1	1,000	1,000	1,000	1,000	1,000
2	1,000	1,000	1,000	1,000	1,000
3	1,000	1,000	1,000	1,000	1,000
4	1,000	1,000	1,000	1,000	1,000
5	1,023	1,023	1,023	1,023	1,023
6	1,000	1,000	1,000	1,000	1,000
7	1,000	1,000	1,000	1,000	1,000
8	1,036	1,036	1,036	1,036	1,036
9	1,036	1,036	1,036	1,036	1,036

For corridor E, option C the following cost prices factors were found:

Cost tarif factor

NSTR 1

	D	CZ	SK	A	HU
D	1,00	0,99	0,99	0,92	0,90
CZ	0,99	0,99	0,99	0,96	0,95
SK	0,99	0,99	0,99	0,91	0,81
A	0,92	0,96	0,91	0,99	0,91
HU	0,90	0,95	0,67	0,91	0,99

NSTR 2

	D	CZ	SK	A	HU
D	1,00	0,99	0,99	0,92	0,90
CZ	0,99	0,99	0,99	0,96	0,95
SK	0,99	0,99	0,99	0,91	0,81
A	0,92	0,96	0,91	0,99	0,91
HU	0,90	0,95	0,67	0,91	0,99

NSTR 3

	D	CZ	SK	A	HU
D	1,00	0,99	0,99	0,92	0,90
CZ	0,99	0,99	0,99	0,96	0,95
SK	0,99	0,99	0,99	0,91	0,81
A	0,92	0,96	0,91	0,99	0,91
HU	0,90	0,95	0,67	0,91	0,99

NSTR 4

	D	CZ	SK	A	HU

D	1,00	0,99	0,99	0,92	0,90
CZ	0,99	0,99	0,99	0,96	0,95
SK	0,99	0,99	0,99	0,91	0,81
A	0,92	0,96	0,91	0,99	0,91
HU	0,90	0,95	0,67	0,91	0,99

NSTR 5

	D	CZ	SK	A	HU
D	0,96	0,88	0,94	0,87	0,85
CZ	0,88	0,96	0,96	0,94	0,93
SK	0,94	0,96	0,96	0,91	0,79
A	0,87	0,94	0,91	0,94	0,89
HU	0,85	0,93	0,66	0,89	0,97

NSTR 6

	D	CZ	SK	A	HU
D	1,00	0,99	0,99	0,92	0,90
CZ	0,99	0,99	0,99	0,96	0,95
SK	0,99	0,99	0,99	0,91	0,81
A	0,92	0,96	0,91	0,99	0,91
HU	0,90	0,95	0,67	0,91	0,99

NSTR 7

	D	CZ	SK	A	HU
D	1,00	0,99	0,99	0,92	0,90
CZ	0,99	0,99	0,99	0,96	0,95
SK	0,99	0,99	0,99	0,91	0,81
A	0,92	0,96	0,91	0,99	0,91
HU	0,90	0,95	0,67	0,91	0,99

NSTR 8

	D	CZ	SK	A	HU
D	0,94	0,83	0,93	0,86	0,84
CZ	0,83	0,96	0,96	0,93	0,92
SK	0,93	0,96	0,95	0,91	0,80
A	0,86	0,94	0,91	0,92	0,89
HU	0,84	0,92	0,66	0,89	0,97

NSTR 9

	D	CZ	SK	A	HU
D	0,94	0,82	0,92	0,85	0,83
CZ	0,82	0,95	0,95	0,93	0,92
SK	0,92	0,95	0,95	0,90	0,79
A	0,85	0,93	0,90	0,92	0,89
HU	0,83	0,92	0,66	0,89	0,97

Speed factor freight flows:

NSTR	D	CZ	SK	A	HU
1	1,013	1,029	1,062	1,030	1,038
2	1,013	1,029	1,062	1,030	1,038

3	**1,013**	**1,029**	**1,062**	**1,030**	**1,038**
4	**1,013**	**1,029**	**1,062**	**1,030**	**1,038**
5	**1,112**	**1,130**	**1,166**	**1,130**	**1,139**
6	**1,013**	**1,029**	**1,062**	**1,030**	**1,038**
7	**1,013**	**1,029**	**1,062**	**1,030**	**1,038**
8	**1,164**	**1,183**	**1,220**	**1,183**	**1,193**
9	**1,164**	**1,183**	**1,220**	**1,183**	**1,193**

Passenger trains:

D	**0,94**
CZ	**0,93**
SK	**0,91**
A	**0,92**
HU	**0,92**

ANNEXE 16

MÉTHODOLOGIE D'ÉVALUATION DE L'IMPACT SUR LE TRANSPORT DE PASSAGERS

- Only impacts with respect to regional passenger trains
- No Transtools network simulation possible due to high share of internal short distance transport in NUTS 3 region and lack of network data
- Baseyear 2020 Transtools was used to make an overview of the number of regional travellers on each NUTS 3 region in the corridor
- Calculation was done on the difference of the average travel time due to increased waiting times (Intervention 3 - TMS)
- Elasticties from literature were used to derive the volume of travelers to shift from rail to road due to increase of travel time, specified for purpose of travel:
  - Business: - 0.4
  - Private: - 0.1
  - Holiday: - 0.1
- Calculation was done on amount of passenger kilometres
- Comparisson was made with the overal pax on corridors

ANNEXE 17

EFFETS SUR L'EMPLOI

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

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 40%, 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.

	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 lenghth	13.595			
N. staff / bn international tkm	0,5	0,1	0,1	0,7
N. staff / 1000 km	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 lenghth	38.078			
Additional needs for the rest of the main European network*	**37,5**	**2,7**	**9,0**	**49,2**
Total main European network*	**83,5**	**4,3**	**20,0**	**107,8**

* 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:

	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	**37,5**	**9,0**	**46,5**
Total main European network	**83,5**	**20,0**	**103,5**

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.

	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%**

EFFETS SUR L'ENVIRONNEMENT

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.

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.

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.

External effects – Option B vs A

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

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

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: CO_2 , NO_x , PM and SO_2. 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).

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.

Energy and emission characteristics of passenger transport by rail

Emission type:	Locomotive electric	Locomotive diesel	Railcar electric	Weighted average	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 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).

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

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 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).

Energy and emission consumption impacts (Corridor A)

	Option B	Option C	Option C	Option C

		freight transport	passenger transport	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).

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.

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

ANNEXE 18

ANALYSE DE SENSIBILITÉ AU NIVEAU OPÉRATIONNEL

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).

Hypotheses for the 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 Option A waiting times are set at 0 (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[19] 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.

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).

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

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 largly encouraging for the implementation of the proposed policy options.

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

Corridor A

	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)

Corridor E

	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)

Overall network

	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)

ANNEXE 19

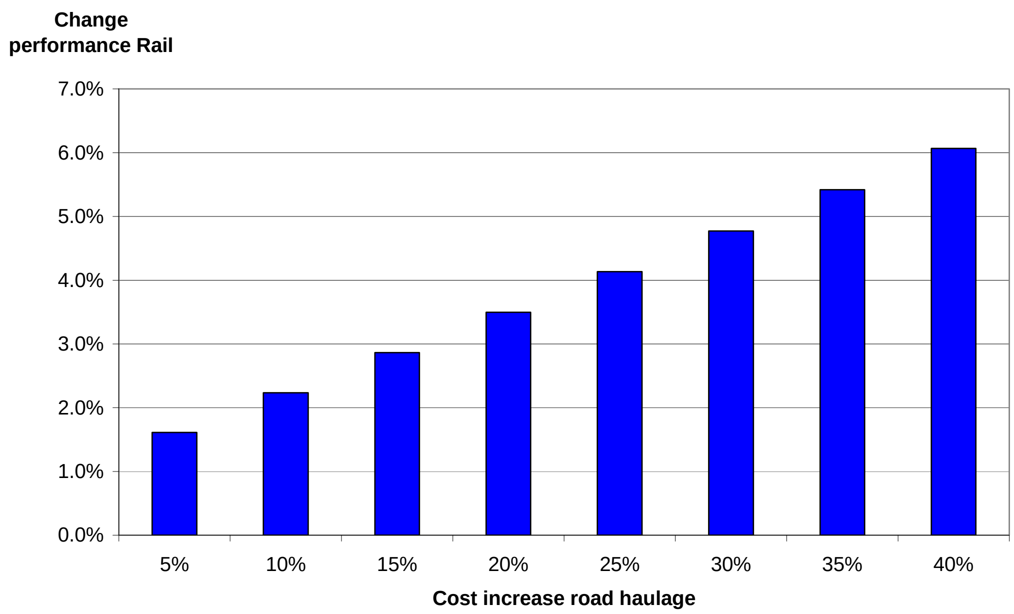
ANALYSE DE SENSIBILITÉ AU NIVEAU SOCIÉTAL

7.16. Introduction

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.

7.17. 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:

an increase of 5% per annum: 99 Euro per barrel in 2020
(4) 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 somewhat optimistic, because electricity generation is into some extend also linked to oil prices (for example 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 shall be seen as the maximum impacts according to Transtools elasticities.

The following table presents the impact on costs 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:

	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:

	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%

7.18. 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:

	Amount of tonne-kilometers rail	Shift to rail in million tonne-	Relative change of rail freight performance in %

	(million) in 2020 ERIM network	kilometres due to scenario 2	
Option A	418,613	20,538	+5.2%
Option B	433,265	21,762	+5.3%
Option C	439,229	21,037	+5.0%

7.19. 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.

NEA calculations 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 results on the estimation on the impact on rail volumes on the ERIM network:

	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 .

7.20. Summarizing tables

The following table presents the final table comparing the shift (Option B versus A, option C versus A) in the base case with the ones in the sensitivities 1-2-3

Rail performance in million tonne-kilometres:

		Sensitivity Scenarios			
Policy Option	Standard scenario	1a) Oil price: +5% p.a.	1b) Oil price: +10% p.a.	2) Internalising External costs for Road haulage	3) Introduction LHV's
A	398,075	408,973	412,498	418,613	384,663
B	411,503	422,250	425,368	433,265	397,795
C	418,193	428,063	430,696	439,229	404,314

Relative difference in rail performance of options B and C compared to Option A:

		Sensitivity Scenarios			
Policy Option	Standard scenario	1a) Oil price: +5% p.a.	1b) Oil price: +10% p.a.	2) Internalising External costs for Road haulage	3) Introduction LHV's
A	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%
B	+3.4%	+3.2%	+3.1%	+3.5%	+3.4%
C	+5.1%	+4.7%	+4.4%	+4.9%	+5.1%

Relative difference in rail performance of options B and C compared to Option A in Standard Scenario:

		Sensitivity Scenarios			
Policy Option	Standard scenario	1a) Oil price: +5% p.a.	1b) Oil price: +10% p.a.	2) Internalising External costs for Road haulage	3) Introduction LHV's
A	+0.0%	+2.7%	+3.6%	+5.2%	-3.4%
B	+3.4%	+6.1%	+6.9%	+8.8%	-0.1%
C	+5.1%	+7.5%	+8.2%	+10.3%	+1.6%

Relative difference in rail performance of sensitivity scenarios compared to results in the standard scenario:

	Sensitivity Scenarios			
Policy Option	1a) Oil price: +5% p.a.	1b) Oil price: +10% p.a.	2) Internalising External costs for Road haulage	3) Introduction LHV's
A	+2.7%	+3.6%	+5.2%	-3.4%
B	+2.6%	+3.4%	+5.3%	-3.3%
C	+2.4%	+3.0%	+5.0%	-3.3%

ANNEXE 20

MÉTHODE D'EXTRAPOLATION DES RÉSULTATS OBTENUS EN TERMES D'IMPACTS OPÉRATIONNELS POUR L'ÉVALUATION DES IMPACTS SOCIÉTAUX SUR LE RÉSEAU ERIM

8. EXTRAPOLATION OF THE RESULTS OBTAINED FOR THE TWO SELECTED CASE STUDY CORRIDORS TO THE WHOLE NETWORK

8.1. 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 lenght 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	Alll remaining corridors (B,C,D, 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 freigh 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.

<u>**NB.**</u> **Corridor D**. Ljubljana – Budapest section has been included

IMPACTS OF INTERVENTION ON TECHNICAL HARMONISATION

8.2. Harmonized train length

Decrease of rail freight operating 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 _etween 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 results are presented in the table below.

	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 bewteen 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

	Impacted traffics	Total Impacted Traffic 2020 (1000 tkm)	Rail traffic split assumption		Overall effect (€ / year in 2020)
			% Intermodal	% Single Wagon	
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

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) appear 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 limits >750 m in the “Rest of Europe” network, and lower density of freight traffic on it with respect to ERTMS corridors.

8.3. Reduction of waiting times at borders

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
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

All Other Border Crossings* (ERIM network)	Borders of West European countries	0	0	0
	Borders of East European countries	-5	-60	-40

**Based on average values on actually analysed border stations*

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.

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**	**- 254.853**
average load (pass. / train or net t / train)	500	600
TOTAL SAVING (passenger.h or ton.h) **on ERTMS corridors**	**- 2.190.000**	**-152.912.050**
TOTAL SAVING (passenger.h or ton.h) - **whole main European newtork**	**- 5.481.270**	**-361.278.806**

9. IMPACTS OF INTERVENTION ON PATH ALLOCATION RULES

9.1. 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.

	Reduction of passenger traffic (milllion 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).

10. IMPACTS OF INTERVENTION ON PATH ALLOCATION AND TRAFFIC MANAGEMENT RULES ON TRAIN PRIORITY

10.1. Reduction in waiting times of freight trains

EXPECTED VARIATION IN FREIGHT TRAINS WAITING TIMES

Country	Infrastructure Manager	ERTMS Corridor	Route length [km]	Average % of freight trains	Corresponding reduction of waiting time* = z		Total reduction in waiting times (scheduled + unscheduled
					Unscheduled - freight (minutes / km)	Scheduled - freight (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
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	**Corresponding reduction of waiting time* = z**		**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, in the TRANSTOOLS modeling waiting times reduction due to priority rules are applied only on the ERTMS corridors</u>.

The 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**

10.2. Increase in waiting times of passenger trains

EXPECTED VARIATION IN PASSENGER TRAINS WAITING TIMES

Country	Infrastructure Manager	ERTMS Corridor	Route length [km]	Average % of freight trains	Corresponding increase of waiting time* = z		Total increase in waiting times (scheduled + unscheduled
					Unscheduled - passenger (minutes / km)	Scheduled - passenger (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
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* = z		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, 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, in the TRANSTOOLS modeling 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**

11. IMPACT OF INTERVENTION ON TERMINALS

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

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]

	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 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.

11.2. 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

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 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	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, 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.

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)
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**

11.3. 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 & 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.

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**

ANNEXE 21

MÉTHODOLOGIE DE MONÉTISATION DES IMPACTS OPÉRATIONNELS

The following table 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 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 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 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)
Path allocation and traffic management rules	Additional capacity for freight trains	Chapter 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 as part of the macro-level assessment.
	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[20], 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 payload of 600 net tons per trains.

[20] 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*
		The freight value of time (including driver cost) in € / ton.h will be taken by the EC *Handbook on estimation of external cost in transpirt 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 transpirt 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 imply that the additional charge become 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 3.2. However the cost-benefit calculation has shown that only an increase by **10%** is acceptable in order not to annul 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.
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	The cost estimated in chapter 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 (cg. chapter 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).

Intervention area	*Impacts*	*Approach for converting the impacts in monetary value and for forecasting the evolution over the time*
	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' (chapter 4.3). For short distance services, the savings is supposed to be 50% of the maximum one. B. The % of short distance traffic (<500 m) 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 € / 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).

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.

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).

ANNEX.I – APPROACH FOR ESTIMATING COST AND BENEFITS OF THE ADDITIONAL CAPACITY

In chapter 9.1 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:

	Potential traffic variation traffic in 2020 (tkm or pass.km)	Estimated modal shift effect in 2020 Option C *(TRANSTOOLS)* (tkm or pass.km)	Potential additional modal shift Option C (tkm or pass.km)
freight traffic	41.007.986.750	20.117.141.692	20.890.845.058
regional passenger traffic	-5.383.556.735	-74.161.685	-5.309.395.050

	Difference between road and rail external costs per traffic unit - 2020 (€ / tkm or € / 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		
freight traffic	2,46	**513.182.869**	8,43	5,43	**627.154.190**	**1.140.337.060**

regional passenger traffic	8,41	**-449.174.821**	23,58	12,94	**-565.322.791**	**-1.014.497.612**
	Total effect	**64.008.048**			**61.831.400**	**125.839.448**

The potential negative shift in regional passenger transport is much higher than the one do to macro-level modal shift, so quite significant external costs are generated. Nevertheless, they are largely offset by the potential benefits due to additional (potential) rail freight traffic, since the additional capacity corresponds to the double of the demand increase due to macro-level modal shift.

ANNEXE 22

MÉTHODE DE CALCUL ET DE MONÉTISATION DES COÛTS EXTERNES ÉVITÉS

11.4. Introduction

The following external cost categories have been identified:

- Congestion costs
- Accident costs
- Air pollution
- Noise
- Climate change

The most complete and state-of-the-art report is the "Handbook on estimation of external costs in the transport sector" published in February 2008 and produced within the study for the European Commission "Internalisation Measures and Policies for All external Cost of Transport (IMPACT). This Handbook provides best practice figures on the moneraty external costs based on vehicle kilometres. The handbook presents figures for types of transport means, circumstances and different countries. The handbook presents for most categories the calculated monetary figures for Germany (value year 2000).

In order to be able to use the figures from the Handbook and to be more accurate the figures from the Handbook have been adjusted for:

- Value in year 2007 instead of level year 2000 (based on GDP development)
- Differences in unit value per country were taken into account (e.g. Switzerland vs Germany) based on GDP per capita estimations for the year 2020
- Share of type of area along the corridor (metropolitan, small/medium urban, rural)
- Type of vehicle and technology: EURO-5 was selected to estimate engine level in 2020 for road vehicles (1.4-2 litre cars and 32t trucks). For trains the development of exhaust emissions was derived from ASSESS Final report and STREAM (TREMOVE)
- Share of diesel locomotives (1/5 of locomotive fleet) based on corridor reports
- Day / night time (relevant for noise and congestion costs) based on traffic data
- Conversion between vehicle kilometre to passenger kilometre and tonne-kilometre. Based on statistics there is an average utilisation of 119 passengers per train and 500 tons per freight train. Moreover, the average load of a freight truck is 14 tons and the average occupation of cars is 1.4 persons per car.

This paper presents the external cost values for the Impact Assessment Freight Priority Network for ERTMS corridors A and E.

11.5. Results

11.5.1. Corridor A

11.5.1.1.

11.5.1.2. Freight Transport

The following table presents the values for Corridor A for Freight Transport. The values are in eurocent per tonne-kilometre for road and rail transport:

	Congestion cost	Accident cost	Air pollution cost	Noise cost	Climate change cost	Total external cost
Heavy Goods Vehicle	2.97	0.03	0.35	0.11	0.27	**3.73**
Freight train	0.02	0.02	0.22	0.05	0.13	**0.44**

One can observe that especially the congestion costs will be the dominant external cost factor in the year 2020. The monetary saving of modal shift on external costs of one tonne-kilometre from road to rail is 3.73 – 0.44 = **3.29** cents per tonnekilometre for corridor A.

11.5.1.3. Passenger Transport

The following table presents the values for Corridor A for Passenger Transport. The values are in eurocent per passenger-kilometre for road and rail transport:

	Congestion cost	Accident cost	Air pollution cost	Noise cost	Climate change cost	Total external cost
Passenger car	8.65	0.26	0.22	0.11	0.64	**9.90**
Passenger train	0.09	0.08	0.08	0.11	0.27	**0.63**

For the passenger train the monetary savings of externalities for a modal shift from road to rail amounts to **9.26** cents per passenger kilometre (corridor A).

11.5.2. *Corridor E*

11.5.2.1.Freight Transport

The following table presents the values for Corridor E for Freight Transport. The values are in eurocent per tonne-kilometre for road and rail transport:

	Congestion cost	Accident cost	Air pollution cost	Noise cost	Climate change cost	Total external cost
Heavy Goods Vehicle	1.49	0.03	0.20	0.11	0.27	2.10
Freight train	0.01	0.02	0.13	0.05	0.13	0.34

One can observe that especially the congestion costs will be the dominant external cost factor in the year 2020. The saving for modal shift of one tonne-kilometre is 2.10 – 0.34 cents = **1.76** cents per tonnekilometre for corridor E.

11.5.2.2.

11.5.2.3.Passenger transport

The following table presents the values for Corridor E for Passenger Transport. The values are in eurocent per passenger-kilometre for road and rail transport:

	Congestion cost	Accident cost	Air pollution cost	Noise cost	Climate change cost	Total external cost
Passenger car	4.31	0.26	0.22	0.11	0.64	**5.55**
Passenger train	0.07	0.08	0.05	0.11	0.27	**0.58**

For the passenger train the savings for a modal shift from road to rail are **4.97** cents per passenger kilometre for corridor E.

11.6. Further explanation

11.6.1. Congestion costs

The Handbook provides figures on congestion costs for passenger cars and heavy goods vehicles (HGV)[21]. However, these are only limited to valid figures for morning peak traffic and are differentiated for type of area and type of road (Large urban area, Small and Medium Urban area and Rural areas). For this study only motorways have been selected.

As a result, in order to have a usable overall figure for average transport, the share of transport during rush hours compared to other times of the day has to be taken into account. According to available figures on motorway traffic, 35% of the truck traffic takes place within rush hour periods. For passenger cars this share is 42%[22].

11.6.2. Accident costs

The Handbook provides unit values for the accidents for different networks and types of vehicles for the different countries. The figures for motorways were selected for passenger cars and HGV.[23]

For rail transport the figure of 0.08 – 0.30 euro per train kilometre was presented as the average European value for average external costs of accidents[24]. The lowest figure (0.08 euro per trainkm) was selected because of increased safety due to expected improved safety systems and traffic management on railways.

11.6.3. Air pollution

For air pollution the figures for cars with an engine of 1.4 – 2.0 litres was selected at Euro-5 class. This represents the expected emission levels in 2020 for the average passenger car. For freight road vehicles the 32t truck Euro-5 was selected.[25]

For freight and passenger trains there was no figure that presented the expected improvements due to engine technology and fuels. Therefore additional literature was studied: ASSESS study by TML Leuven and STREAM by CE Delft. Subsequently the reduction factors of NO_x, SO_2, PM was derived and monetary value was estimated for year 2020 for air pollution caused by rail transport.

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[21] Page 34, table 7 of Handbook External Costs
[22] Source: Adviesdienst Verkeer en Vervoer, "Het vrachtvervoer op het hoofdwegennet in de Spitsperioden", Rotterdam August 2005
[23] Page 44, table 10 of Handbook Externa Costs
[24] Page 45 of Handbook External Costs
[25] Page 57 of Handbook External Costs

11.6.4. Noise

For the noise costs the time of day is relevant and also the type of area (urban, suburban, rural).[26] These factors have been taken into account to estimate an average figure per vehicle kilometre.

11.6.5.

11.6.6. Climate change

The Climate change is linked to emission of greenhouse gasses such as CO_2, N_2O and CH_4. The value for CO_2 was recommended at 40 euro per tonne in the year 2020[27]. Subsequently the climate costs were derived from the table in the handbook. Again Euro 5 vehicles were selected (1.4-2 litre car and 32t truck).

[26] Page 69, table 22 of Handbook External Costs
[27] Page 80, figure 9 of Handbook External Costs

ANNEXE 23

ANALYSE COUTS-BENEFICES

ASSUMPTIONS AND INPUTS

Micro-level cost and benefits

The assumptions taken for CBA calculation are presented in the papers in the files "Corridor A impact first results", "Corridor E impact first results" and "Extrapolation results".

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

	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.

Cost / benefits of modal shift – 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 unit cost values are 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.

The following unit cost values have been applied.

Freight transport			
Corridor	**Option**	**Rail cost per ton kilometre**	**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	B	**€ 0,129**	**€ 0,236**
ERIM	C	**€ 0,129**	**€ 0,236**

Cost / benefits of modal shift – externalities

The unit cost value per ton.km and passenger.km of road and rail have been estimated 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.

The data for 2020 (Corridor A & E) have been already presented in the meeting of July 31st. At the network level the following unit external costs in Euro 2007 have been applied for year 2020.

ERIM Network **External costs in eurocent per tonkilometer or passenger kilometer**

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**

Traffic data (modal shift impacts)

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

Table 1 **Result performance Option B - 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	2.453	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 % 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%

Table 3 **Overall figures option A (baseline)**

	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	

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.

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 monetariaing 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.

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			-6,5	-3,9	-47,1
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 €)			**99.539,9**	**33.180,8**	**553.057,0**
INTERNAL RATE OF RETURN			**132,7%**	**98,9%**	**86,2%**
BENEFIT / COST RATIO			**39,6**	**56,6**	**51,0**

Without congestion impacts

TOTAL NET PRESENT VALUE (mn €)	**18.240,0**	**6.287,4**	**104.005,2**
INTERNAL RATE OF RETURN	**83,0%**	**57,3%**	**49,5%**
BENEFIT / COST RATIO	**31,5**	**22,8**	**22,7**

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		2.193,9	260,9	6.314,3
	Additional capacity for freight trains		0,0	0,0	0,0
ADMINISTRATIVE COSTS			-5,8	-3,3	-40,5
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 €)			**86.161,2**	**272,6**	**372.043,5**
INTERNAL RATE OF RETURN			**127,7%**	**12,9%**	**76,1%**
BENEFIT / COST RATIO			**216,9**	**6,6**	**88,4**

Without congestion impacts

TOTAL NET PRESENT VALUE (mn €)	**15.286,8**	**260,3**	**68.131,2**
INTERNAL RATE OF RETURN	**77,3%**	**12,6%**	**41,0%**
BENEFIT / COST RATIO	**41,0**	**6,5**	**23,6**

ANNEXE 24

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ANNEXE 25

GLOSSAIRE

CER	Community of European Railways
EM	Etat Membre
ERIM	European Rail Infrastructure Masterplan
ERTMS	European Rail Traffic Management System (système de signalisation ferroviaire européen).
GI	Gestionnaire d'infrastructure
RNE	RailNetEurope
RTE-T	Réseau Transeuropéen de Transport
STI-TAF	Spécification Technique d'interopérabilité Application Télématique au Fret.
UIC	Union Internationale des Chemins de Fer