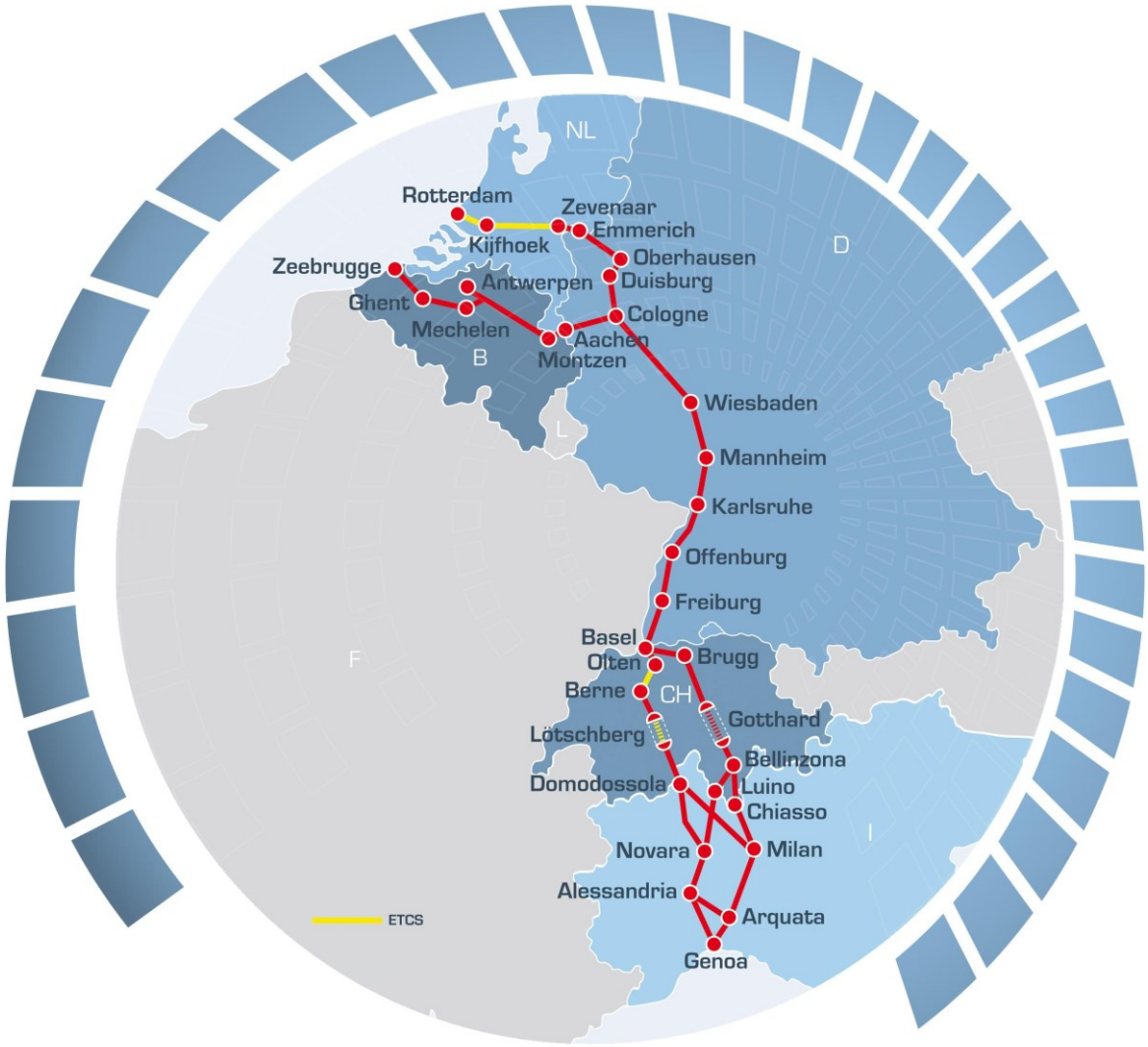
CORRIDOR
ROTTERDAM <> GENOA

Study Long Trains (740m)

on Corridor Rotterdam-Genoa



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Preamble

This study "long trains 740m" on Corridor Rotterdam-Genoa has been prepared by the infrastructure managers due to the stipulations in the Rotterdam Declaration of Ministers on Rail Freight Corridors dated 14th June 2010, chapter C1, clause 6 and on request of the Executive Board of the corridor. The study indicates technical and operational measures, as well as dates by when 740 m long trains could be accommodated on the corridor, if the measures are implemented. The study does not imply an obligatory implementation.

It is in the responsibility of the ministries of transport of the corridor countries to decide upon the implementation of the measures and provision by the related funds, which are needed for materialising the results of this study.

The preparation of this study was supported by co-financing from the European Union.

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Abbreviations

BLS	Bern Lötschberg Simplon Railway
CER	Community of European Railways
DB Netz AG	Deutsche Bahn Netz AG, German Railway Network
EEIG	European Economic Interest Group - Corridor Rotterdam-Genoa
IM	Infrastructure Managers
MC	Management Committee of EEIG
MoU	Memorandum of Understanding
RFI	Rete Ferroviara Italiana, Italian Railway Network
RNE	Rail Net Europe
RU	Railway Undertakings (also including applicants)
SBB	Schweizerische Bundesbahn, Swiss Federal Railway
TMS	Transport Market Study
UIC	Union Internationale des Chemins de fer
WG	Working Group - WG Infrastructure & Terminals by EEIG

Management Summary

„The challenge to run long freight trains (740m) on Corridor Rotterdam-Genoa".

Initiated by the Ministerial declaration of Rotterdam (2010), the Executive Board passed the mandate for a study of 740m long trains to the EEIG of the Corridor formed by the Infrastructure Managers (IM) and the allocation body of CH. A Subgroup was set up with the task to realize this study.

The Transport Market Study (TMS) provides basic data related to traffic development and demand for potential long trains. The railway undertakings (RU) and terminal operators gave their advice for further development and their needs. They strongly wish to have the complete Corridor Rotterdam-Genoa upgraded for long trains as soon as possible. This would enable multisystem locos to achieve more of their full potential.

Close international cooperation sets the infrastructural ground for this study. Some line sections can handle long trains already today. The infrastructure managers are well aware of the RU's needs and have realized numerous projects for long trains for many years already. For example, the majority of shunting yards on Corridor Rotterdam-Genoa can handle 740m trains. However, missing links still remain, blocking the opening of the whole Corridor Rotterdam-Genoa for long trains.

To close these missing links, the infrastructure managers studied alternative solutions:

- Short term: Operational measures showed some workarounds without additional investments. For one difficult line section, the start of a study has to be decided.
- Medium/long term: Small to medium projects with a short realisation time could bridge the missing links. These so called consistency projects on eight line sections are postulated as solutions in this study.

Line sections with consistency projects	Cost [Mio. €]	Remarks, time horizon
BE - All Infrabel corridor line sections	45 to 70	Eliminating the restriciton "off peak only"
DE - All line sections without major projects	50 to 60	
CH - Gotthard north access	--	Funded by project ZEB Gotthard line
IT - Novara–Alessandria	35 to 50	Realisation before 2020
Total cost of 8 consistency projects	**130 to 180**	

Table 1: Eight line sections with consistency projects, total cost 130 to 180 Mio. €.

The total corridor investments amount to € 46 billion in the period 2007 to 2030. Without the realization of these, the extra investments in the consistency projects are of limited use for long trains.

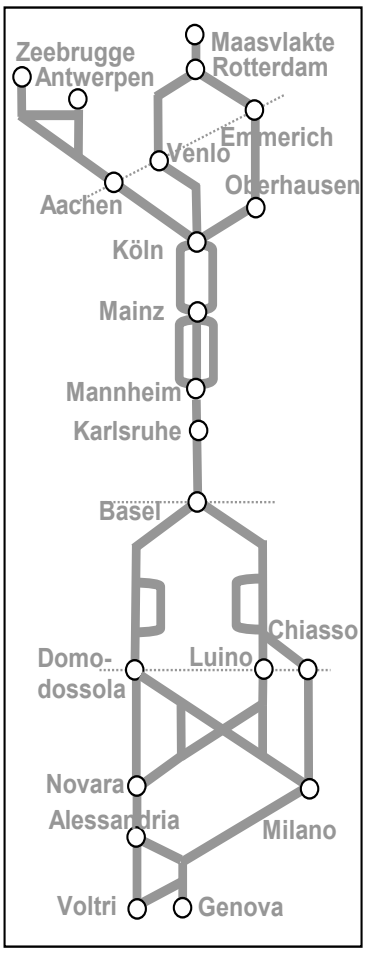
The result: **The Corridor Rotterdam-Genoa can be upgraded for long trains with investing an additional 130 to 180 M. €.** The benefit for the RU would be longer trains (more waggons) by 10% to 25% depending on the line section.

Funding, planning and realisation of the proposed consistency projects are still open until the Ministries of Transport decide to fund and have them implemented.

1 Introduction and Overview

The railway undertakings (RUs) strongly wish to run trains up to 740m – hereafter referred to as long trains - on all line sections of Corridor Rotterdam-Genoa as soon as possible to reduce the cost per train. However, there are different reasons that prevent riding long trains today.

This requirement by the market is considered in the ministerial declaration of Rotterdam (14.06.2010). An international study was commissioned to the EEIG of Corridor Rotterdam-Genoa with the task to identify possibilities for opening the Corridor for 740m long freight trains as soon as possible with reasonable cost.



The simplified topology of Corridor Rotterdam-Genoa and some relevant near-by line sections is shown in Figure 1. Linking the North Sea harbours of Belgium and the Netherlands, passing through important industrial regions in Germany and crossing the Alps in Switzerland it reaches the North Italian industrial region Novara / Milano and the ports of Genoa.

Corridor Rotterdam-Genoa is characterized by traffic flows on line sections in five countries combined with complex national organisational and technical regulations. Hundreds of international freight trains cross borders daily and have to change or switch over locos and drivers. A growing amount of locos is multisystem and can easily cross borders. In addition, some drivers have more than one national licence and can continue the journey in a second country.

The focus of the study is on all corridor line sections including the handover points. Regarding the last mile, only the track length of handover points and terminals are considered (see Figure 2). Technical aspects as power supply systems, train radio, braking tables, street level crossings, hot axle detectors, entrance / exit speed at stations are respected in the national studies and are not additionally mentioned in this report. All elements must be consistent since the weakest part in the system defines the maximal train length.

Figure 1: Corridor overview

The figure below shows the the study focus and limits it in a graphical form:

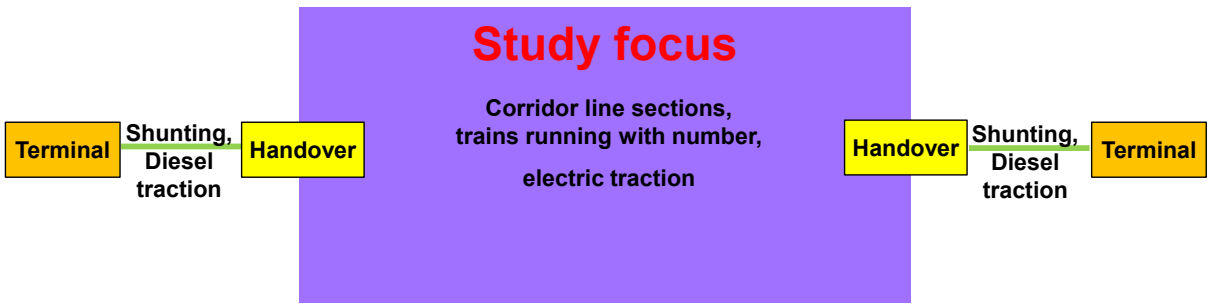


Figure 2: Geographical limits last mile

All planning work on the Corridor is based on the national systems. Passenger trains are the majority of trains on almost all line sections. Notable exceptions are the Dutch Harbour Line and Betuwe Line (Maasvlakte - Rotterdam – Zevenaar) with almost exclusively international freight trains. Therefore, Corridor Rotterdam-Genoa is a virtual construction and always a combination of national regulations, operation, planning and financing / funding.

The methodology for this study is based on the combined know how in the Subgroup with many years of experience.

- Step 1: Determination of current and future market demand for long trains based on the results of the TMS. Train and traction aspects are also treated (chapter 2).
- Step 2: Collection of current infrastructure data with hinderings for long trains (chapter 3).
- Step 3: Illustration of benefits for long trains after realization of all projects of the corridor investment plan. Display and description of missing links (chapter 4).
- Step 4: Description of operational and technical solutions for opening Corridor Rotterdam-Genoa for long trains (chapter 5).
- Step 5: Combination of results and recommendation as synthesis (chapter 6).

Below, the identified driving aspects for the study are shown:

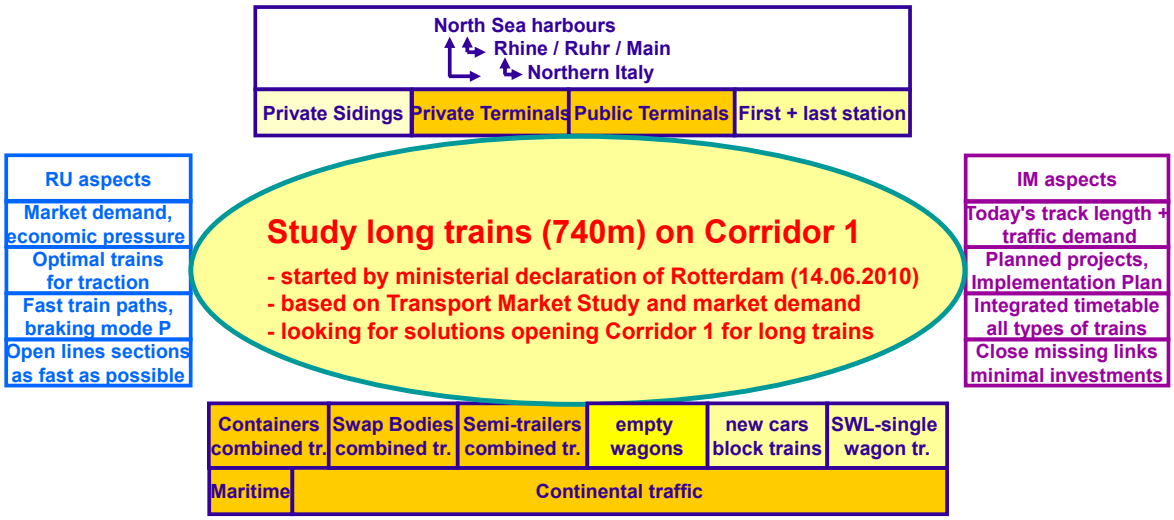


Figure 3: Driving aspects for long trains (740m)

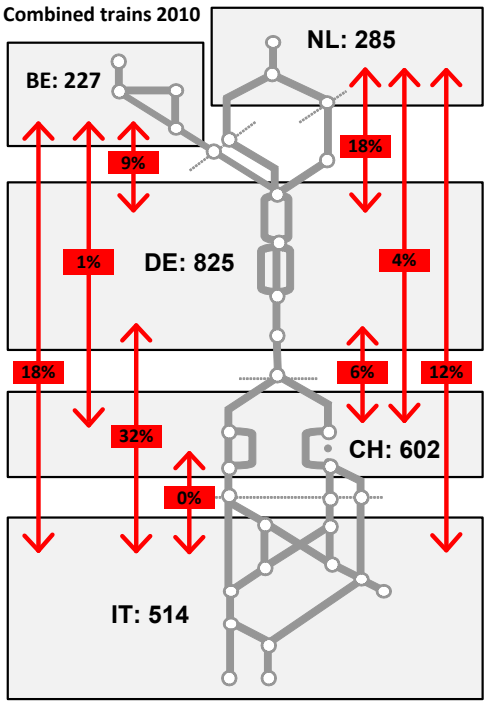
General information and explanations for this study report:

- Train lengths mentioned in the study (740m) always consist of **all waggons and locos**. Trains of 740 m are consistent with saying that the usable tracks for freight trains should be at least 750 m long. The 10 m extra are for stopping tolerance and viewing signals.
- Corridor Rotterdam-Genoa is systematically treated from North to South..
- Technical aspects as power supply systems, train radio, braking tables, street level crossings, hot axle detectors, entrance / exit speed at stations are respected in the national studies and not mentioned in this study report.
- Passenger trains are fully considered but not directly mentioned in this study.

2 Freight Market Demand and Trains

This chapter shows the current and the future market potential for 740m long trains based on results of the corridor Transport Market Study (TMS). Further, it is shown which train parameters are limiting long trains and which trains are suitable to be 740m long.

2.1 Current freight market demand



All results in the TMS only consider trains with origin and destination on the corridor.

The analyses of today's freight traffic within the TMS show that combined trains with containers, semi-trailers and swap bodies dominate the international rail freight market on Corridor Rotterdam-Genoa. In 2010, they had a share of 56% of the total rail freight market. Additionally, 24% of the total number of international freight traffic accounts for single-wagon trains and 20% for block trains.

Figure 4 shows the share of combined traffic in each country on the Corridor Rotterdam-Genoa. The importance of Germany (DE) as the central part is evident for international freight traffic on the corridor.

All numbers indicate values per week and contain all combined trains including the rolling highway (RoRo / RoLa).

Figure 4: Combined trains on Corridor Rotterdam-Genoa in 2010 per week.

Reading example: *- NL 285 means that 285 trains per week cross the border of the NL.*
- 12% means that 12% of all corridor trains are direct trains NL-IT.

Market and RU ask for long trains (740m) on **all relations along the entire Corridor Rotterdam-Genoa** linking all industrial zones as soon as possible. During the workshops the RU's defined their priorities. In the south, they would upgrade first Luino, then Chiasso, last Genoa. Not only the corridor trains but also many "touching-trains" would benefit.

2.2 Future freight market demand

Based on the results of the TMS, further growth of rail freight traffic on Corridor Rotterdam-Genoa around 30% is expected until 2025. This also accounts for combined traffic, which will further increase in the future, while single wagon traffic is expected to decline slowly.

Concerning combined traffic, an end of its steady growth is not in sight. Global trade with ever-larger vessels and huge automated harbour terminals prove the belief in the chances. In the EU, the switch to semi-trailers and swap-bodies will grow. An increase by 29% from 2010 to 2016 is expected. A distinction between containers, semi-trailers and swap bodies does not seem useful; all are transported on combined trains. The rolling highway is considered to remain at a stable volume. More details can be derived from the essential elements of the TMS report that is part of the Investment Plan of the corridor.

2.3 Potential long trains

The challenge of running long trains (total length 740m, always including all wagons and locos – plus 10m for visibility gives track length 750m) asks for train-side and track-side elements to be coordinated. Therefore, considering the following train parameters is mandatory:

- Speed: 90 – 100 km/h.
- Traction: One multisystem loco (6 MW) running through.
- Braking regime: P up to 1'600t (5GP, long loco – loco and 5 first wagons G, rest P) allows faster train path. All RU prefer the P braking mode. Every change of braking mode during train run is a loss of 30 – 60 minutes.
- Last mile: Train must fit into handover points and terminals regarding track length.
- Operating program: Complete trains or train parts with forming/joining and splitting up.
- Train weight: Depending mainly on gradients of line sections used.

To better understand the requirements of the RU, three potential long trains (740m) were set up and verified by the RU in two workshops:

1. Light long train, max. 1'200t, max 100 km/h, P braking mode
2. Medium long train, max. 1'600t, max 100 km/h, P braking mode (5GP, long loco)
3. Normal long train, over 1'600t, max 90 km/h (some 100 km/h), G braking mode

Trains with heavy goods (coal, ore, steel) are limited by the maximum trainload and not by their length. For example, the daily coal trains Rotterdam – Ruhr (with double traction) weight 4'800t but are only 550m long.

The potential for long trains depends on the type of freight:

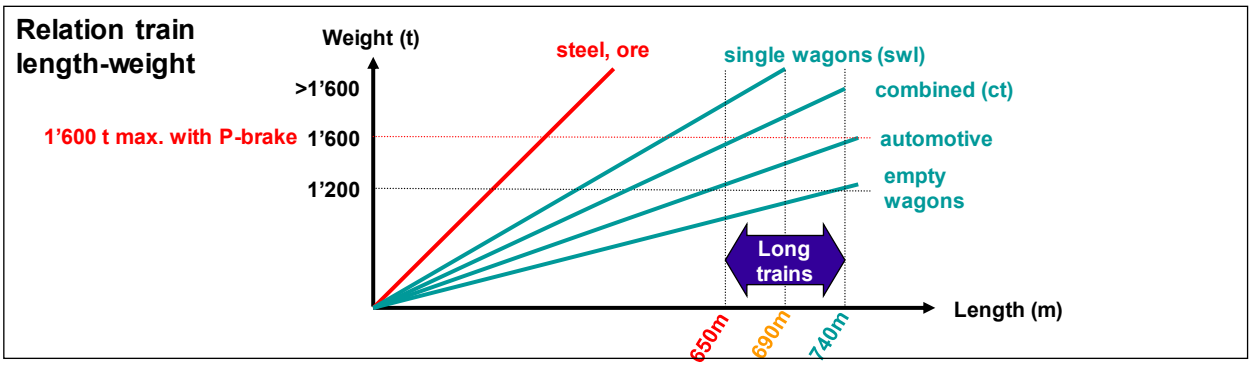


Figure 5: Relation between train length and train weight.

Due to the rather low weight, freight trains with empty wagons, automotive or combined traffic have the biggest potential for long trains.

Clearly, not all trains on Corridor Rotterdam-Genoa will ever be 740m long. The RU plan for the longest realistic value that a train might have and some trains reach this limit. Economically, it is interesting to have any train as long as possible to make the best use of train path and traction with the same cost. By increasing the train length from today's 600/650m to 740m, the benefit for the RU would be 10% to 25% per train.

2.4 Multisystem Traction

One key factor for an economical production is traction. The analysis in this study is based on traction with modern multisystem locos (see Figure 6). Several hundred are in daily use on Corridor Rotterdam-Genoa, many taking the train on its complete journey. The most often used multisystem loco is the TRAXX in many versions:

Multisystem Locomotive TRAXX
Bombardier F 140 AC/MS, 5.6 MW, 84t, V max 140 km/h,
SNCB L 28/29, DB Schenker BR 185, SBB Cargo 482/484,
BLS Cargo 465/486, Trenitalia E 412.
Similiar: Alsthom Prima 6000 (6 MW), Siemens ES64S4 (6.4 MW).

Figure 6: Multisystem locos TRAXX running on Corridor Rotterdam-Genoa.

The combination of multisystem locos with the three types of potential long trains is shown in this figure:

3 potential longer trains:

- light max 1'200t / max 100 km/h / P braking
- medium max 1'600t / max 100 km/h / P (5GP*)
- heavy over 1'600t / max 90 km/h / G braking

all max 690m / 740m,
traction with one multisystem loco.

*** 5GP, "Lange Lok": Loco and first 5 wagons = G, rest = P**

3 electric multisystem Locos (ca. 6 MW each):

Alsthom Prima 6000 **Siemens ES64F4**

Bombardier F 140 TRAXX

Figure 7: Combination long trains and multisystem locos.

Maximum possible train weights are shown in the following chapters. For actual values see chapter 3, planned values 2020 are shown in section 4.1.

3 Current Limitations of the Train Length

This chapter shows the actual possibilities for the operation of the 3 potential long trains with one loco. More detailed information on shunting yards, handover points and terminals can be found in Annex 3 and 4.

The train length is limited with given train parameters by

- national regulations
- gradients on the line sections and
- tracklength limitations combined with operational guidelines of the IM.

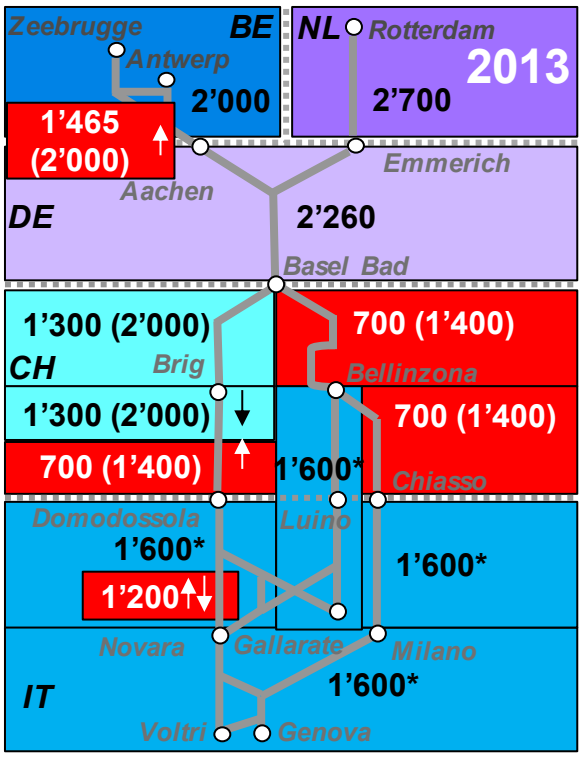
The weakest part on the entire run defines the maximal train length.

National regulations

Generally, the national regulations of all countries allow long trains up to 740 m. In Italy, national regulation limits trains to 1'600 t maximum train weight. This limit clearly excludes the most potential long trains (combined traffic, see Figure 5) in Italy.

Gradients

Due to the inclination, the following line sections are critical for traction today:



- Aachen-Montzen: Trains South-North with workaround by pushing loco (18 per mille).
- Gotthard line: Most trains need double traction until the base tunnel is open.
- Domodossola-Brig: Trains South-North often with double traction (26 per mille).
- Domodossola-Borgomanero-Novara: Route heavier trains via Arona (16 per mille).

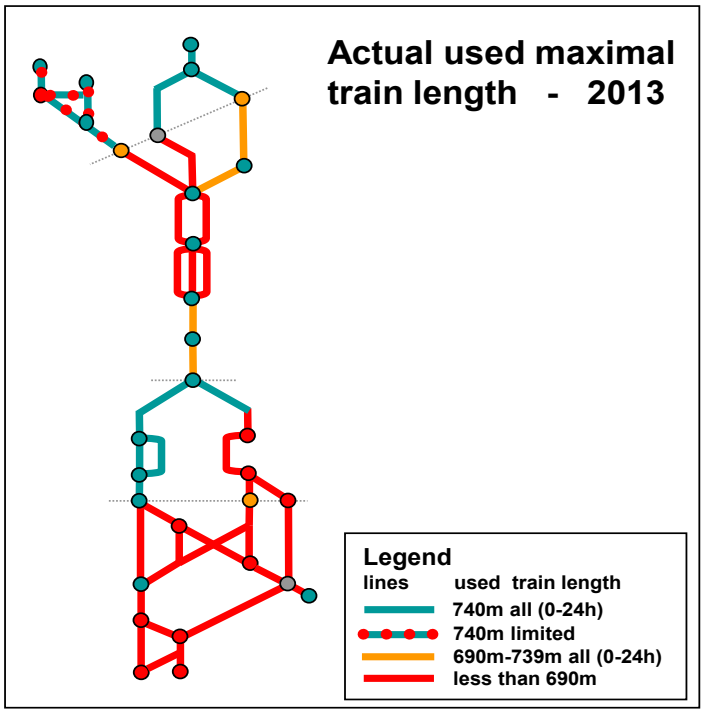
The traction limitations will change fundamentally on the Gotthard line with the opening of the base tunnels (2016/2019). The line section Bellinzona-Chiasso will remain critical South-North even afterwards (17 per mille):

Figure 8: Actual maximum train weight (* limit by national regulation, numbers in brackets are max. weight with double traction).

Reading example: *Significant differences of maximum train weight to the neighbouring line sections are marked in red. Numbers in brackets are maximum train weight with double traction or with pushing loco.*

Track length

Today it is possible to run long trains on only few line sections on Corridor Rotterdam-Genoa, namely the following:



- NL: All line sections from Maasvlakte 2 to Zevenaar (border NL/DE).
- BE: All line sections of Corridor Rotterdam-Genoa – but only during **off peak hours** (9-16h and 20-06h).
- DE: The lack of long sidings (740m) on the corridor lines does not allow the construction of economically usefull train paths,
- CH: All line sections the Lötsch-berg-Simplon line and Basel-Brugg on the north side of the Gotthard line.

Figure 9: Current maximum train length

The main hinderings today are the following:

- Belgian line sections can operate long trains (740m) only during **off peak hours**.
- German line sections use **650m**, some use **690m**, caused by operational issues and missing long sidings for overtakings.
- Switzerland has the Gotthard and the Luino lines limited to **600m**.
- Italy needs to upgrade **all line sections** on the Corridor.

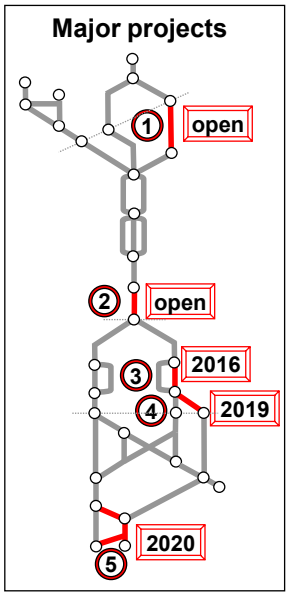
It is often believed that it is already possible to run long trains from the North to Chiasso and Milano. It can be clearly seen in Figure 9 that **this not possible today** with good quality.

4 Development with Planned Infrastructure Projects

This chapter shows the effect of the planned projects in the corridor investment plan on the possibility to run long trains on corridor line sections and the missing links.

4.1 Corridor investment plan

Central base for this study is the EEIG investment plan by the IM showing all planned projects and upgrades with their funding state and timeline. Main driver is capacity.



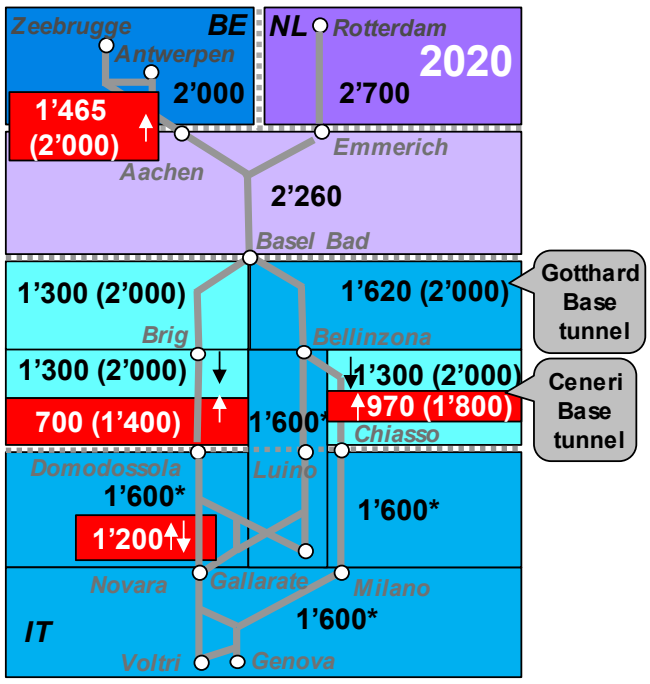
Since 2007, the Harbour and Betuwe lines (NL, freight only), the Katzenberg tunnel (DE) and the Lötschberg base tunnel (CH) are in operation.

Today, five major projects are still under construction and/or in planning with the goal to eliminate capacity bottlenecks and to enable long trains (Figure 10). Train length of 740m is a standard AGC/AGTC norm by UN since 1988.

- Emmerich – Oberhausen (third track)
- Karlsruhe – Basel (third and fourth tracks)
- Gotthard base tunnel
- Ceneri base tunnel
- Giovi base tunnel.

Figure 10: Five major projects with timeline highlighted in red

Gradients



Regarding traction, the opening of the three base tunnels will have positive consequences.

However, a limit will still remain on the Gotthard line section Chiasso-Bellinzona. Two parts with 17 per mille remain for trains S-N. The workaround will be double traction for trains over 970t.

On the Lötschberg-Simplon line, the access to the base tunnel limits trains to 1'300t; double traction allows 2'000t.

Three other limitations for traction will remain as explained in chapter 3.

Italian regulation limits weight to 1600t.

Figure 11: Improvements for traction with major projects in the investment plan (* limit by national regulation, numbers in brackets are max. weight with double traction).

Track length

The development of possibilities for long trains with the **major projects** over time is shown in this figure:

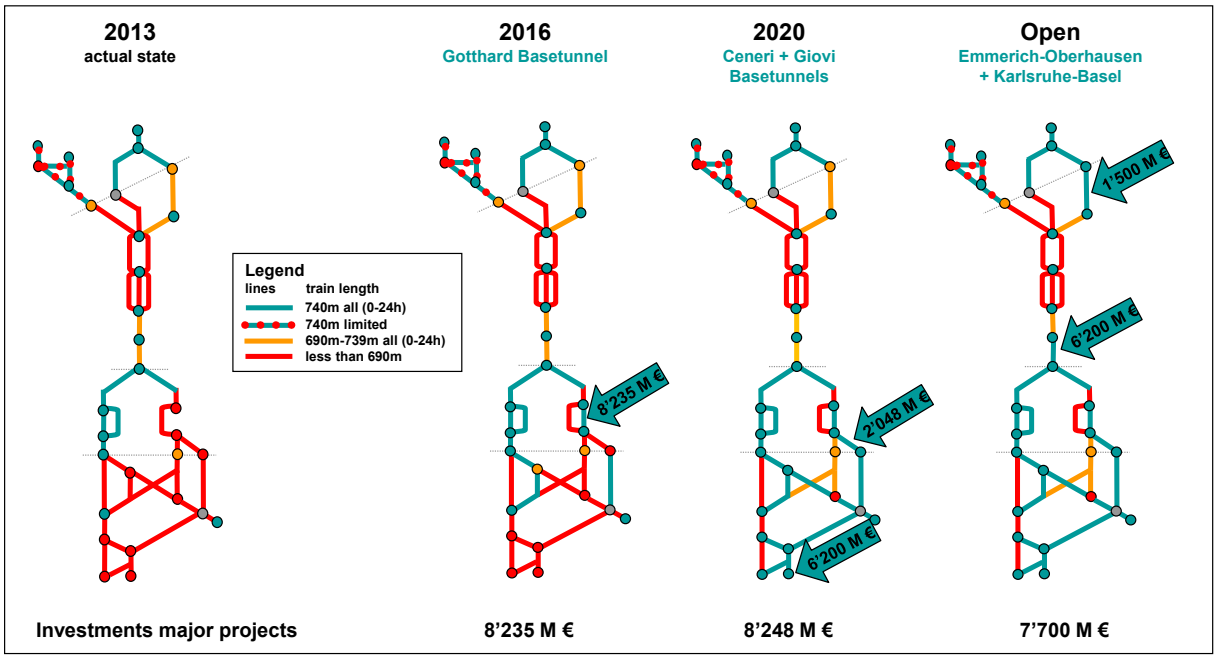


Figure 12: Development of topology for long trains with investment plan of Table 2.

In addition to these five major projects shown in figure 12, many more small to medium sized projects enabling long trains are planned or under construction. Not all projects of the investment plan are financed today. Some further information on national investment plans can be found in Annex 2.

The investments in figure 12 contain the major projects only. Table 2 below shows all infrastructure investments (major and small) on Corridor Rotterdam-Genoa:

Year	< 2014 *	2015–2019	2020–2024	> 2025	**Total**
Investments	8'700 M €	13'500 M €	14'300 M €	9'700 M €	**46'200 M €**

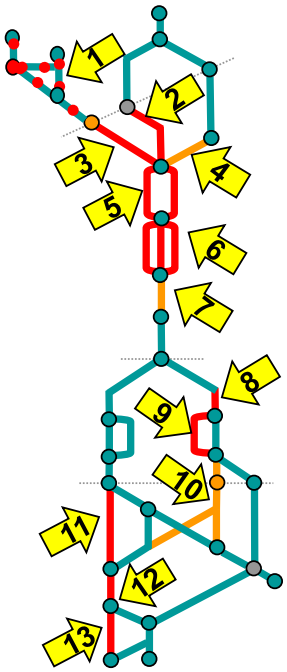
Table 2: Complete investment plan of 2007 to ca. 2030. * Including investments for realised major projects (Betuwe Line, Lötschberg- and Katzenberg Tunnels).

Although important progress is made with these investments, still many line sections remain blocked for long trains as missing links.

4.2 Missing links

With all planned projects described above and displayed in Figure 12 still many missing links for long trains remain. Most important are the gaps in the middle part in Germany blocking long trains. If all planned projects of the investment plan will be realised, thirteen missing links for long trains remain.

13 missing links



1	BE	Zeebrugge/Antwerp–Aachen (off peak only)
2	DE	Venlo–Köln
3	DE	Aachen–Köln
4	DE	Oberhausen–Köln
5	DE	Köln–Mainz
6	DE	Mainz–Mannheim
7	DE	Mannheim–Karlsruhe
8	CH	Gotthard line north access
9	CH	Gotthard mountain line
10	CH+IT	Bellinzona–Luino–Novara/Gallarate.
11	IT	Domo–Borgomanero–Novara
12	IT	Novara–Alessandria
13	IT	Alessandria–Genova

Figure 13: Missing links (numbered arrows) after realization of investment plan.

To open the corridor for long trains the investment plan has to be completely realized and for the thirteen missing links solution should be elaborated by the IM's (see chapter 5).

5 Solutions to open the Corridor for Long Trains

The IM studied possible solutions for opening the entire corridor for 740m trains. This chapter shows the methodology and results of the national studies.

5.1 Methodology

The methodology applied for the development of the solutions is described hereafter, split in two time horizons:

- Short-term (up to five years) with operational solutions
- medium to long-term (more than 5 years) with consistency projects for long trains

Short-term horizon: The infrastructure managers worked on national studies based on timetable projects for the next years in order to find possible chances (quick wins) for long trains without investments. The timetable specialists met with the colleagues for network planning and operating studying also unconventional solutions. This is a most difficult task as most line sections are charged with dense mixed traffic and have high demand for operational quality. The variants studied are:

- line sections (fast or cheap earlier than rest),
- trains (some trains earlier than all trains),
- time slice (night only, off-peak only, 24h).

Just the first variant proved to bring results. The findings for short-term solutions are small, two concrete operational studies shall be realised. This can be explained by the strong traffic flows on most line sections on Corridor Rotterdam-Genoa, crossing many agglomerations with dense passenger traffic. Further restrictions are set by the ongoing and planned heavy construction works for the major projects, all to be realised with the shortest possible interruption of operations. Finally, the usable down time at night (without passenger trains) of only 4 to 8 hours is generally too short to allow freight trains to cross the regions. The result can be found hereafter in 5.2 and 5.2.2.

Medium to long-term horizon: The infrastructure managers studied possibilities to close the missing links with infrastructure projects. In order to close all missing links on eight line sections and handle long trains consistent on most line sections, such projects must

- have a reasonable time horizon and
- be small investments.

The national studies considered all actual planning bases such as topology, timetable and many more regional aspects.

Resulting projects are **small additions or upgrades**, i.e. new signals, shift of signals and/or switches by some meters, additional switches, lengthening of tracks by a few meters. Realisation time after funding and permission for these projects is approximately three years. For the results see 5.3.

All national studies are property of to the responsible Infrastructure managers and are not published in this corridor study. However, the results are fully integrated.

5.2 Operational solutions

The Infrastructure Managers worked on national studies based on timetable projects for the next years: “Where are the chances for long trains (740m) without investments?”, searching for Quick Wins.

For four of the thirteen missing links (see 4.2) there are alternative routes:

- **2 DE Venlo–Köln:** Diversionary line; operational solution routing long trains via Emmerich,
- **9 CH Gotthard mountain line:** Gotthard mountain line not to be upgraded, operational solution routing long trains via the base tunnel,
- **11 IT Domo–Borgomanero–Novara:** Not to be upgraded, operational solution routing long trains via Arona.
- **13 IT Alessandria–Genova:** Not to be upgraded, operational solution routing long trains via Arquata (base tunnel terzo valico).

For **10 CH/IT Luino line** there is no alternative route for long trains and therefore an other operational solution was searched for, see 5.2.2.

During the search for short-term solutions, the sections with the major projects were also looked at. For **Mannheim–Basel,** DB Netz AG found operational possibilities to allow some long trains earlier, see 5.2.1.

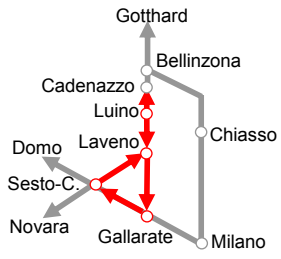
5.2.1 Mannheim–Basel

Most critical is the missing link Mannheim-Basel. To enable *all 740m trains* here the major projects quadrupling the line section has to be completed. Because the time horizon is actually open, DB Netz AG analysed operational possibilities to allow some long trains earlier.

Mandatory for running some long trains is the upgrade of the node Basel. Right on the border six new tracks are planned and partially already under construction to stack freight trains for a short time (Basel Bad Rbf, group F). Time critical is the South part on Swiss territory regarding the construction rights. The stop should typically last a few minutes to change drivers and fit in the next national timetable system. Additionally, the finished restructuring of Basel SBB RB I with fewer but longer tracks will also help handling long trains in the Basel area.

With the opening of these six tracks, it should be possible to run 4 – 8 long train pairs a day using best operational skills and optimal dispatching on this very charged line section.

5.2.2 Operational solution Luino Line



A special case on the Corridor is the **Luino line**, linking Bellinzona with Gallarate / Novara. This single-track line is almost flat (max. 12 per mille) but it is located in a topographically difficult region. An upgrade of the single track Luino line from 600m to 700m is planned and agreed. This lower value is due to crossing stations limited by two tunnels. The upgrade to 740m would require much more costly modifications on tunnel entrances and would be beyond a reasonable cost – benefit margin.

Figure 14: Luino line topology

As workaround, in a first step a general feasibility analysis by RFI and SBB will verify the chances for a “tidal flow” operation, allowing long trains (740m) in e.g. 4-hour time slices **strictly in one direction**.

Once the general feasibility affirmed, a timetable/operational study “Luino Line – tidal flows” would look at possible time windows and the complete area Bellinzona-Gallarate / Novara, how to handle long trains (740m), including the handover points and terminals.

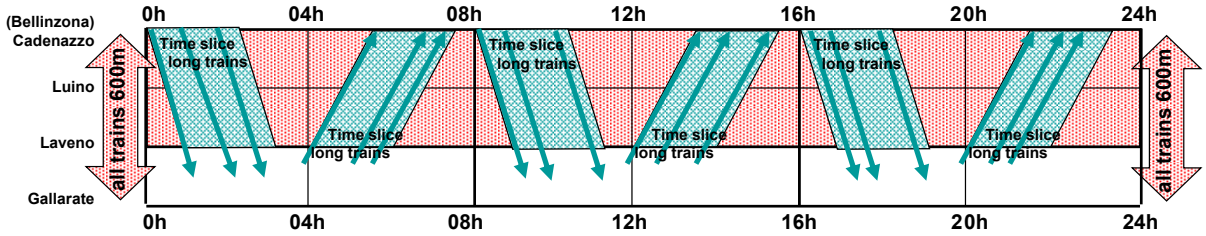
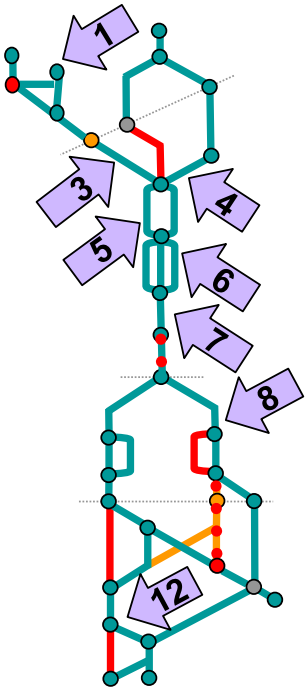


Figure 15: Graphical timetable Luino line

In November 2013, the Management Committee decided to start this study by RFI and SBB. It shall include the draft of a recovery plan in case of train breakdown on the line. Monitoring will be by the working group Infrastructure & Terminals, supervision by the Management Board.

5.3 Infrastructure solutions – consistency projects

Consistency projects on eight line sections are needed to open the Corridor for long trains:



1 Belgian network will eliminate the restriction “off peak only”, first from/to Antwerp and then Zeebrugge.

3 Aachen–Köln opens link with Belgian network.

4 Oberhausen–Köln fills the missing link with the Netherlands, also to be used by strong traffic from/to Hannover/Bremen.

5 Köln–Mainz opens on both banks of the Rhine river the central part of Corridor Rotterdam-Genoa assuring better operations quality.

6 Mainz–Mannheim allows long trains for important “touching traffic” and guarantees stable operation on all three lines.

7 Mannheim–Karlsruhe close the missing link between Mannheim and the major project Karlsruhe-Basel

8 Gotthard North access line brings full use of base tunnel.

12 Novara–Alessandria opens second access to Genoa via 3° valico line avoiding transit of Milano area.

Figure 16: Eight line sections with consistency projects (numbered arrows).

The **eight line sections with consistency projects** compliment the major projects and allow with “just a little more money” huge benefits for the RU. Planning and realisation need to be coordinated for optimal results. The main characteristics are shown in Table 3.

	Line sections with consistency projects	Cost [Mio. €]	Remarks, time horizon
1	BE - All Infrabel corridor line sections	45 to 70	Eliminating “off peak only”
3	DE - Aachen–Köln	50 to 60	Plus project by S-Bahn
4	DE - Oberhausen–Köln		Connects NL and North-East
5	DE - Köln–Mainz		Lines on both banks needed
6	DE - Mainz–Mannheim		All 3 lines needed
7	DE - Mannheim-Karlsruhe		Both lines needed
8	CH - Gotthard north access	--	Funded by project ZEB
12	IT - Novara–Alessandria	35 to 50	Realisation before 2020
Total cost of 8 consistency projects:		**130 to 180 Mio. €.**	

Table 3: Eight line sections with consistency projects

Most of these projects are small to medium sized, construction taking typically 3 years realisation time after planning and financing and construction rights.Each IM has the study information about the own consistency projects. Only results are mentioned here.

5.4 Results and summary of infrastructure solutions

National studies have searched intensively for solutions and found that Corridor Rotterdam-Genoa could be opened for long trains with reasonable cost. All solutions need to be coordinated on corridor level to make best use of resources and giving optimal benefit to the RU.

An overview of all costs on Corridor Rotterdam-Genoa:

Year	< 2014 *	2015–2019	2020–2024	> 2025	Total Mio.
Investment plan [Mio. €]	8’700	13’500	14’300	9’700	46’200
Consistency projects [Mio. €]		**130 to 180**			**max. 180**
Total [Mio. €]					max. 46’380

Table 4: All Corridor investments 2007 – 2030 in Mio. €. including Consistency projects
* Including investments for realised major projects (Betuwe Line, Lötschberg- and Katzenberg Tunnels).

Conclusion: **Corridor Rotterdam-Genoa can be upgraded** for long trains (740m) for 130 to 180 Mio. €. on most line sections – **in reasonable time,** 3 years **after** clearing of **funding and obtaining permission rights**.

Investments for the eight line sections with consistency projects are roughly two per mille of the total costs listed in the corridor investment plan.

This figure shows the development of the Corridor Rotterdam-Genoa for long trains over time. Starting on the left side with the actual state, in the middle the planned state with all major projects is shown. The most difficult problems (steep gradients and capacity) for long trains will be solved be these “big five”. Finally, on the right the result of this study is displayed.

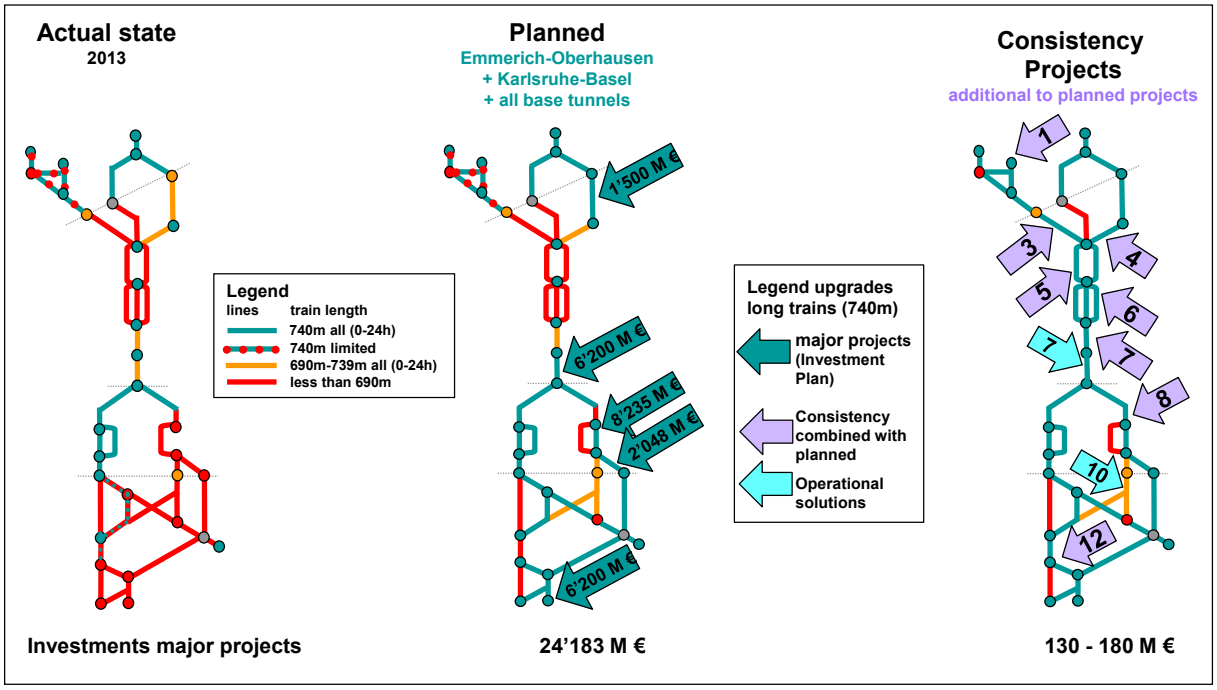


Figure 17: Development of topology for long trains with planned projects, consistency projects and operational solutions.

With the consistency projects, most missing links could be closed. For the remaining missing links, workarounds are possible with re-routing long trains as described in section 5.2.

6 Conclusions and Recommendation

The study has shown that it is possible to open most sections of Corridor Rotterdam-Genoa for long trains with eight line sections with consistency projects after 2015 with relatively small additional investments.

However, they must be in addition to the projects foreseen in the corridor investment plan, some of which still need to be financed.

Based on the findings in this study, the following next steps are proposed by the subgroup:

- Short term (up to five years): Operational measures showed some workarounds without additional investments. For one difficult line section, a study shall now be started.
- Medium / long term (more than five years): Funding, planning and realization of all eight line sections with consistency projects in the period after 2015 to open the corridor for long trains (740m) as explained in section 5.3.
- One sensible point is the train weight restriction in Italy (max. 1'600t) by regulation. This limits long trains to a few categories of light goods only. - Italy will have to consider how best to approach the process of a progressive alignment to existing corridor values.

Chances	Risks
+ With investments of 130 - 180 Mio. €. on top of already planned investments, all urgent missing links can be closed.	**-** The benefit of the consistency projects fully depends on the funding and realization of the major projects, which is not yet secured.
+ RU's can form most trains 50m to 150m longer than today which would lead to a gain in productivity by 10% to 25% (depending on line sections used).	**-** Without consistency projects, the three most powerful industrial zones would not be connectable by long trains.
+ Operating long trains increases capacity and competitiveness of the corridor.	**-** Besides financing, the critical point is the timeline: All time estimations in this report are pure realisation times - after financing, planning, and getting construction permission. Those last activities take more time than the realization itself.
+ The potential market demand could be met and additional traffic be acquired.	

Table 5: Chances and Risks

Annexes

Annex 1 - Bases for the study

This study on Corridor level is based on some international studies:

- UIC DIOMIS (2006), DIOMIS WP 7 (2007).
- CER: Business Cases, working paper longer trains.
- RNE: Brochure Corridor 2.
- DB Netz AG: GZ 1000.
- EEIG Corridor Rotterdam-Genoa, Infrastructure data
  - Inputs of the essential elements of the Transport Market Study Corridor 1.
  - Collected new data Last Mile (Handover, Terminals) and Traction Table.

Annex 2 - National investment plans

Parts from the national investment plans with other projects with effects for long trains:

Investment plan Switzerland

Longer tracks in Bellinzona, Chiasso and the Luino line (Swiss part) and Chiasso are planned but not listed. They are part of the general upgrading of the Gotthard line with secured funding by the Swiss Infrastructure fond, as well as the major projects base tunnels and project upgrade to 4 m gauge.

Investment plan Italy

Many upgrades are planned on the line sections Domodossola-Arona-Novara, Arona-Gallarate-Milano, Luino-Gallarate/Novara, Chiasso–Milano and Milano-Genoa. Most allow 740m trains, just the Luino will be limited to 690m trains, explained in chapter 5.2.2.

The list of small / medium projects for train length (Investment Plan) in Italy:

Station (line section) and upgrade to ….. m	Investment	Year	Status
4 stations (Domo-Novara - 650m)	25 Mio. €	2015	Approved
Borgo Ticino (Luino-Novara – 700m)	3.5 Mio. €	2016	Approved
Premosello (Domo-Novara - 740m)	2 Mio. €	2016	Approved
One station (Chiasso-Milano – 740m)	5 Mio. €	2016	Approved
Arona (Domo-Gallarate/Novara – 740m)	26 Mio. €	2020	Approved
Gallarate (Domo/Luino-Milano – 740m)	5 Mio. €	2020	Planned
3 stations (Luino-Novara/Gallarate – 700m)	31 Mio. €	2020	Planned

Table 6: Italian small / medium projects for long trains

Annex 3 - Terminal track table

CB2:M102orridor Terminal Tracktable and transfer stations
Data by Subgroup study long trains (740m)

Version: 22.10.2013
by Subgroup long trains & H.Pulfer

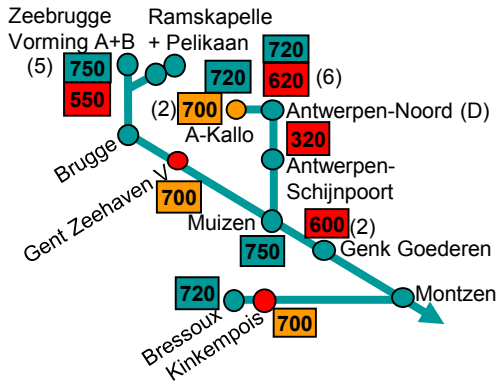
Country	Region with shunting yard normally also handover	max. length **tracks**	number of tracks	hand-over station	hand-over **tracks**	Name of Terminal, owner / operator	max. length **wagons**	number of tracks	remarks, projects, detailled track length (m)
NL	Rotterdam Maasvlakte West + Oost	750	> 20	SY	750	ECT (RTW + ORT)	750	10	2 railterminals (4 + 6 tracks)
				SY	750	APMT	750	3	to be opened in 2014
				SY	750	EMO	630	5	4 Coal + 1 Ore
	Rotterdam Waalhaven Zuid	750	> 20	SY	750	Waalhaven Zuid RSC	750	8	SY Waalhaven Zuid: 2 tracks 750m
	Rotterdam Kijfhoek	750	> 20	-	-	-	-	-	
	Vlissingen Sloehaven	750	5	SY	750	Vopak	350	3	Vopak 1x 350m, 1x 325, 1x 235
	Beverwijk	540	1	SY	540	Tata steel	650	4	Handover upgrade 750m planned, steel
	Blerick	600	1	SY	600	Venlo ECT	600	3	
BE	Zeebrugge Vorming bundel A+B	850	10	SY	850	Zeebrugge APM	750	3	SY (shunting yard): 7 x 850-750, 3 x 630
				SY		Zeebrugge PSA	720	6	
				SY		Container Handling Zeebrugge			Terminal CHZ
				SY		P&O ferrymasters	550	3	
				SY		2XL			
				SY		Zeebrugge international Port	under construction		planned 5 x 750m
	Zeebrugge Pelikaan	850	12	-	-		-	-	SY: 6 x 900-800, 4 x 545 -500, 2 x 435-390
	Zeebrugge Ramskapelle	750	16	-	-		-	-	SY: 6 x 740-730, 2 x 672,1 x 534, 6 x 480-435
	Gent Zeehaven Vorming	640	> 20	-	-	Gent container terminal	under construction		
						IPG Intermodaal Platform Gent	700	2	SY: 18 x 640-600, 22 x 580-535
	Antwerpen Schijnpoort	780	10	T	620	Terminal à Meerhout (WTC)	320	2	SY: 4 x 800-720, 6 x 660-620
				-		Antwerpen HTA - HUPAC	620	5	
			3	SY	870	Antwerpen Combinant	620	5	
			9	SY	870	Antwerpen Noord Main hub	720	8	
	Antwerpen Noord bundel D	870		-	-	Antw. Cirkeldyck (MSC home)	600	4	SY: 4 x 870-710, 5 x 680-630
				-	-	Antwerpen Zomerweg	600	4	
				-	-	Noordzee Terminal PSA	450	9	
				-	-	Antwerpen ATO	600	4	
				-	-	Mexico Natie N.V	-	-	
	Antwerpen Kallo	710	3	SY	710	Deurganck PSA	680	5	
						Antw. Gateway DP world terminal	700	6	SY: 1x788, 2 x 710
						Shipit	under construction		
	Genk Goederen	820	20	SY	820	Genk Euroterminal	600	4	SY: 9 x 730-820, 6 x 610-650, 5 x 500
	Genk Zuid Rechterover			SY	820	Genk Haven	500	5	SY: 9 x 730-820, 6 x 610-650, 5 x 500
	Muizen	820	20	SY	820	Ambroggio	750	2	SY: 14 x 925-800, 2 x 793-760
	Kinkempois	650	> 20	SY	-	Renory, Liège Containerterm.	-	-	SY: 9 x 650 -600, 15 x 580-500, 22 x 480-420
					-	Liège Logistique Intermodal	700	4	SY: 9 x 650 -600, 15 x 580-500, 22 x 480-420
	Bressoux	960	> 20	T	960	Port de Liège Trilogiport	under construction		SY: 8 x 960-710, 5 x 680-610, 8 x <585
DE	Duisburg Ruhrort Hafen	750	> 20	SY	950	Duisburg DeCeTe	700	1	1 x 650, 1 x 700, 1 x 181, 1 x 222, 1 x 202
				SY	950	Gateway West	310	4	k.A.
				SY	950	Ruhrort Hafen DUSS = PKV	780	9	DUSS: 1 x 780, 5 x 680, 3 x 600
				SY	950	Duisburg RRT	400	2	2 x 400
				SY	950	Duisburg Megahub	700	4	4 x 350? (total lenght with 4 tracks 1400 m)
				SY	900	Duisburg DKT	470	6	6 x 470
	Rheinhausen	750	> 20	SY	900	Duisburg DIT	700	6	6 x 700
				SY	900	Duisburg DBT	350	4	4 x 350
				SY	700	Neuss Trimodal	650	8	Hessentor 8 tracks 420 to 650 or 3 x 580, 3 x 510
	Neuss Gbf	700	> 20	SY	700	Neuss Intermodal Terminal (NIT)	690	1	2 x 180
				SY	700	uct Umschlagbahnhof Container	?	?	heavy goods, dry transshipment
	Germersheim	720	< 20	SY	720	Germersheim	420	?	4 x 420? (total lenght with 4 tracks 1'680 m)
	Köln Eifeltor Rbf	750	> 20	SY	770	Köln Eifeltor DUSS	700	13	DUSS: 8 x 700, 5 x 630 (with upgrade)
	Gremberg Gbf/Köln Kalk	750	> 20	SY	790	Köln Niehl Hafen	750	3	3 x 750, 4 x 450
	Köln Ehrenfeld								
	Mainz Bischoffsheim Rbf	750	> 20	SY	770	Mainz Frankenbach	600	1	4 between 250 and 600
				SY	1300	Mannheim Handelsh. Contargo	600	3	3 x, total length 1'350 m
				SY	1300	Mannheim Handelsh. DUSS	650	5	DUSS: 4 x 650, 1 x 550
	Mannheim Rbf	750	> 20	SY	1300	Mannheim MCT	125	2	2 x125
				SY	1300	Ludwigshafen KTL (BASF)	680	13	KTL: 6 x 620, 3 x 620, 4 x 560, 12 x 800 (holding siding)
				SY	1300	Ludwigshafen Triport	475	2	2 x 475
	Karlsruhe Rbf	750	> 20	SY	900	Karlsruhe DUSS	500	4	4 x 500 (possibility up to 700 m)
				SY	900	Karlsruhe Contargo	400	?	4 x 226-320, 2 x 400
	Offenburg Gbf	750	> 20	SY	1080		-	-	
	Freiburg Gbf	750	> 20	SY	840	SA/SGV Südbaden (DUSS)	?	-	Terminal RoRo/RoLa, HUPAC Intermodal
	Basel Bad Rbf	690	> 20	SY	690	Basel Weil am Rhein (DUSS)	640	6	DUSS: 4 x 640, 2 x 550
				SY	690	Rheinhafengesellschaft	?	?	Weil am Rhein, total length 4'600 m
CH	Basel SBB RB 1 + 2 (hub)	750	> 20	SY	750	Wolf - SBB Cargo + HUPAC	340	6	
			+	SY	500	KH Hafen - Swissterminal	160	3	SY = Kleinhüningen Hafen
			> 20	SY	500	KH Hafen - BMT Contcargo	250	2	SY = Kleinhüningen Hafen
				SY	550	Birshafen - Swissterminal	180	5	SY = Birsfelden Hafen
				SY	450	Frenkendorf - Swissterminal	200	3	SY = Frenkendorf
	Zürich RB Limmattal	750	> 20	SY	750	Dietikon SBB Cargo	160	2	project for new terminal Limmattal (750m, 2018)
	Aarau GB	450	3	SY	450	HUPAC	280	5	
	Cadenazzo	450	1	SY	450	SBB Cargo	220	4	
	Lugano Vedeggio	550	2	SY	550	SBB Cargo	400	2	
	Chiasso Smistamento	650	15	SY	-	-	-	-	project for upgrade to 750m Chiasso Vg
IT	Domo II	750	10	SY	750	Henggartner	730	2	
				SY	750	Crossrail	300	1	
	Novara Boscetto	840	2	SY	840	CIM	650	7	3 x 650, 4 x 600; 750 under construction
	Gallarate - fascio HUPAC	580	2	SY	670	HUPAC (Termi)	760 *)	11 *)	HUPAC: 3 x 760, 3 x 710, 2 x 630, 2 x 540
	Gallarate Parco	580	2	SY	570	Ambroggio	750 *)	3 *)	
	Mortara	525	1	SY	650	TIMO	650	3	upgrade to 680m to be confirmed
	Rivalta Scrivia	750	1	SY	500	Terminal Europa	680	5	
	Milano Certosa	645	1	SY	645	Terminali Italia	350	1	
	Milano SM Segrate	580	2	SY	600	Terminali Italia	560	4	Project for longer tracks (750m)
				SY	670	Messina	550	2	
	Milano Smistamento	750	>20	SY	750	FS Logisitica	600	2	Planned new terminal (CEMAT / HUPAC, 10 x 750m (2016)
				SY	670	Terminali Italia	550	2	
	Melzo Scalo	750	3	SY	560	Sogemar + Hannibal	730 *)	7 *)	3 x 500, 4 x 730
	Brescia Scalo	630	2	SY	630	Terminali Italia	460	3	
	Piacenza	700	1	SY	700	Piacenza intermodale	850	3	
	Genova Voltri	585	1	SY	585	Terminal Voltri	650	8	
	Genova Sampierdarena	540	1	SY	540	Messina	440	5	
	Genova UM Bacino	600	9	SY	600	Calata Bettolo SECH	400	3	

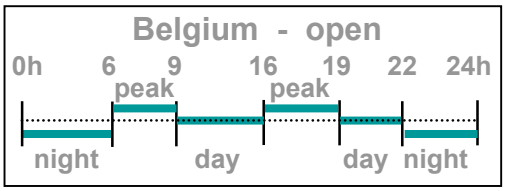
Legend					
Shunting yards +handover tracks			**Terminals**	**m**	Bulk terminals not shown (no long trains)
track length (trainlength + 10m) **740 + more**	SY = shunting Y		**wagon** length (without loco)	**> 720m**	Private Terminals not completely listed
track length (trainlength + 10m) **690m - 739m**	T = Terminal		**wagon** length (without loco)	**> 670m**	***) according to Subgroup Terminali IT-CH**
track length (trainlength + 10m) **< 690m**			**wagon** length (without loco)	**< 670m**	

Annex 4 – ZOOMs – line sections, handovers and terminals

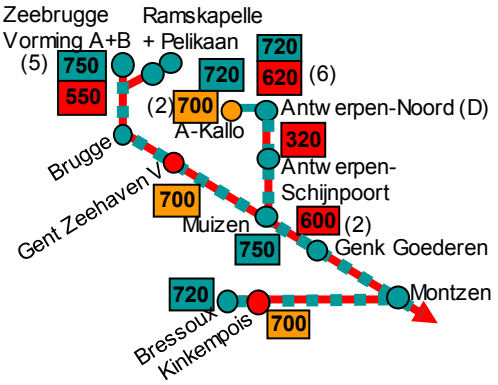
Corridor Rotterdam-Genoa is split in three parts for the last mile. The line sections with their characteristics are completed with the handover points and the most terminals. In the North, the Netherlands and Belgium are separated. Middle and south parts show development in time.

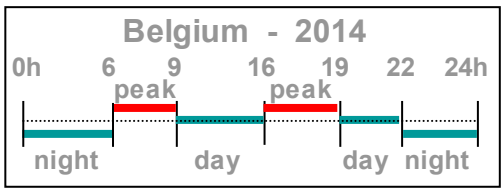
North - Belgium - open
with consistency project



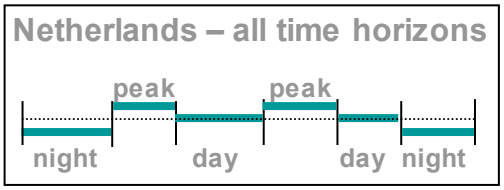


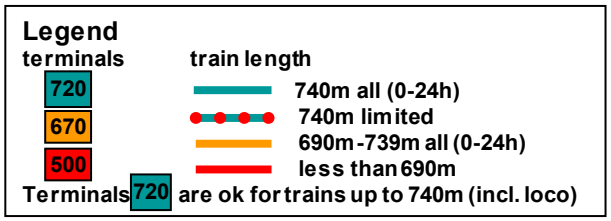
North - Belgium 2014
with Liefkenshoek - Tunnel



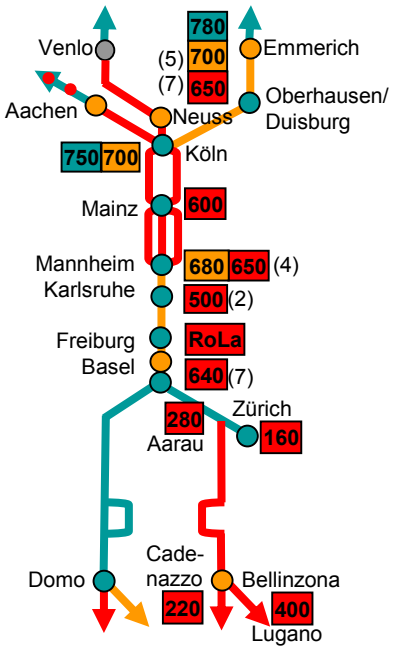


North – Netherlands 2013

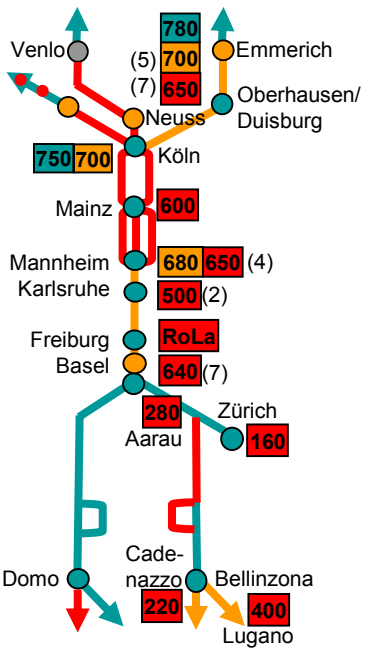




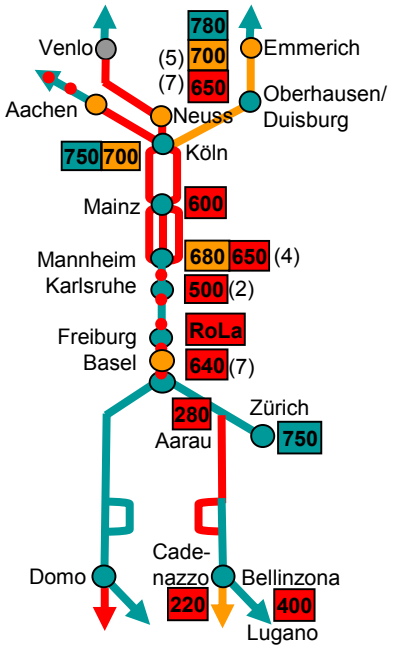
Middle part – 2013
with Lötschberg Basetunnel



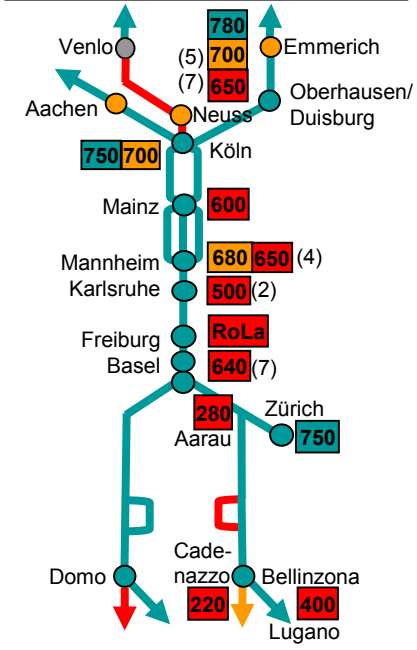
Middle part - 2016
with Gotthard Basetunnel



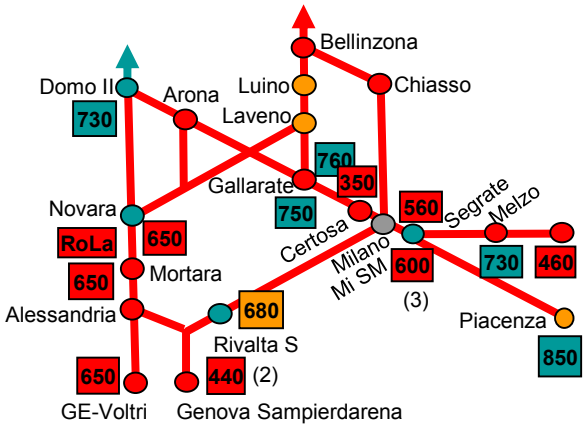
Middle part - 2020
with Ceneri Basetunnel



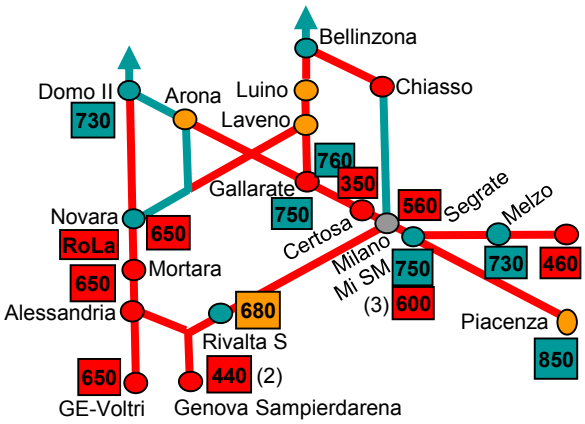
Middle part - OPEN
with Emmerich-Oberhausen,
Karlsruhe-Basel
and consistency projects



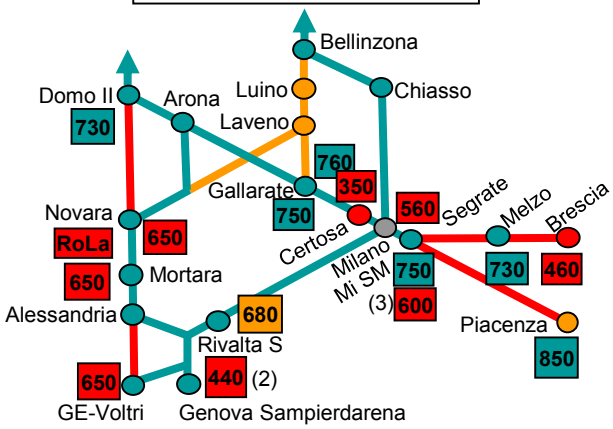
South - 2013
with Lötschberg Basetunnel



South - 2016
with Gotthard Basetunnel



South - 2020
with Ceneri Basetunnel
and Giovi Basetunnel
and consistency project



Legend

terminals

720

670

500

train length

740m all (0-24h)

740m limited

690m-739m all (0-24h)

less than 690m

Terminals 720 are ok for trains up to 740m (incl. loco)