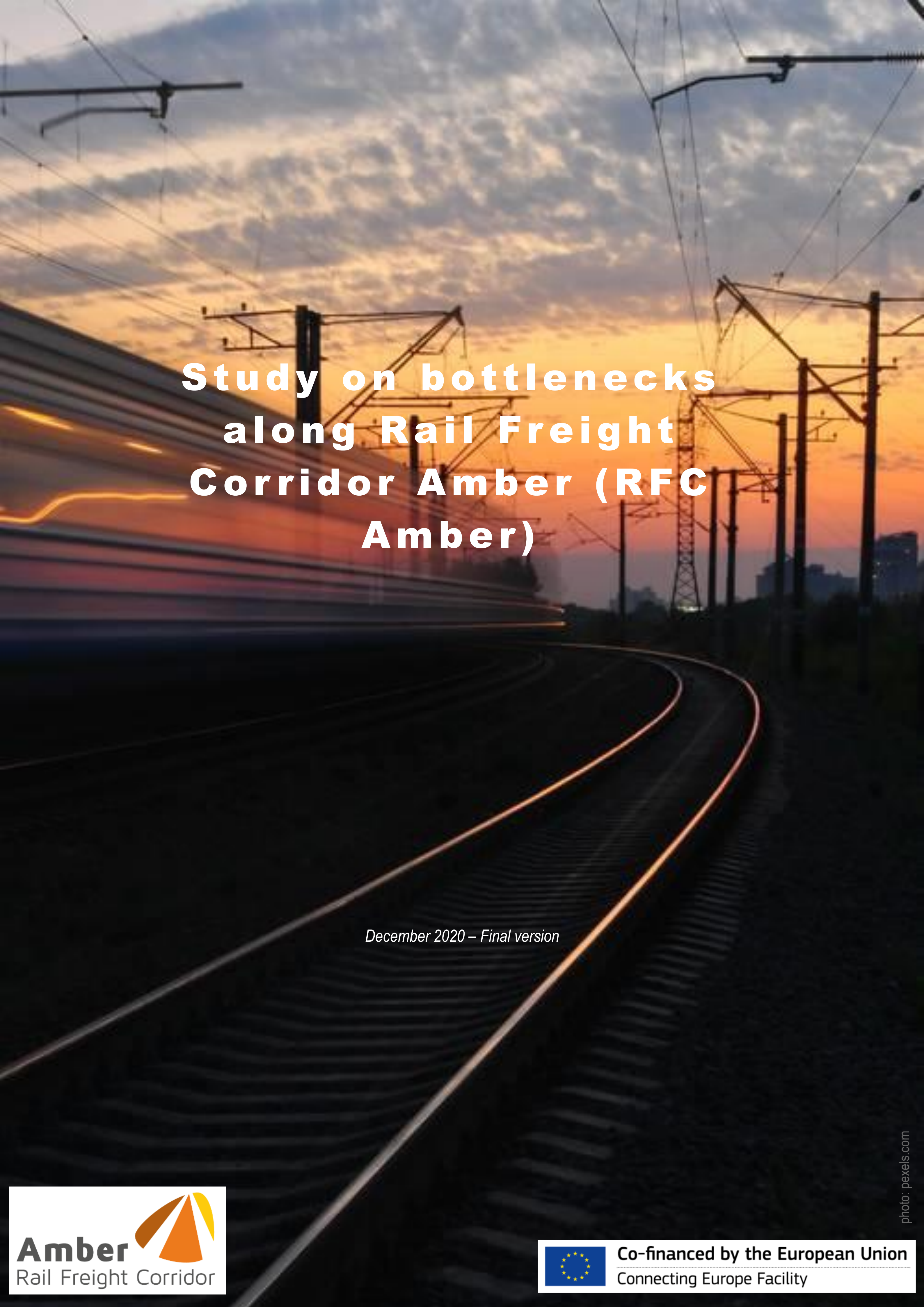

Study on bottlenecks along Rail Freight Corridor Amber (RFC Amber)

December 2020 – Final version

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Amber Rail Freight Corridor

Co-financed by the European Union
Connecting Europe Facility

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Contracting Authority: GYSEV Zrt.

Contractor: Kontúr Csoport Ltd.

Subcontractor: TRENECON Consulting and Planning Ltd.

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Abbreviations used in the study

AB	(Capacity) Allocation Body
CID	Corridor Information Document
CIP	Customer Information Platform
CIS	Charging Information System
CCS	Common Components System
ERTMS	European Rail Traffic Management System
ETCS	European Train Control System
GYSEV	Győr-Sopron-Ebenfurti Vasút Zrt. (Raaberbahn Raab-Oedenburg-Ebenfurter Eisenbahn AG) – IM, Austria/Hungary
IM	Infrastructure Manager
MÁV	MÁV Magyar Államvasutak Zrt. (MÁV Hungarian State Railways Limited Company by Shares) – IM, Hungary
MCA	Multi-Criteria Analysis
OECD	Organisation for Economic Co-operation and Development
OBI	Oracle Business Intelligence
PaP	Pre-arranged path
PCS	Path Coordination System
PKP PLK	PKP Polskie Linie Kolejowe S.A. (PKP Polish State Railways) – IM, Poland
RAG	Advisory Group of Railway Undertakings
RC	Reserve Capacity
RFC	Rail Freight Corridor
RNE	Rail Net Europe
SŽ-I	SŽ-I Slovenske Železnice Infrastruktura d.o.o (Slovenian Railways Infrastructure Co.) – IM, Slovenia
TAG	Advisory Group of Terminals
TCC	Traffic Control Centre
TCR	Temporary Capacity Restriction
TEN-T requirements	TSI requirements for interoperability as laid down in Art. 39(2a) of the TEN-T Regulation 1315/2013
TIS	Train Information System
TMS	Transport Market Study – RFC Amber
ToR	Terms of Reference (of the Bottleneck Study contract)
TPM	Train Performance Management
TSI	Technical Specifications for Interoperability
VPE	VPE Vasúti Pályakapacitás-elosztó Kft (VPE Rail Capacity Allocation Office) – AB, Hungary
WG	Working Group
ŽSR	Železnice Slovenskej Republiky (Railways of the Slovak Republic) – IM, Slovak Republic

1 Executive Summary

1.1 Introduction

RFC Amber has received a grant from the European Commission under the Program Support Action for the action entitled *'Establishment and development of the "Amber" rail freight corridor (RFC Amber)'*, with the action number 2016-PSA-RFC11 – with a total funding amount of circa 1.1 million EUR and running from September 2017 until December 2020 –, mainly aiming to support the set-up and further development of the corridor according to Regulation (EU) No 913/2010.

In this process, the elaboration of a comprehensive *"Study on bottlenecks along Rail Freight Corridor Amber (RFC Amber)"* has been launched (hereinafter: Bottleneck Study, abbreviated as BS)

GYSEV Zrt. (hereinafter the Contracting Authority), member of the Management Board of RFC Amber and Coordinator of the Program Support Action, is in charge of managing the study. Based on selection of the winning bidder, it has signed a service contract on elaboration of the Study with Kontúr Csoport Ltd. (hereinafter the Contractor) in the beginning of 2019. Kontúr Csoport Ltd. undertook the elaboration of the study in cooperation with TRENECON Consulting and Planning Ltd. (hereinafter the Subcontractor).

An **Ad-Hoc Working Group** has been established by RFC Amber to support project implementation and ensure delivery of a meaningful and consistent strategic document to substantiate future interventions. The members of the working group include the Infrastructure Managers (IM) and the Capacity Allocation Body (AB) of RFC Amber, as follows:

- Poland: PKP Polskie Linie Kolejowe S.A. (IM)
- Slovak Republic: Železnice Slovenskej Republiky (ŽSR) (IM)
- Hungary: GYSEV Zrt., MÁV Zrt. (IMs), VPE Kft. (AB)
- Slovenia: Slovenske Železnice Infrastruktura d.o.o. (IM)

The Advisory Groups of RFC Amber (RAG/TAG, railway undertakings' and terminals' groups as users of RFC services) are actively involved into the working group to ensure high-quality, efficient and meaningful contractual performance and delivery.

As a result, the identification and assessment of the infrastructure, capacity, operational and administrative bottlenecks in the Bottleneck Study and evaluation, justification of interventions dominantly rely on the information and data supplied by the involved stakeholders and corridor representatives, mainly the RFC Amber official bodies (Management Board, C-OSS Manager, RAG/TAG), the IMs, AB and the users of the corridor (RUs). Collection of data was an iterative process to have all information confirmed and ready to support meaningful and genuine conclusions, recommendations for a more competitive RFC Amber service. Also, extensive desktop research efforts were conducted with regard to relevant policy documents, other RFC studies, actions and RNE initiatives, then findings were discussed with RFC Amber Ad-Hoc Working Group members to identify generic operational and administrative issues of international rail freight transport having relevance to the functioning of RFC Amber as direct experience is limited for RFC Amber going operational in late 2019.

The regular meetings (both personal and online) and the consultations during the whole process of Bottleneck Study elaboration ensured a common understanding of the assessment concept, the applied methodology, and provided common grounds for data analysis and interpretation of issues. Also, the conclusions and recommendations were discussed and revisited whenever it was justified in line with the expectations and objectives of the RFC Governance (ExBo, MaBo), the Infrastructure Managers and the Railway Undertakings alike.

During the finalisation phase, the Ad-hoc Working Group and also the Executive Board members of RFC Amber (Ministries representing the member states' transport decision making bodies) revised, commented the Study and after the modifications by the Contractor, the Management Board of RFC Amber approved the Study. So, this study is a consensual summary and assessment of infrastructure bottlenecks and operational and administrative issues adversely or unfavourably affecting the functioning of RFC Amber and, also an agreed inventory of prioritised set of interventions for improvement, for more efficient rail freight service.

Note, that it is beyond the scope of the Study to set a timeframe and schedule for the execution of the proposed interventions because implementation of individual projects is largely subject to national particularities, regional policy considerations, upgrading priorities of the national railway network (incl. passenger traffic and lines outside RFC Amber), availability of funding, etc. in the four Member States concerned or need consensus/regulations at EU level.

1.2 Objectives of the study

The Bottleneck Study is expected to give an in-depth understanding of the compliance of the corridor infrastructure with TEN-T minimum requirements (defined by Regulation 1315/2013 EU Art 39. (2a)), bottlenecks in terms of capacity and line standard, and of potential measures for infrastructure and operational improvements for efficient rail freight operations along the network of RFC Amber. The Terms of Reference (ToR) request to elaborate a study which identifies and also describes the bottlenecks of administrative, operational and infrastructural nature along the lines of the corridor with particular attention to the cross-border areas.

The study is proposing appropriate measures for infrastructure and operational improvements with the aim to eliminate or reduce the negative effects of such bottlenecks and to allow more efficient rail freight operations along RFC Amber. The study can therefore provide support for decisions relating to future investments concerning infrastructure and operational, administrative and capacity-related measures and improved cross-border cooperation regarding the network of RFC Amber.

1.3 Current characteristics of the freight corridor

1.3.1 Topology and general presentation of RFC Amber

The network of the Rail Freight Corridors (RFCs) densely covers the Central-European area that is served by RFC Amber. RFC Amber connects the Adriatic seaport of Koper in Slovenia and the border crossing between Poland and Belarus in Terespol to their hinterland, in the territory of Slovenia, Hungary, the Slovak Republic and Poland. The route of RFC Amber connects the major cities and also further industrial centres of the countries involved, such as Ljubljana, Sopron, Budapest, Bratislava, Žilina, Košice, Kraków and Warsaw and such smaller but important industrial areas, e.g. Dunajská Streda in the Slovak Republic or Novo mesto and Velenje in Slovenia.

The corridor has an end-to-end extension of approximately 1.400 km and includes in total more than 3.700 km railway lines considering even the different branches, connecting lines and including the planned (future) principal and diversionary routes to Warsaw. The total length of the principal route sections is slightly more than 3000 km.

The countries covered by RFC Amber are densely served by both north-south and east-west corridors therefore RFC Amber overlaps with some other RFCs. The network is quite heterogenous in terms of technical parameters and interoperability, though.

1.3.2 Infrastructure elements

In terms of infrastructure, bottlenecks are deemed to be the parameters of the main infrastructure elements that fail to ensure interoperability and to facilitate service quality level corresponding to the line function required by demand or potential traffic. Such failure hampers future growth of railway transport. Elimination of infrastructure bottlenecks is possible with major developments or sometimes, in a more cost-efficient way, with technical interventions of smaller scale and, though to a more limited extent, by operational measures. Identification of the location of such bottlenecks has been based on data provided by IMs, documents like CID, TMS, Network Statements, and open databases and consolidated into excel files, and a GIS database with graphic representation in maps. This allowed an effective assessment and illustration of the main features (basic TEN-T requirements like 740 m train length, 22.5 tons axle load, 100 km/h speed, ERTMS and electrification, but also other parameters influencing train forwarding efficiency, e.g. a meter-load of 8.0 t/m and P/C 400 intermodal loading gauge).

The section quality, based on combined assessment of infrastructure parameters, therefore represents to what extent currently a section fulfils the TEN-T requirements and further RU needs on the whole.

It must be stressed that the compound index is primarily a relative number, allowing to compare the sections to each other and rank them.

The share of RFC Amber sections in terms of the compound index / section quality is as follows (detailed tables can be found in chapter 7.3.1):

Section quality compared to the requirements	Acceptable > 4.0	Fair 3.51 – 4.00	Poor 3.01 – 3.50	Very poor ≤ 3.0	Total
Poland	269km	317km	354km	300km	1240km
Slovak Republic	474km	189km	53km	-	716km
Hungary	289km	755km	212km	16km	1272km
Slovenia	110km	241km	-	162km	512km
Total	**1142km**	**1501km**	**619km**	**478km**	**3740km**

Table 1: Categorisation of RFC Amber sections by compound index

As can be seen from the table the majority of the network is far from fulfilling the TEN-T requirements and can be considered as a barrier for efficient and competitive railway traffic along the Corridor. It should be noted that even the lines of a compound index above 4.0 may have some deficiencies that hinder the efficiency of the RUs operation.

Overall, it can be stated that the parameters of the RFC Amber lines are rather heterogenous, partly due to different national standards applied when the infrastructure had been built (long before the EU interoperability objectives were defined), partly due to different network role, age and condition of the infrastructure. All in all, only a small proportion of the corridor currently fulfils the TEN-T requirements – and only a part falls under the TEN-T obligations since more than 500 km line of the RFC Amber lines are not part of the TEN-T network.

1.3.3 Demand assessment and forecast

Railway performance data in the RFC Amber countries are rather showing a slowly decreasing trend over time then stagnation. Except Poland the domestic freight transport performance is comparably low, the international (import, export, transit) is the dominant; this is particularly the case in Slovenia.

In contrast to the general trend, the total train traffic on the sections of RFC Amber slightly increases year by year (considering also the years where RFC did not exist, before 2018). The number of freight trains and the total gross ton km data of the RFC Amber line sections are higher by almost 20% in average in 2018 than it was in 2013. However, decrease is shown in eastern Hungary and the sections in southern Poland where the Carpathian Mountains form a natural barrier and are cause to less efficient train operations.

Highest traffic lines are in and around Warsaw, Bratislava, Budapest and Ljubljana, mostly due to dense local and regional passenger traffic. Here the annual number of trains exceeds 60 thousand (even 80 thousand at some sections).

Comparing the countries and branches of the RFC, the main characteristics that can be recognized is the considerably higher traffic on the western branch of the Corridor. These lines are partly overlapping with the eastern branch of RFC Baltic-Adriatic, connecting Poland to the Mediterranean through the Slovak Republic, Czech Republic and Austria however, excluding Hungary. Similar is the case with the Slovenian sections where corridors from Italy, towards not only Hungary but Austria and Croatia are also intertwined.

RFC Amber offered 28 pre-arranged train paths (PaP) in total in the 2020 timetables, 4.2 million PaP*km*days in total. Considering PaP pre-requests of the 2019/2020 timetable period, approximately 40% of the PaP catalogue offer was pre-booked. The proportion is slightly lower for the 2020/2021 TT period as of June 2020. Based on RUs feedback it is partly attributed to the fact that the PaP-concept as such only to a very limited extent meets customer requirements and therefore actual RU preferences cannot be fully considered by the IMs when offering PaPs (i.e. the pre-booking deadlines, conditions of the RFC paths, defined in the Framework for Capacity Allocation, FCA, are not in correspondence with market demand for flexible service).

It has been widely proved that GDP growth and the performance of the transport sector develop in close correlation. The current and future transport volumes in general and rail freight on RFC Amber in particular are discussed in addition to general economic growth and population change in the concerned regions, countries. The recent GDP growth in Central-Eastern Europe outpaces the average growth of the EU, however, the COVID-19 pandemic causes currently a severe recession globally in 2020, badly hitting all countries (around 10% drop in GDP growth in the EU and Amber countries) and heavily impacting international trade and transport.

Based on EU and OECD statistics of actual GDP drop and the short-term forecasts, the economy is expected to slowly recover starting in 2021 according to OECD, however, current transport volumes are not expected to be reached before 2022. The realistic scenario in the TMS was corrected inevitably using the actual COVID-caused decline in economic performances. International rail freight can have good prospects (i.a. via the landbridge between Europe and Asia – ever growing rail transport volumes on the Silk Road – and assuming measures of infrastructure upgrades to improve competitiveness),and assumed to show a moderate increase through 2050 parallel with prospected modest economic growth. According to the EU Reference Scenario, prepared in 2016 (when the impact of the COVID-19 crisis was obviously not taken into account), the expansion of freight transport and rail freight transport in the concerned countries are on a decelerating trend through 2050 corresponding with general economic growth rates, which underlines the need for adequate countermeasures.

Based on the latest available inputs about the GDP impact of the pandemic the TMS short term forecast has been revised and corrections to future rail freight performances have been applied resulting in the following forecast in rail freight performances by member states (base year is 2018 as that is the available statistics for RFC Amber currently):

RFC, ton km, 2018 base	2018	2019	2020	2021	(…)	2030	(…)	2050
Slovenia	100%	102,4%	93,1%	97,3%		113,1%		196,4%
Hungary	100%	104,9%	94,4%	101,8%		118,4%		157,7%
Slovak Republic	100%	102,3%	90,9%	95,9%		111,6%		145,0%
Poland	100%	104,1%	94,2%	98,0%		114,0%		143,1%
			COVID corr.					

Table 2: Railway performance forecast by member states to short, mid- and long term, considering impact of COVID epidemic and its impact on the economies

In medium- and long-term, a change in transportation efficiency can be expected due to the infrastructure developments and EU TEN-T objectives to allow operation of longer (and consequently in many cases) heavier trains on many destinations. This correction is applied in the 2030-2050 period, as follows (efficiency change based on 2018 train parameters):

- 10% by 2030
- 15% by 2040
- 20% by 2050

This results in lower development in the number of freight trains compared to the above presented tonkm performance. However, it is important to note that nonetheless an increase in the number of freight trains is expected in all countries.

RFC, no of trains, 2018 base	2018	2019	2020	2021	(…)	2030	(…)	2050
Slovenia	100%	102,4%	93,1%	97,3%		102,9%		163,7%
Hungary	100%	104,9%	94,4%	101,8%		107,6%		131,4%
Slovak Republic	100%	102,3%	90,9%	95,9%		101,5%		120,9%
Poland	100%	104,1%	94,2%	98,0%		103,6%		119,2%
			COVID corr.					

Table 3: Train traffic forecast by member states to short, mid and long term

The train performance forecast is largely in line with the realistic scenario of the TMS for short term (except the corrections due to the epidemic) that considers that the possibility to operate longer and heavier trains on the RFC lines can improve the competitiveness of rail and may increase the performance. While the pessimistic scenario of TMS would represent the situation when this improvement in competitiveness does not come about.

1.4 Methodology, steps of evaluation

1.4.1 Infrastructure and capacity bottlenecks and interventions

The steps of identifying and assessing infrastructure and capacity bottlenecks and that of the measures for improvement are summarised briefly in the flowchart below.

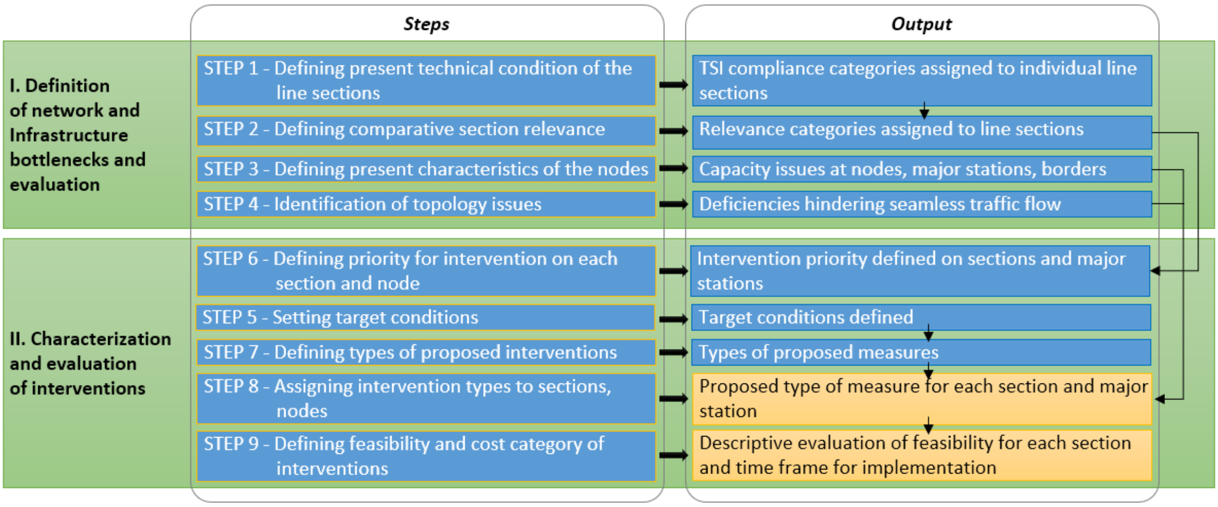


Figure 1. Steps of evaluating infrastructure bottlenecks and definition of improvement measures

The identification and evaluation of bottlenecks is based on the collection and consolidation of data on current infrastructure deficiencies and capacity problems (both factual and qualitative from IMs, where sections having capacity shortage is not necessarily identical to congested sections as EU terminology defines), including summarisation in tables and graphic representation.

In STEP 1, the infrastructure parameters are assessed one by one. To get an overall picture of the current quality and appropriateness of the infrastructure (compared to RU needs and TEN-T requirements), a complex approach of the infrastructure parameters' representation has been adopted producing a compound index scoring for individual line sections (weighting parameters by their relevance). Four score ranges have been identified, defining four categories of general infrastructure state. Lowest scores were given to sections where interventions are theoretically the most imperative for competitive rail freight operations. Sections in the highest range have infrastructure parameters that meet (or are close to) the high-quality rail freight service requirements.

The sections are categorized by the compound index, as follows:

Compound index value	Section quality
≤ 3.0	very poor
3.01 – 3.50	poor
3.51 – 4.00	fair
4.0 <	acceptable

Table 4: Compound index value ranges translated into comparative section quality

The compound index values are also interpreted in consideration of current capacity utilisation and function of the line section (see intervention priority) thus they theoretically show, where upgrading interventions, improvement of line parameters is crucial to ensure operability of RFC Amber. This information can support IMs, decision makers when appraising importance, relevance, or priority of the envisaged projects on the corridor. Projects planned by the member states (IMs) have also been described and their graphic presentation allows collating with sections where infrastructure bottlenecks are identified.

In STEP 2 comparative relevance of sections is assessed. The network role and the volume of (freight) traffic defines the "section relevance" i.e. its relevance, importance amongst the sections of the Rail Freight Corridor. This section relevance indicator shows how important the section is on the RFC, based on its RFC and TEN-T network role and its traffic volume, and consequently how much relevance it has (compared to the other RFC sections) to be TEN-T compliant without capacity issues. Sections are assigned into four relevance groups: outstanding/high/medium/low.

The network role is based on two main characteristics: role on TEN-T network and role on RFC Amber.

The defined traffic categorisation is based on the RFC sections' average rail freight traffic volume (in freight trains/year). The categorisation is as follows:

- ”high” if traffic volume is higher than 125% of the RFC average,
- “average” if traffic volume is between 125% and 75% of the RFC average,
- “low” if traffic volume is lower than 75% of the RFC average.

The section relevance can be, by combining the above listed three characteristics of the line section:

- outstanding
- high
- medium
- low

In STEP 3 the nodes are defined at first, considering urban nodes and railway junctions and the important service points such as marshalling and shunting yards and border crossing stations along RFC Amber. Their infrastructure is assessed according to available data on their trackage, with emphasis on electrified freight train tracks of at least 740 m length; additionally, capacity issues are indicated, as strategic level and information supply allows, mainly by judgement and assessment of infrastructure managers and capacity allocation bodies (therefore, as mentioned, sections having capacity shortage is not necessarily identical to congested sections as it is defined by EU terminology). The long track availability is presented for the other stations, too, and intermodal freight terminals are also listed and characterised.

STEP 4 identifies those network topology issues, mainly local deficiencies, that influence seamless traffic flow, e.g. necessitate direction change of trains or increase train path length due to geographical or network alignment reasons.

STEP 5 is setting target conditions. The desired conditions for rail freight forwarding (RFC performance) are the core TEN-T parameters, including modern signalling system and ETCS. Additionally, the appropriate free capacity on the line is a target to serve the forecasted traffic demand. Besides, “Level of Service” targets can also be set, e.g. preferred maximal waiting times at border crossings.

Differentiation of targets is possible based on the network role (e.g. TEN-T core/comprehensive vs. non-TEN-T) and the traffic categories defined for TEN-T requirements.

The targets have impact on implementation time horizon, too.

STEP 6: definition of intervention priority. Based on assessment of current traffic, capacity and infrastructure situation and defining network role, the major steps of the definition and ranking of interventions:

a) Prioritizing, ranking the lines according to their TEN-T infrastructure compliance (compound index) and section relevance
b) Setting target conditions and corresponding types of interventions to reach the targets and consequently eliminate the bottleneck(s)

c) Definition of measures by line sections and nodes to support Amber RFC developments, assessment of feasibility and time frame

The previously introduced compound index scores are interpreted in consideration of current capacity utilisation and function of the line section. Thus, they theoretically show where upgrading interventions and improvements of line parameters are crucial to ensure operability of RFC Amber. This information can support IMs, decision makers when appraising importance, relevance, or priority of the envisaged projects on the corridor. Projects planned by the Member States and their IMs also need to be considered and their graphic presentation allows collating with sections where infrastructure bottlenecks are identified.

The intervention priority is based on the compound index value (compliance of current technical conditions with TEN-T Guideline requirements), the already introduced section relevance (highlighting the most important ones, where traffic and network role demands for high quality, capacitive infrastructure) and these two characteristics are modified by capacity utilisation where it is reasonable.

Investment priority groups are:

1. improvement imperative
2. intervention proposed
3. desired for optimal RFC performance

The following table shows how priority grouping is done, based on section relevance and compound index:

Section relevance: Compound index:	outstanding	high	medium	low
≤ 3.0 very poor	1	1	1	2
3.01 – 3.50 poor	1	1	2	3
3.51 – 4.00 fair	1	2	3	3
4.00 < good	2	3	3	3

Table 5: Matrix for prioritisation of sections considering compound index and section relevance

Priority groups of sections are composed at RFC level but presented by member states to support national decision making and allocation of sources.

Capacity utilisation is considered with high importance: all sections get priority (moved to higher priority group) in case capacity shortage is present or expected.

STEP 7 and STEP 8 are defining types of interventions, identifying proposed interventions on sections and also on nodes (stations) on a strategic level.

In the future, the interventions formulated by the Bottleneck Study can be transformed to projects by the IMs, based on funding conditions, other RFC/network aspects etc. To do so, further analysis for derived projects must be done in feasibility studies, impact studies, in line with national/network development strategies and sector priorities.

Considering the typical deficiencies on the infrastructure, types of measures or intervention categories are set as follows:

- New line/new section construction
- Upgrade to TEN-T requirements, by distinguishing where:
  - Full reconstruction/upgrade is needed
  - Only partial upgrade is needed

- Capacity enhancement
  - of line sections
  - of sections being part of an urban node
  - of stations, marshalling and shunting yards, border crossings

STEP 9: Defining feasibility and realisation time frame of proposed interventions. Feasibility of the interventions is evaluated in consideration of cost and complexity. Consequently, the assessment is influenced by (primarily) the volume of intervention (based on section's length and the type of measure) and the complexity of the investment (e.g. it is a full reconstruction or partial upgrade only, or the section is in a node or at a border crossing where the intervention faces much more other development aspects and limitations).

Time frames of the line development measures (hence the priority) is, on one hand, influenced by the obligations:

- On short term (by 2030) the TEN-T core network shall meet minimum TSI requirements for interoperability
- On medium-long term (by 2050) the TEN-T comprehensive network shall meet minimum TSI requirements for interoperability

The TEN-T obligation influences therefore how the priorities and time frame are set. But on the other hand, the timing is also based on intervention priority and expected capacity issues, defining how important is to remove the specific bottleneck on the section.

The interventions at nodes are ranked to low, medium and high priority, based on the severity of the capacity problem and the traffic on the connecting lines, i.e. network role of the station.

The final output of the analysis is the list of interventions defined for each sections and major nodes of RFC Amber. The strategic level results can be the foundation of further analyses of bottleneck eliminating interventions and project generation at national and IM level.

1.4.2 Operational and administrative bottlenecks and interventions

The methodological steps of identifying and evaluating operational and administrative bottlenecks and that of the measures for improvement are summarised briefly in the flowchart below, similarly to the previously presented chart on infrastructure bottlenecks' assessment. The figure also shows the output of each action (i.e. step) in the evaluation process.

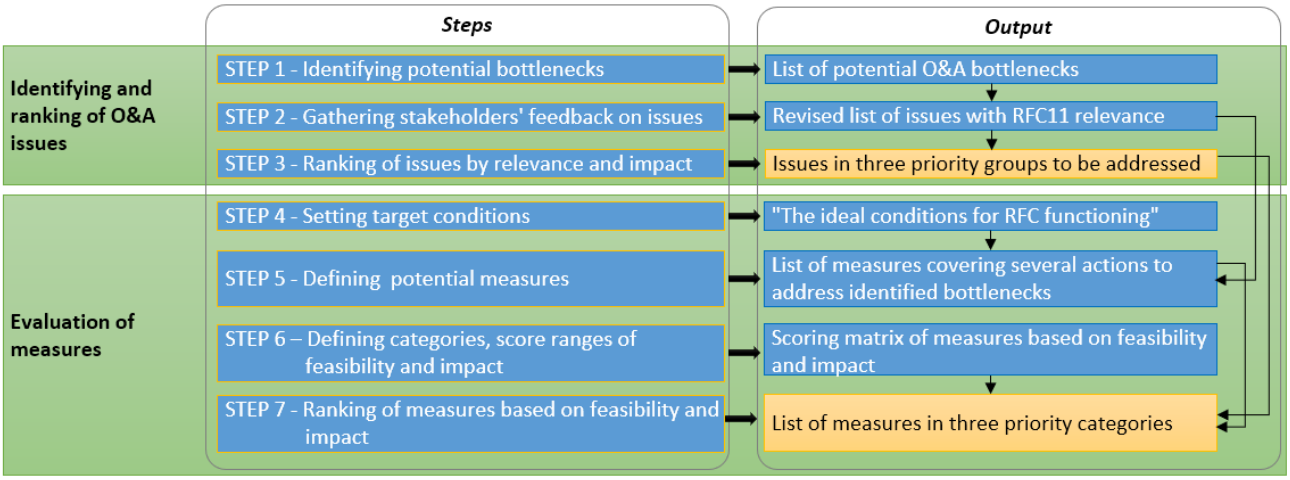


Figure 2. Steps of evaluating operational and administrative bottlenecks and definition of improvement measures

A more detailed description of the methodology to identify bottlenecks and to evaluate measures for improvement is given in Sections 8.2 and 9.3.1, respectively. However, the main features of each step are briefly introduced here.

In Step 1 extensive desk research was carried out and potential operational, administrative issues impacting RFC service, competitiveness, efficiency of operation were identified. Four main areas of operation were defined where “bottlenecks” were identified and improvements were considered necessary: (1) capacity management, (2) communication, (3) traffic management and (4) administrative requirements. The issues were presented to IMs/AB in the form of a questionnaire survey to evaluate their RFC Amber relevance and impact. Based on the feedback the questionnaire was revised and shared with RAG/TAG. Analysing the causes and impact through personal discussions, meetings in Step 3 the issues were ranked by relevance and impact into three impact categories: high, medium, and low. So, the final output, the categorized and prioritized list of issues in the awareness of causes served as the basis for identifying and evaluating potential measures.

In Step 4 a qualitative description of target conditions was given for the four main operational areas while in Step 5 the potential measures were identified based on the main causes of inefficiency or inadequate functioning for each O&A bottleneck. The measures often cover several potential actions however these can be duly designed at a later stage after thorough investigation also taking into account national particularities which is beyond the scope of this study.

In Step 6, the approach of multicriteria analysis has been adopted for the evaluate of potential measures targeting the improvement of the particular bottlenecks. Several aspects have been considered for assessing impact and feasibility alike.

When assessing impact of a measure in addition to the potential degree of improvement of the particular bottleneck, its assumed impact on any other O&A issue or interdependence with any other measure (joint impact, relation to infrastructure development) were considered. Similarly, in terms of feasibility the assumed magnitude of cost, resources, previous efforts (availability of RNE tools, guidelines), possible implementation timeframe, the number of stakeholders involved, and their interests were taken into account.

Three categories of both impact and feasibility were set with scoring as follows:

Criteria category/score	1	3	5
impact	low	medium	high
feasibility	unrealistic	complex	feasible

Table 6: Scoring of impact and feasibility of O&A interventions

A simple and homogenous hierarchy of scoring categories were set up to ensure coherent and flexible rating of interventions. Three score ranges were identified that determine the three priority groups of interventions as follows:

Ranges for priority group	**4-9**	**10-14**	**15-20**
Intervention priority group	desired	to be considered	proposed

Table 7: Scoring categories to define O&A intervention priority groups

When ranking the measures in Step 7, the measures having the highest scores are assumed to be the most feasible and desirable (low cost, strong stakeholder support, maturity – ongoing RNE action – and the highest impact), therefore they are proposed to be implemented in the first place, while the implementation of those in the second category are to be considered. Limited potential is attributed to measures that target bottlenecks with lower impact coupled by weak feasibility. Nevertheless, they are desired for optimal and efficient RFC operation.

1.5 Identification and assessment of bottlenecks

1.5.1 General routing issues

Topology characteristics hindering efficient traffic

The network of lines which RFC Amber consists of crosses four member states of the European Union in a mainly south-west – north-east direction. As mentioned in previous chapter, topology of the Corridor, besides the interoperability deficiencies of the infrastructure (addressed in chapter 1.3.2), the network structure is not in all sections of the corridor fully supporting a seamless traffic flow and high efficiency of train operations, causing trains to make major detours and/or change their travelling direction at some stations.

Naturally, relief and other terrain and natural characteristics also influence the topology and parameters of the RFC Amber lines, the alignment (curve radiuses) and track gradients are determined at these areas, in the mountainous regions of Southern Poland and North-Eastern Slovakia (by the Carpathian mountains) and in Southern Slovenia (by the Alps).

Besides, the line route structure hinders efficient operation at some points. For example, in the part of the corridor located in western Hungary and southern Slovakia, trains from Slovenia to key destinations in Slovakia or further to Poland (or vice versa) have to change their travelling direction up to three times (in Zalaszentiván, Komárom and Komárno) over a distance as the crow flies of only ca. 130 km. (In this part of the corridor the lines are mostly single-track only therefore reversing a freight train causes more disturbance on the lines' traffic than at double-track sections.)

Similar locations are present in Poland, at e.g. Tunel, where train direction change is needed at some origin-destinations, however, not on the routes of the main traffic flows (minority of the trains need to be reversed actually). In Slovenia, at Celje tovorna and Ljubljana, there is also a need for direction change towards the connecting lines of the RFC Amber (to Velenje and Novo Mesto). But on the one hand the connecting lines are not electrified therefore locomotive change is imperative, on the other hand there are no direct trains typically to these lines hence the composition of trains is done on the junctions.

In several parts of the corridor the routes of lines are rather sinuous and/or involving major detours in relation both to the distance as the crow flies and to road distance. This concerns in particular the corridor section between eastern Slovenia (Pragersko) and Western Hungary (Szombathely) and the section in Southern Poland between Krakow and Nowy Sącz. In the latter case the current major detour will be eliminated when a planned, mostly entirely new, straightening line between Podłęże and Nowy Sącz will have been built. However, in the case of the routing in Eastern Slovenia and Western Hungary no adjustments of the routing are planned in the foreseeable future, except a triangle track in Zalaszentiván, which will facilitate traffic operations, but not shorten the route substantially.

Network alignment problems

Network bottlenecks are considered such bottlenecks which are related to the (geographical) structure of the network of lines designated to the RFC, rather than the state of the infrastructure per se. A corridor section may very well provide an infrastructure of high standard, possibly even fulfilling or being close to fulfilling the TEN-T requirements but may require trains to make major detours due to the routing of lines or may require trains to change travelling direction due to the lack of connecting curves.

These network bottlenecks may not always be easy to eliminate in a foreseeable future, since the geographical alignment of railway lines can often not easily be changed. Nonetheless it appears relevant to identify these network bottlenecks, so that they can be taken into account in the long-term plans for the development of the railway networks. To some extent this is also the case already (see also chapter 1.5.2), but not all of these bottlenecks are fully addressed yet by current infrastructure plans.

Corridor sections in RFC Amber constituting network bottlenecks, in the sense of the above definition, are the following:

1. Eastern Slovenia – Western Hungary: Between Pragersko and Szombathely the rail distance is with 207 km almost 75% longer than the distance as the crow flies (119 km).
2. When looking at the sections in the two countries separately, the rail distance Pragersko – Hodoš/Őriszentpeter border is with 110 km ca. 60% longer than the distance as the crow flies (68 km); the rail distance between Hodoš/Őriszentpéter border and Szombathely is with 98 km ca. 92% longer than the distance as the crow flies (51 km).
3. Southern Poland: Between Podłęże (near Kraków) and Nowy Sącz the rail distance is with 147 km 158% longer than the distance as the crow flies.
4. Western Hungary – Slovakia: Freight trains between the Slovenian-Hungarian border and key destinations in Southern Slovakia (Dunajská Streda) have to change their travelling direction up to three times – in Zalaszentiván, Komárom and Komárno – over a distance as the crow flies of only ca. 130 km.

The network bottlenecks above weaken the competitiveness of rail freight towards other transport modes, but also have the potential to weaken the competitiveness of the route via RFC Amber versus alternative routes. Thus, measures to maintain and strengthen the competitiveness of RFC Amber should take into account its current network bottlenecks.

1.5.2 Infrastructure and capacity bottlenecks

Compliance of RFC lines with TEN-T requirements

The essential requirements of the infrastructure can be summarised as safety, reliability and availability, technical compatibility, accessibility and interoperability. The basic approach for corridor bottlenecks is laid down in Regulation 1315/2013 of the EU (Art 39(2a)).

Bottlenecks means firstly sections where the main infrastructure elements fail to facilitate service quality level corresponding to the line function required by demand or potential traffic. Such failure thus interferes with future growth of railway transport.

Hence, bottlenecks on the infrastructure is defined by two main parameters:

- Infrastructure bottlenecks are identified by using the compound index (representing the overall state compared to the TEN-T requirements) and the evaluation of the main problematic parameter(s)
- Limited or no free capacity for further freight trains/PaPs (overall capacity problems are present)

IMs have additional aspects to bottleneck definition: namely, that bottleneck is not only a factor resulting in a lack of competitiveness but in low efficiency, both on the side of IMs (causing higher operational costs) and users (causing higher transport costs).

The official RFC Amber documents and RFC bodies (e.g. RFC Amber CID Book 5 – Implementation plan, TMS and RAG-TAG) have identified previously the infrastructure bottlenecks along the corridor, however, these did not categorized the issues nor ranked them by impact or importance, nor did they forecast future capacity issues. Besides the identified infrastructure bottlenecks, the available RFC Amber documents also deal, however, with other non-infrastructure type bottlenecks (operational, administrative, capacity and other types as classified by the Implementation Plan). The TMS deals with all aspects of railway competitiveness compared to road freight transportation, too; and a SWOT analysis for the Corridor is also included. These are also considered as inputs for bottleneck characterisation and classification.

Summarizing the findings, the main infrastructure parameters influencing RU train forwarding efficiency the most are:

- Electrification that is almost complete along RFC Amber, but differences are in the current system applied (25kV vs. 3kV); besides, some few sections are still diesel,
- Train length and train load/weight capacity is low on almost 50% of the network,
- Line speed is inadequate on almost 40% of the network and frequent speed restrictions, with the additional traffic management (operational and administrative) problems, often reduce the circulation speed and also the reliability, punctuality and calculability of transportation.

It is fundamental to assess the importance of the infrastructure bottlenecks by considering the traffic and the available capacity. All in all, as assessed by IMs/capacity allocation bodies, capacity shortage is not common on the corridor and only present on a moderate level (except some sections in Slovenia and Poland where the capacity shortage is serious). Where currently capacity shortage is present or capacity utilisation is above 50%, it can be supposed that future, expected growth in train traffic will cause capacity issues. On sections, where an introduction of more dense passenger services is foreseen capacity issues may arise even if freight traffic would not see any growth. On the other hand, administrative and/or operational deficiencies, characteristics causing inadequate capacity supply or ineffective use of the infrastructure can be found, too (all factors of inefficiency are interlinked).

Stations and border crossings

Major service points along RFC Amber are the marshalling yards and the border stations (they are the same at some point).

Railway nodes to be improved (typically in densely populated areas) identified by the IMs and border sections with particular procedures in place are also considered in the study when looking for bottlenecks. Assessment of the administrative and technical procedures performed at border crossing points includes the time requirements of the currently obligatory procedures.

Marshalling yards are facilities with a key role in train handling (train composition or rearrangement, short term parking or longer time storage etc.). In this aspect these are the main and most important stations for traffic management purposes – not only as handling the trains but to solve capacity issues on the network, e.g. by short term parking of the trains for ad-hoc traffic management.

Border stations handle the trains at network borders, having significant administrative duties, even inside the EU Schengen area. As the data shows, even the fulfilment of TEN-T requirements for handling freight trains is often limited: availability of long station tracks (parking sidings) is limited at the border stations and, also at some marshalling yards and terminals, consequently handling of long freight trains, in line with TEN-T requirements and EU goals, faces capacity issues not only on the lines but at the handling points, too.

Furthermore, there are capacity problems at many border-crossing points and the average time for a train to cross the national (mostly EU internal and Schengen zone internal) borders is high and exceeds the generally expected 2 hours/train (and almost always higher than a Western-European standard of 0,5 hour/train). It should be noted, however, that the dwelling time of trains in border stations is not only related to operational processes, but also depending on the operational planning by the RUs, which may accept a longer dwelling time at border stations if this allows them to optimize the use of locos or staff.

But not only the above-mentioned major facilities, even the smaller stations are very important to ensure capacity on the network. It is essential for freight train operations that there are such stations with the capability to hold ≥740m long trains in suitable distances available on the network; this is particularly important on single-track lines.

It is a problem, however, if investments on the corridor lines decrease the number and availability of long tracks for freight trains at the stations (freight train capacity along the line), when focusing mainly on passenger train requirements and traffic. This is a frequent complaint from the RUs and from capacity allocation bodies as this capacity shortage can decrease the capacity of a line for freight significantly and increase the transit time of freight trains; it can also considerably reduce the possibility to handle traffic disturbances and to re-route trains, thus affecting the reliability of freight trains considerably.

Overall state of the infrastructure parameters

The service level on the line sections i.e. the competitiveness of rail freight service is subject to the above parameters, however they impact perceived service standard differently. The individual infrastructure parameters are not suitable to judge the overall appropriateness of the line sections against the TEN-T requirements. Besides, the relevance of infrastructure parameters for railway undertakings is not identical; for example, train length or axle load are more important than track gradient for their business. Therefore, a more accurate evaluation of the sections in terms of competitiveness (need for improvement) can be made if these factors are compared with actual user expectations. To this end, a compound index has been produced, using the different characteristics described previously.

This compound index is a theoretical and complex manifestation of the combination and weighting of parameters. It has been developed to enable comprehensive but simple comparison of compliance with required corridor parameters – eventually, theoretical comparison of the need for improvement – also taking into account market players' expectations. Each parameter in the compound index is weighted by its importance and a compound index score for individual section has been generated by comparing the actual infrastructure values against the TEN-T requirements. The higher the overall score is, the better the infrastructure is in terms of interoperability and level of service. Note, that it is a theoretical and focused approach and several other factors – like capacity utilisation, funding source, environmental issues, national priorities, etc. – will and may affect what sections are to be developed.

Infra parameters	Required min.	Importance for RUs	RU issue	RFC AMBER relevance
Traction	electrified	decisive (route choice)	some sections are diesel and different voltages (25 vs. 3kV) also causes extra cost	93% is electrified but different current systems
Number of tracks	-	not important in itself	only punctuality and capacity matters, number of tracks has indirect impact on this	55% double track
Axle load category	22.5t	important efficiency criteria	D* category needed for modern locos (>21t per axle)	54% is D3 or D4 (22.4 tons/axle)
Maximum gradient	< 9‰	important efficiency criteria	relevant for train gross weight, ideal would be <4.5‰	63% of the corridor is <9.00‰
Max. speed for freight trains	100km/h	important efficiency criteria	average circulation speed is more relevant than line speeds themselves	60% of the corridor is ≥100km/h (considering line speed)
Max. freight train length	740m	important efficiency criteria	train length is core for efficient use of resources	28% is appropriate for ≥740m trains
ERTMS equipment	ETCS	less important criteria	other parameters determine operation efficiency	GSM-R (w. or w/o. ETCS) is installed on 34%
Intermodal gauge	P/C 80/400	important efficiency criteria	high-cube containers' requirement; physical gauge can be an issue, but administrative problems also occur (e.g special permission for HQ container trains)	mainly structures/tunnels can cause restriction but considered exceptional cargo in Hungary, Poland

Table 8: RUs' assessment of main infrastructure parameters affecting rail competitiveness

The share of RFC Amber sections in terms of the compound index (section quality) is as follows:

Section quality compared to the requirements	Acceptable > 4.0	Fair 3.51 – 4.00	Poor 3.01 – 3.50	Very poor ≤ 3.0	Total
Poland	269km	317km	354km	300km	1240km
Slovak Republic	474km	189km	53km	-	716km
Hungary	289km	755km	212km	16km	1272km
Slovenia	110km	241km	-	162km	512km
Total	**1142km**	**1501km**	**619km**	**478km**	**3740km**

Table 9: Categorisation of RFC Amber sections by compound index

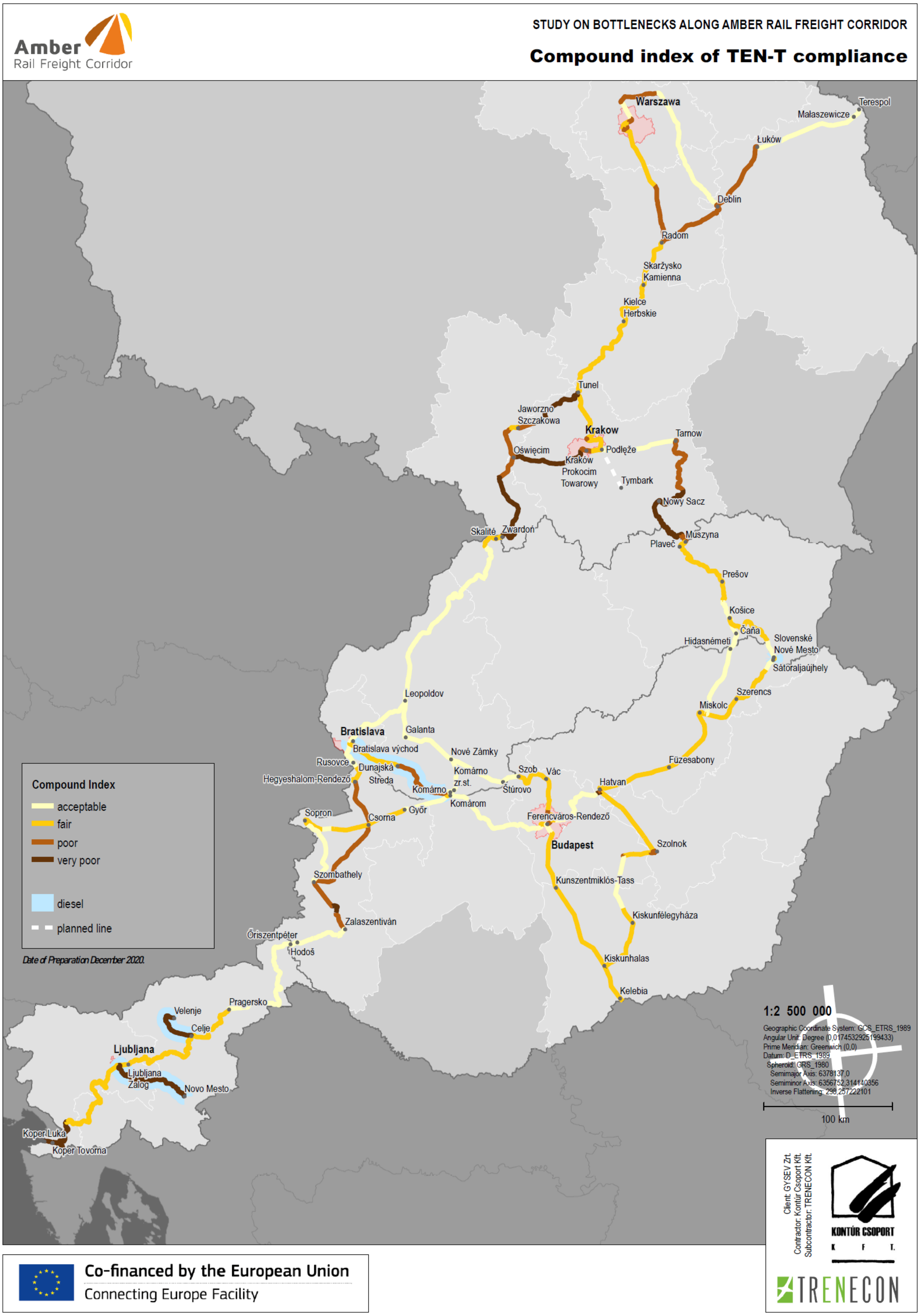


Figure 3. Overall quality of line parameters determined by the compound index values

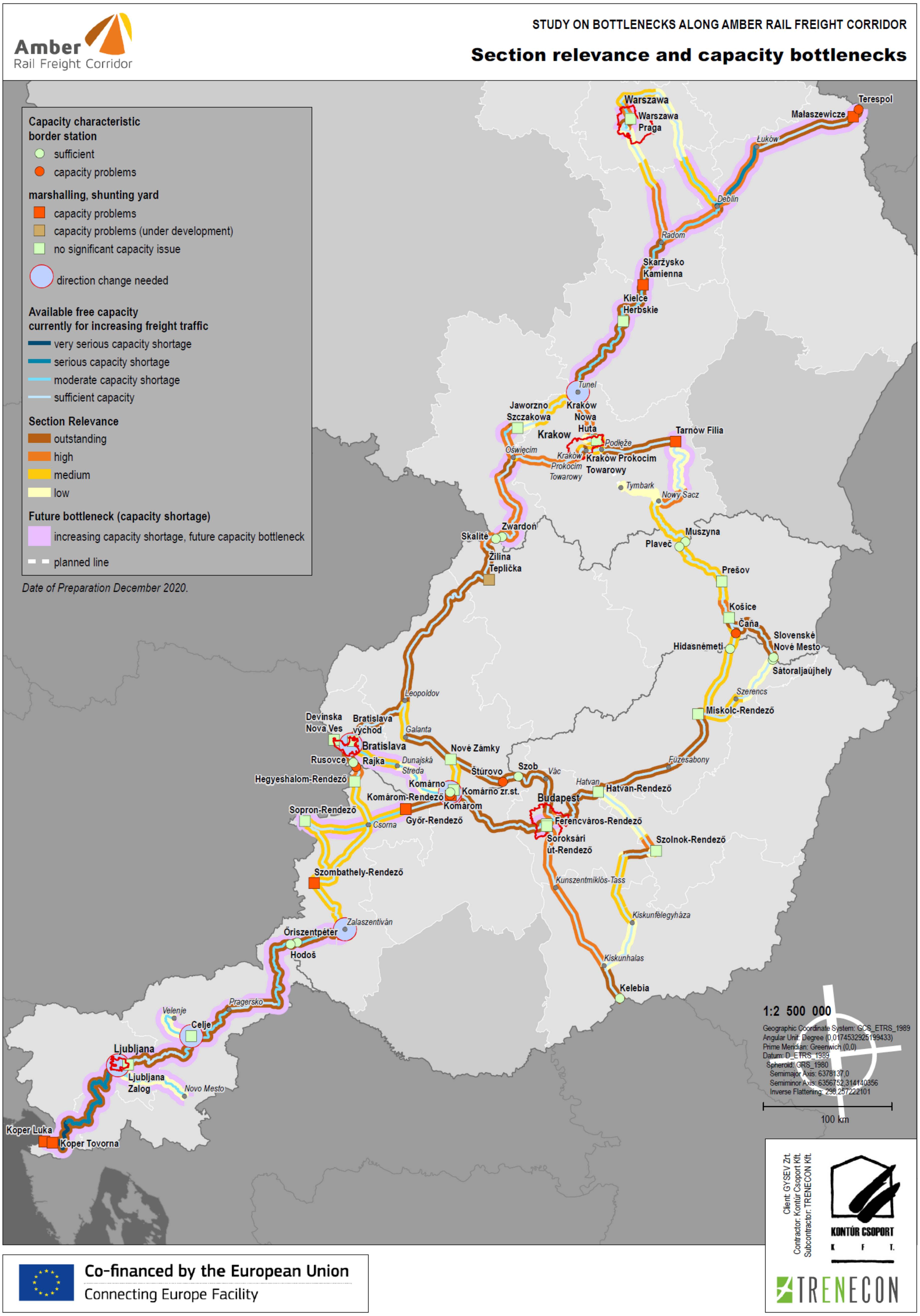


Figure 4. Combination of section relevance and forecasted capacity line and node bottlenecks along RFC Amber

1.5.3 Administrative and operational bottlenecks (O & A bottlenecks)

Issues relating to procedural and organisational or administrative aspects affecting the functioning of freight transport services along the corridor, i.e. **administrative and operational deficiencies** causing inadequate capacity management or ineffective use of the infrastructure are also considered bottlenecks and are described and assessed in a qualitative manner based on feedback from RFC Amber stakeholders. However, considering limited experience regarding RFC train operation, traffic management on the Amber Corridor (since it has been established in 2019), generic policy and relevant technical papers (e.g. sector statement, documents of overlapping RFCs, -Issues Logbook, RNE guidelines, TMS) were also consulted to support descriptive account of the current status and assessment of underlying causes and impacts of operational barriers affecting RFC Amber performance.

Four main areas of the issues assumed to interfere with competitive international rail freight on RFC Amber were identified to ensure consistency and common grounds for discussion: capacity management, communication, traffic management and administrative issues (at handover points). It has been revealed that the "operational bottlenecks" on RFC Amber are very much the same as the ones identified by other RFCs and which are in the forefront of RNE activities and initiatives. Main O&A bottlenecks (issues) identified and to be improved are as follows:

1. CAPACITY MANAGEMENT
1A - Path allocation procedure via C-OSS is inadequate
1B - PaP parameters and RC fail to meet market requirements
1C - Limited applicability of the PCS and reliability of data
2. COMMUNICATION
2A - Communication difficulties at handover points, borders
2B – Poorly functioning interfaces between national IT tools and the RNE tools
2C – Inadequate coordination and sharing information on capacity restrictions, disturbances
2D - Insufficient language skills of staff
3. TRAFFIC MANAGEMENT
3A - Ineffective arrangements, processes at border crossings
3B – Low reliability of RFC trains impacts competitiveness
3C - Competitive re-routing, contingency measures for traffic disturbances/TCRs are not available
3D – RFC traffic management staff is not properly prepared
4. ADMINISTRATIVE ISSUES
4A - Cross-border interoperability difficulties due to lack of harmonisation of national rules
4B - Not transparent, calculable procedures and charging in case of multimodal transport
4C - Long technological times of forwarding outside the EU

Table 10: Operational and administrative bottlenecks identified and classified

In *capacity management* the process of definition and allocation of freight train paths on RFC Amber by the C-OSS, is facing a general underlying risk of priority given to passenger traffic. The needs of freight transport should always be taken into account at an early stage when developing timetable-concepts for passenger traffic to support a PaP capacity offer in correspondence with the actual needs of the railway undertakings. Theoretically, C-OSS operates as the single entry point for RUs to receive path request and allocate capacity. Apparently, the RFC Amber C-OSS at present is not fully functioning with all the services provided usually by national OSSs. (such as handling modification, cancellation, adding of different services, billing of infrastructure charges and collection of the relevant charges, serving all capacity needs of the customers). PCS is expected to be the common IT platform for efficient RFC capacity allocation, however interface with national systems is not operable yet.

In terms of *communication* the main problems include inefficient exchange of information at borders, the lack of coordination of upgrading works (TCRs), not consistent numbering of international trains, low reliability of data, which can be improved by interoperable interfaces with national IT systems to take full advantage of CIS, TIS and OBI to improve train performance management.

It has been revealed that a lack of reliability of information on estimated times of departure and arrival (ETD/ETA), poor harmonisation of TCRs, long dwelling time at borders due to insufficient coordination and lack of trusted handover heavily impacts *traffic management.* Waiting time is mostly due to technical inspection requirements of rolling stock which can be shortened by better coordination, collaboration of national stakeholders, extended application of the trusted train approach which also improves the predictability of the expected time of arrival (ETA). Train performance management activities (i.e. monitoring of KPIs, analysing dwell times) need to be enhanced to improve service. International freight transport enjoys less attention in traffic management, re-routing options, contingency measures in case of disturbance, capacity restriction are not demand-driven affecting reliability and efficiency. That current average speed along many sections of RFC Amber is very uncompetitive and predictability of ETA is low.

At borders, the *administrative issues* are of key importance for RFC operability, efficiency of IMs. Due to lack of harmonisation of national rules on train composition, safety, vehicle authorisation, certification, the lengthy procedural, technological times requires additional capacities, impact punctuality, and eventually increase cost of freight transport. Complex administrative requirements, not transparent calculation of costs and time interferes with the expansion of rail transport on the corridor failing to promote intermodality, one of the explicit challenges of the rail freight corridors.

In each of the four main categories of O&A issues affecting the functioning of RFC Amber were analysed in consideration of impact and relevance and were grouped into low/medium/high categories. The following issues have to be highlighted which has the highest impact-relevance score in terms of RFC performance and efficiency:

- Capacity management: PaP/RC allocation process fails to respond to actual RU needs (RFC preference)
- Communication: poor coordination and information on Temporary Capacity Restrictions (TCRs)
- Traffic management: long dwelling time at borders/handover points – insufficient cooperation, lack of RFC priority/reliability, poor train performance management
- Administrative issues: lengthy procedural times at borders due to various national rules (cross-border interoperability difficulties)

1.6 Proposed measures

Potential measures are identified and ranked in consideration of the impact to improve main bottlenecks hindering freight train operations and seamless traffic flow on RFC Amber, and negatively affecting the competitiveness of rail freight. The main objective of the elimination of these bottlenecks is to establish infrastructure and operational conditions for competitive international rail freight transport and provide capacity on RFC Amber in correspondence with traffic demand. These objectives are also serving EU targets related to climate change.

1.6.1 Infrastructure and capacity interventions

It is assumed, in consideration of current capacity utilisation and future freight transport expectations, that section where infrastructure parameters are characterised with a compound index value under app. 4.0 and run at capacity shortage are the ones where improvement of line parameters are imperative. On other sections with lower scores where moderate capacity shortage is indicated the upgrading interventions are not crucial in the short term but also need developments in the future. As traffic increases in the future, new sections are expected to run at capacity shortage, those sections shall be included in the development programs.

However, to meet TEN-T requirements and make steps towards an interoperable single European rail network and a competitive RFC Amber, on sections where compound index values are relatively low, interventions are needed. Without that, in our opinion, the line cannot be expected to serve RFC Amber international train traffic efficiently. As there are capacity bottlenecks along the Corridor, these lower score sections can be considered bottlenecks in terms of infrastructure parameters hindering efficiency of rail forwarding and level of service. These lines, sections are consequently calling for investments on the infrastructure.

Interventions to improve efficiency by forming the network topology

As has been pointed out in chapter 1.3.1 measures to address network bottlenecks, i.e. bottlenecks which are related to the (geographical) structure of the network of lines designated to the RFC rather than the state of the infrastructure per se, can be helpful and important to maintain and strengthen the competitiveness of RFC Amber versus alternative routes. Naturally, any such measures will also contribute to improve the competitiveness of rail freight in general versus other transport modes.

We can positively note that two of the three identified network bottlenecks of RFC Amber are already addressed or partly addressed in current infrastructure planning:

- This concerns for the first the plans for a new straightening railway line in Southern Poland between Podłęże (near Kraków) and Nowy Sącz, which will substantially shorten the rail distance between both towns and de facto eliminate this network bottleneck. A pre-requisite, however, is that the line parameters of the new line will be favourable for freight traffic, e.g. concerning gradients. The importance of this project is underlined by the fact that the line is part of only three border crossing rail lines between Poland and Slovakia, all of which today of a relatively low standard.
- A further measure which will at least help to reduce a current network bottleneck of RFC Amber are the plans for a triangle track at Zalaszentiván station in Western Hungary, which will eliminate the need for freight trains to change travelling direction at that station. Preparatory works for the triangle track have started. Its implementation will have an important role in facilitating freight traffic between Slovenia/Port of Koper on the one side and destinations in Slovakia (e.g. Dunajská Streda, Žilina) respectively Central Hungary (Budapest) on the other side.

At the same time, it has to be noted that certain network bottlenecks of RFC Amber will remain even after implementation of the above measures and that these are currently not yet addressed in any official infrastructure plans:

- The need for change of travelling direction in Komárom and Komárno, two stations just a few kilometres apart on the opposite banks of the Danube river, remain.
- Also, the major detours between Eastern Slovenia and Western Hungary, more concrete in the section Pragersko – Szombathely, remain.

In the case of the first two-mentioned it should be considered to investigate the possibilities for eliminating them through (shorter) local connecting curves in Komárom respectively Komárno.

In case of the latter one a solution can probably not be implemented in the nearer future since it would probably require major investments with new line sections. A solution might be found in the context of a broader approach to improve rail connections between Slovenia and Hungary, not only focusing on freight, but also addressing passenger traffic. A recommendation, however, is to investigate the potential of the railway line Körmend – Zalalövő, which is currently our of use, but might – at least partially – but whose alignment has in principle the potential to form part of new shorter route between the Slovenian-Hungarian border and Szombathely. Taking into account that the rail network in this part of the corridor is almost entirely single-track – and with few exceptions will remain so in the foreseeable future – such a route could also be an enabler to introduce the operational concept of directional running for freight trains.

Priority of sections by member state

The sections are prioritized in order to define the importance of making intervention for bottleneck elimination.

The next map shows the combination of section relevance and capacity shortage. The second map presents the priorities. The data and classification for each section is included in the study, at the definition of interventions, where the investment priority is included to underpin the investments on the section.

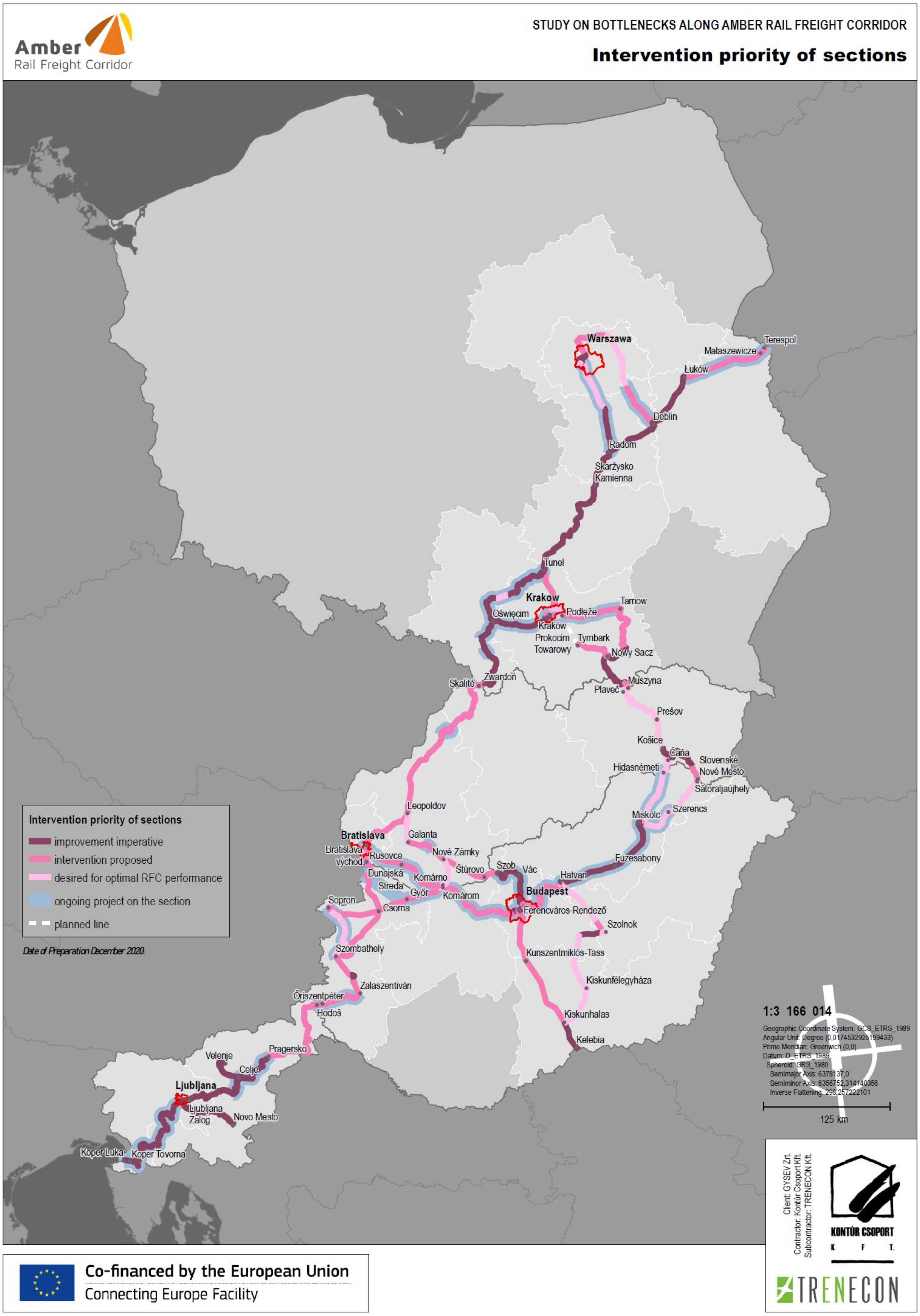


Figure 5: Investment priority (considering capacity issues) of sections along RFC Amber

Proposed interventions along the lines

For each line sections of RFC Amber, the appropriate intervention type is assigned and presented in tables and maps.

New line construction is proposed only at locations where it is decided previously and included in the RFC Amber as future line; namely it is the Tymbark – Podłęże section in Poland. However, it is possible at some locations that the capacity increasing intervention by building a 2nd track along a section is physically results in a new line on new alignment (due to external conditions mainly, i.e. terrain, built-in area limitations) as it is the case in Slovenia with the Divača – Koper “second track” construction project.

The upgrade to TEN-T requirements has two main sub-categories, full reconstruction and partial upgrade. First is needed and proposed in case the full reconstruction is expected to meet the required parameters, as it is the case when axle load or line speed raise is needed or the compound index is low-moderate, suggesting that full, complex reconstruction and development is imperative. Partial upgrade is considered on the sections where the axle load, speed currently fulfils TEN-T requirements or compound index is relatively high (section considered good) but further development of e.g. ERTMS system is needed or speed restrictions

Capacity enhancement intervention is not defined in more details as it is a very complex issue, depends on current parameters, traffic circumstances, etc. of the section that needs detailed analysis and planning one by one; it cannot and should not be judged or decided on strategic level. The intervention or later the project can be, for example, building a second track on full length or only partially, upgrade of the signalling system, development of some stations along the line, speed increase etc.

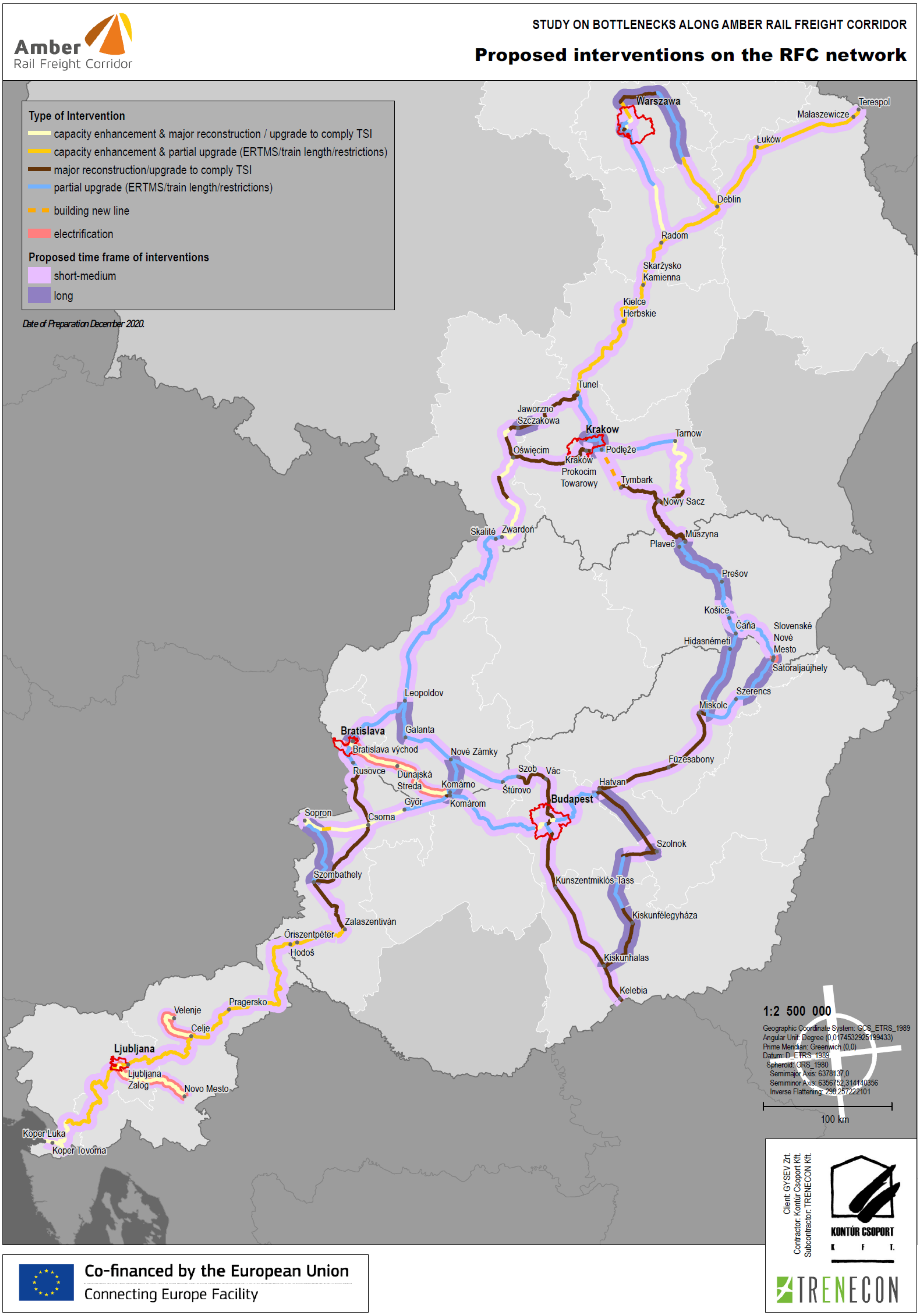


Figure 6: Type and time frame of the RFC Amber line infrastructure interventions

Proposed interventions at major service points as yards and border stations

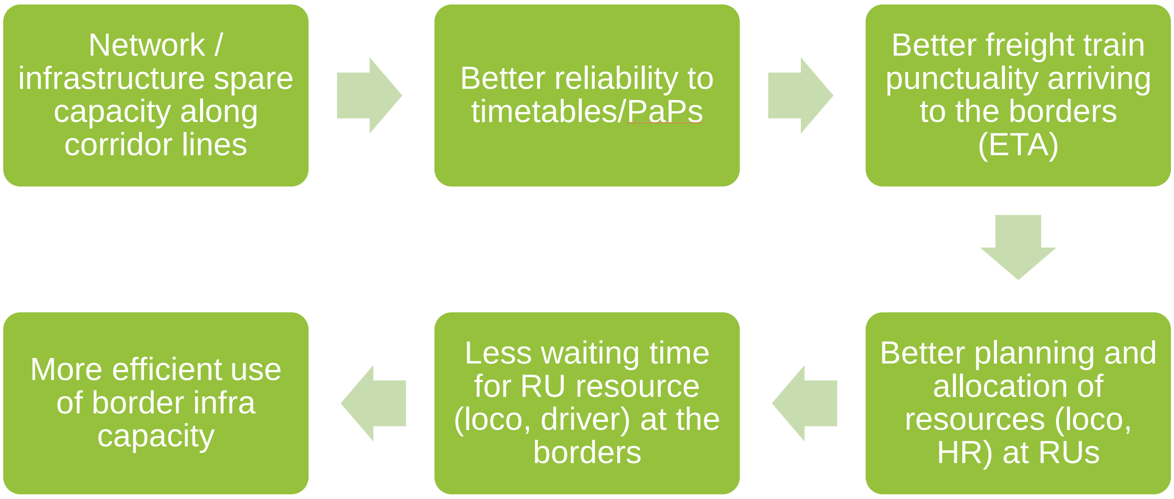
To ensure appropriate capacity and higher flexibility of traffic management along the whole network, it would be important that a sufficient number and density of >740m station tracks is available along the lines.

All line capacity increasing and upgrading investments should increase the number of 740m long freight train tracks (currently it is prevalent that such tracks are ceased along the TEN-T corridors if the project development focuses on passenger train capacities and demand).

At appropriate density on the network there should be such station, having more than one dedicated freight train track. In single-track sections the distances should ideally be even shorter. The current practice of dismantling 740 m long freight tracks in connection with modernisation passenger transport projects should be avoided, if not alternatives with the same track lengths can be provided in the same station or its closer vicinity. With the number of 740 m long freight trains expected to grow, this is of particular importance in order to facilitate traffic management in case of disturbances.

It is also important that new track connections can substitute station developments, e.g. new delta tracks at Zalaszentiván, Komárno and Komárom, Bratislava or Tunel, if needed, can ease the operation in the neighbouring stations (that are also border crossings in the case of Komárno-Komárom).

The often too long (being much above the 2 hours threshold) dwelling times in border stations or also the processing or train handling times at marshalling yards are the result of complex impacts. At these points, interdependence is the highest with other aspects of RFC operation. The operation, capacity and reliability of the overall RFC is in close interaction with border efficiency:



Consequently, border station developments are proposed to be planned and assessed considering the complex impacts on its efficiency and operation. The infrastructure capacity extension might not be the most cost-efficient intervention when it comes to shorten the waiting times at the border crossing stations. Of course, any planned infrastructure development shall be subject to an in-depth cost-benefit analysis.

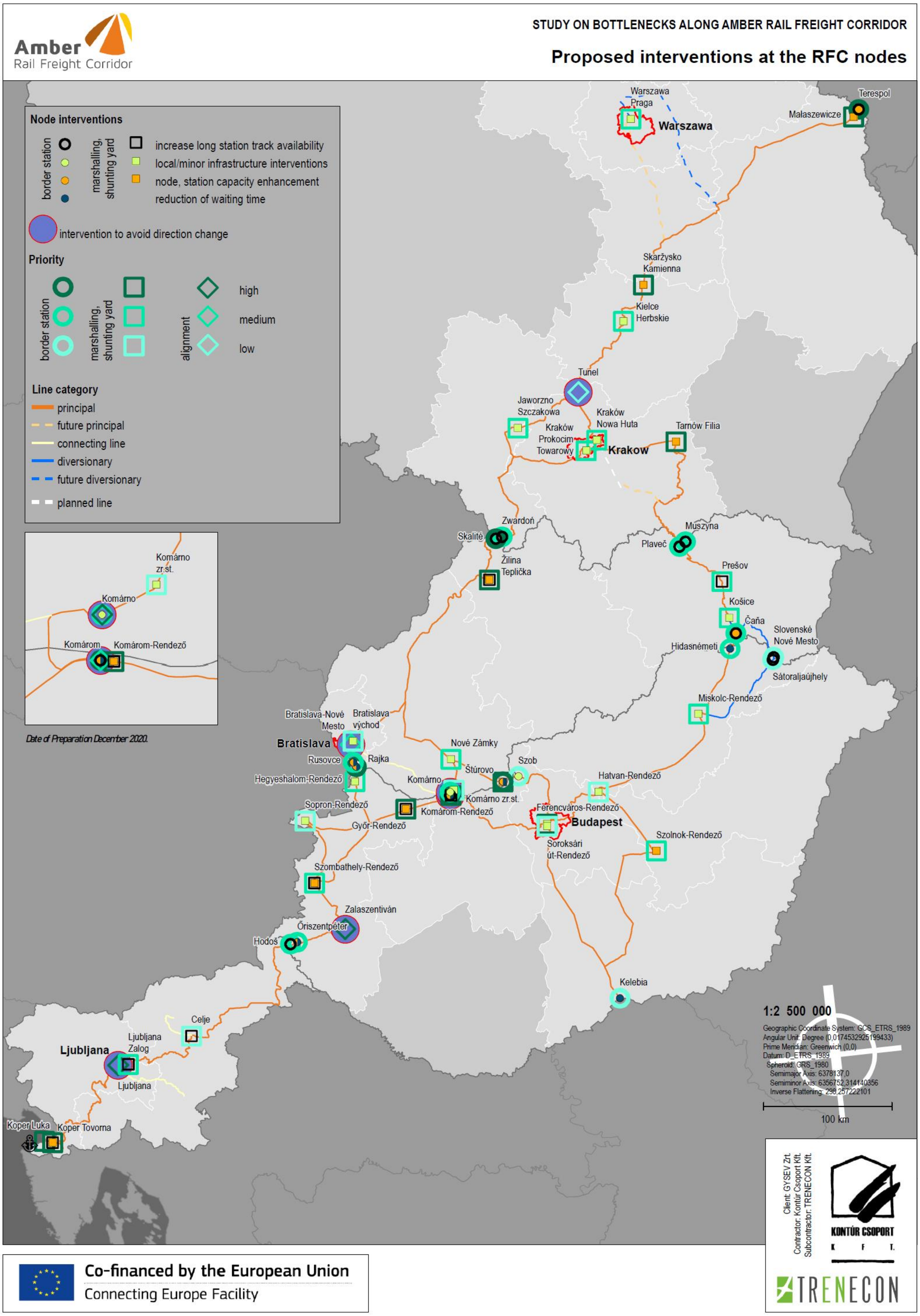


Figure 7: Type and priority of the interventions at the important stations and nodes of RFC Amber

General considerations for developments and interdependencies

It is supposed and proposed that new lines and developments on the RFC topology (i.e. future principal sections) get development priority.

It can be subject of debate that developments should be focused for all relevant sections along the same line as a scheduled investment programme. It is proposed because the main objective is to remove and develop most crucial bottlenecks, but it is also important to reach homogenous network/lines along the Corridor.

The electrification should be one of the first priorities even if they are required only on connecting and diversionary lines. It is possible and can be considered and assessed that a sole electrification project is started prior to the complex upgrade to fulfil TEN-T requirements.

It is worth considering also that new sections (even relative short triangle tracks) can substitute station developments and/or other line infra developments:

- e.g. new delta tracks at Zalaszentiván, Komárno/Komárom, Bratislava can ease the operation in the neighbouring stations (no direction change is needed that occupies capacity currently)
- e.g Nowy Sącz – Tymbark upgrade and planned Tymbark – Podłęże new section can substitute reconstruction of line sections already in operation.

1.6.2 Measures to improve administrative and operational issues

Operational and administrative issues are usually very complex and have been addressed previously by EU legislation, RNE guidelines, initiatives and by overlapping RFCs' action programmes. Also, note that there is limited direct experience concerning RFC Amber, so potential measures, interventions were evaluated in consideration of general sector, RFC initiatives, endeavours.

The approach of finding the solutions or mitigating measures best suited to improve the particular operational or administrative bottlenecks is similar to that for infrastructure (development) measures; the target conditions i.e. general qualitative criteria for each bottleneck category are set at first, measures are defined and evaluated corresponding with the relevance of the issue (see section on methodology above). The final ranking and prioritisation are based on a scoring matrix of impact (including interdependence) and feasibility.

Complex measures including several individual actions to mitigate main causes of the issue were defined for improvement of each O&A bottleneck. Each of the complex measures were evaluated and ranked into one of the main priority groups as follows:

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Ref. no.*	Proposed measures	Issue impact	Total score	Priority category
1B	Enhance surveying and consideration of RU demand in PaP parameters and RC to offer competitive RFC capacity	high	18	proposed
2A	Actions to improve communication efficiency and transparency at national borders	high	18	proposed
2C	Interventions improving coordination in planning and sharing information on capacity restrictions, disturbances	high	16	proposed
3A	Harmonisation of processes and procedures at borders	high	16	proposed
3B	Interventions to ensure priority and increase punctuality of RFC trains	medium	16	proposed
3C	Develop efficient re-routing options, contingency for disturbances, restrictions	high	16	proposed
4A	Enhance cross-border interoperability by harmonisation of national rules, requirements and use of common IT platforms	high	16	proposed
2B	Improve functionality and reliability of RNE Tools for RFC Amber	medium	14	to be considered
1A	Ensure resources and increase role of a competent C-OSS for path allocation and capacity planning	medium	12	to be considered
2D	Improve language skills of staff and ease their communication by using standardized forms, messages with IT support	medium	12	to be considered
3D	Strengthen the role and capacity of RFC traffic management by preparing staff and exchange of experience	low	12	to be considered
4B	Simplify procedures in the multimodal transport chains and support freight forwarders in route planning, cost calculation and path reservation	medium	10	to be considered
1C	Improve applicability of the PCS and reliability of its data content	low	8	desired
4C	Harmonisation of rules/legislation to ease administrative burden (at EU border)	medium	6	desired

**reference numbers of measures are identical with that of the corresponding operational bottleneck for transparency*

Table 11: Ranking of O&A interventions by impact and feasibility score

A theoretical order of potential measures based on impact and feasibility is shown above, however note that it is not intended to suggest an actual order of implementation priority. The assessment and ranking of the potential measures provide a substantiated recommendation for RFC Amber on how and what aspects of corridor functionality should be targeted for material result in the short-medium run.

Interventions for improvement do not apply uniformly to procedures of member states, IMs RUs or to handover points. National particularities, level of implementation of OPE TSI, transposition of legislation, effective operational agreements or capacities of individual border crossings can considerably affect implementation potential and priority or resource requirements. Further preparatory efforts, in-depth assessments are required to determine the implementation potentials of each and priorities at national level.

1.7 General conclusions on interventions

Efficient functioning of rail freight corridors (among them RFC Amber) largely contributes to the implementation of the Single European Railway Area; free movement of freight trains, overcoming national borders, achieving interoperability. Therefore, it is vital to identify infrastructure deficiencies, capacity shortages and operational, administrative issues that interfere most with operational efficiency of international rail freight service along the corridor. Initiatives, commitments and actions at European level, such as publication of the Sector Statement on RFCs, development of RNE IT platforms, the introduction of the 4th Railway Package in addition to the implementation of RFC Amber set the framework, the preconditions for improving bottlenecks to achieve competitive, fully functioning RFC Amber. Also, coherence with the Implementation Plan of RFC Amber (CID Book 5) including main line infrastructure bottlenecks, the conclusions of the TMS was observed throughout the elaboration of the Bottleneck Study.

This Study gives a thorough inventory and evaluation of current infrastructure, capacity bottlenecks on the line sections of RFC Amber based on the data input of member state IMs. The have been identified and prioritised considering their compliance with TEN-T requirements, network role and traffic potentials and several intervention types corresponding with the technical and capacity problems, section priority have been proposed for improvement. They are categorised to bring the assumed highest benefit to the functioning of RFC Amber (value-added service: higher efficiency, reliability, simpler procedures), however national considerations, other network developments, availability of funding, etc. can affect implementation preferences, feasibility of individual actions. Even the corridor authorities may suggest countries to give investments higher priority or project maturity can allow for earlier funding.

It has to be pointed out that it is beyond the means of this Study to set an exact priority list of interventions either for the entire corridor or for the relevant national lines, stations within the individual member states. However, the three priority groups of interventions clearly indicate what sections and connecting stations or nodes and at what level of development could mostly improve functioning, competitiveness of RFC Amber. Therefore, the focus of developments is established keeping a close eye on the efficient functioning of RFC Amber which is in line with national network development priorities of IMs. Because the main objective is to remove and develop most crucial bottlenecks, the developments should be focused but it is also important to reach homogenous network/lines along the Corridor.

For more detailed definition of the interventions, technical content or implementation framework, specific studies, designs have to be prepared. Similarly, actual developments at stations, marshalling yards, terminals require detailed analysis of technical conditions of tracks, capacity, layout, etc. and they are also very much subject to the connecting line’s role in freight transport, track number, daily train runs, etc. and consequential impact on traffic which is beyond the scope of this Study. Station capacity developments, no doubt, can ensure flexibility for traffic management, the necessary puffer capacity for efficient and competitive international service.

RFC Amber went operational in 2019, so IMs/AB and RUs have limited experience with regard to the adequacy and efficiency of RFC Amber capacity and traffic management processes, border procedures communication, collaboration between national players. Therefore, operational and administrative issues where identified, ranked and then converted into proposed interventions based on the main causes of the issues mostly in consideration of experience gained, lessons learnt in general international freight train forwarding and other RFC operations.

Operational or administrative inefficiencies and technical condition of infrastructure, capacity problems often interrelate. Measures improving traffic management, communication or coordination can result in more efficient operation potentially mitigating the need for costly infrastructure investments. However, interdependence is rather between operational or administrative measures which were taken into consideration when ranking measures by the impact. A wider impact or collateral improvement of some other issue invites higher priority of the particular measure. Impact score coupled with feasibility determined if the measure was proposed or found less promising for the improvement of RFC Amber functionality. All in all, it has been found that preferential treatment of RFC trains (understanding priority of passenger transport), market driven capacity allocation procedures, better communication and cooperation between IMs (co-ordination of timely information on TCRs) and RUs (trusted train), use of common IT platforms (RNE) and harmonisation of national rules at handover points would improve efficiency, competitiveness of RFC trains. We can be confident - thanks to the common efforts - that

RNE IT tools, like PCS for efficient capacity management or OBI for train performance management will soon be commonly used for the benefit of a more competitive RFC Amber service improving operational efficiency for RUs and IMs alike.

The assessment, ranking of the potential measures is a substantiated recommendation for RFC Amber on how and what aspects of corridor functionality should be targeted for material result in the short-medium run. Nevertheless, it is a theoretical categorisation of potential measures, it is not intended to suggest any order of implementation priority. Interventions for improvement do not apply uniformly to procedures, member states, IMs or handover points. National particularities, level of implementation of OPE TSI, transposition of legislation, capacities of individual border crossings can considerably affect implementation potential and priority or resource requirements. Thus, implementation often require in depth consideration of processes and procedures, investigation of regulatory compliance and seeking compromises. RFC Amber stakeholders are committed, regulatory and policy framework as well as IT support are mostly in place to implement most of the proposed measures, however future implementation is subject to investigation of local conditions, national particularities or the level of harmonisation, collaboration. Further preparatory efforts, in-depth assessments are required to determine the implementation potentials of each measure and priorities at national level.

2 Background and preliminaries

2.1 Background

RFC Amber has received a grant from the European Commission under the Program Support Action for the action entitled ***'Establishment and development of the "Amber" rail freight corridor (RFC Amber)'***, with the action number 2016-PSA-RFC11 - with a total funding amount of circa 1.1 million EUR and running from September 2017 until December 2020 -, mainly aiming to support the set-up and further development of the corridor according to Regulation (EU) No 913/2010 (hereinafter: ***the Action***).

This Action includes under Activity 4 the elaboration of a comprehensive ***"Study on bottlenecks along Rail Freight Corridor Amber (RFC Amber)"*** (hereinafter: *the current Project or* ***Project***). Implementation of this Activity 4 is expected to give an in-depth understanding of the compliance of the corridor infrastructure with TEN-T minimum requirements, bottlenecks in terms of capacity and line standard, and potential measures for infrastructure and operational improvements for efficient rail freight operations along the network of RFC Amber.

2.2 Aim of the project

The Terms of Reference (ToR) requests to elaborate a study which:

- Identifies and describes bottlenecks of administrative, operational and infrastructural nature along the lines of the corridor with particular attention to
  - the cross-border areas,
  - capacity and line standards,
  - relevant infrastructure TSI requirements and TEN-T minimum requirements according to Regulation (EU) 1315/2013 Art 39. (2a)
- Proposes appropriate measures for infrastructure and operational improvements with the aim to eliminate or reduce such bottlenecks and to allow more efficient rail freight operations.

The study shall provide support for future investment on infrastructure, operational, administrative and capacity-related decisions and improved cross-border cooperation regarding the network of RFC Amber.

2.3 Contracting parties

GYSEV (hereinafter the Contracting Authority), member of the Management Board of RFC Amber and Coordinator of the Program Support Action, is in charge of tendering and contracting the study. Based on selection of the winning bidder, he has signed service contract on completion of the current Project with the Kontúr Csoport Ltd. (hereinafter the Contractor) in the beginning of 2019.

The Kontúr Csoport Ltd. undertook the elaboration of the study in cooperation with TRENECON Consulting and Planning Ltd. (hereinafter the Subcontractor).

Thus, the contracting parties are as follows:

- Client and Contracting Authority: GYSEV Zrt. / Raaberbahn AG
- Contractor: Kontúr Csoport Ltd.
- Subcontractor: TRENECON Ltd.

(Hereinafter the Contractor and Subcontractor together: the Contractors)

An international ad-hoc working group has been established to support the bottleneck study project. The most relevant actors include the Infrastructure Managers (IM) and the Capacity Allocation Body (AB) of RFC Amber:

- Poland: PKP Polskie Linie Kolejowe S.A. (IM)
- Slovak Republic: Železnice Slovenskej Republiky (ŽSR) (IM)
- Hungary: GYSEV Zrt., MÁV Zrt. (IMs), VPE Kft. (AB)
- Slovenia: Slovenske Železnice Infrastruktura d.o.o. (IM)

Advisory groups of RFC Amber (RAG/TAG, railway undertakings' and terminals' groups as users of RFC services) have also been actively involved in the efforts to ensure high-quality, efficient and meaningful contractual performance and delivery.

2.4 Phases of Implementation, milestones

Main tasks of the Contractors included:

- Propose suitable data collection methods
- Carry out the collection of data
- Carry out the data processing and analysis
- Identify the bottlenecks, draw conclusions
- Propose improvement measures and to develop a proposed strategy tackling bottlenecks
- Provide support to related corridor activities and wider discussions of the strategy

The project implementation activities were phased in line with the ToR.

2.4.1 Inception phase

A Work Plan – identifying the methods to be used, the staff resources to be deployed and including a schedule for the activities to be carried out – was elaborated and submitted to the Contracting Authority within 14 calendar days after the contract had taken effect.

Draft Work Plan was discussed at two meetings:

a. Meeting with representatives of the Contracting Authority on 23 January 2019 in the office of GYSEV,
b. Meeting with Hungarian corridor representatives (GYSEV, MÁV, VPE as IM/AB and RAG/TAG spokesperson) on 12 February 2019 in the office of TRENECON.

Comments and requirements indicated at those meetings had been considered by the Contractors and the amendment of the Work Plan was presented at the Kick-off meeting in February of 2019 in Budapest. attended by the corridor representatives of interested organisations in four member states of RFC Amber. Members were delegated to a new ad-hoc working group that supported the work of the Contractors during the Project.

The preparatory documents (Work plan, Schedule) were discussed with the participants.

The inception phase was concluded by submitting the Inception Report in June 2019, three weeks after the Kick-off meeting as agreed by all the parties. The content of the Inception Report was compiled according to the requirements in the Terms of Reference (ToR).

- *Milestone 1: Inception Report*

2.4.2 Data collection phase

The Contractor has duly completed the data collection phase that included desk research, interviews, presentations and several rounds of questionnaire survey in order to possibly address the largest number of stakeholders and get feedback from potential users, service providers from each country on infrastructure and operation or administrative bottlenecks alike. IMs and the Hungarian AB shared their views and experience while RUs were apparently less open to cooperate.

Three rounds of data collection were completed during 2019:

- 1st round: infrastructure and its utilization to identify "hard" bottlenecks. The data request was compiled in excel sheets and sent out in April 2019.
- 2nd round: traffic flows and train forwarding costs, additionally operative-administrative issues to identify the "soft" bottlenecks. The data request was also compiled in excel sheets and sent out in May 2019.
- 3rd round: this was an additional round of communication to collect missing data and information of the first two rounds. It was organised and compiled after the ad-hoc working group meeting in September 2019.

The data collection phase was concluded with the submission of the report "*Summary on activities and results of the data collection phase*" in November 2019.

- *Milestone 2: Summary on Activities and Results of the Data Collection Phase*

2.4.3 Analysis phase

The **Analysis phase** – following the inception and data collection phases – was the third phase of project implementation activities in line with the ToR. The two main categories of bottlenecks that are analysed based on data collection include infrastructure and administrative-operational bottlenecks. This phase also includes the traffic analysis of the corridor, including present and future demand (prognosis).

The analysis phase was concluded with the submission of "Discussion Note" that was considered to be the meaningful summary of stakeholders' feedback on bottlenecks in the light of current and future rail freight traffic and the expected role of RFC Amber. As such, it substantiates the final conclusions on RFC Amber, the potential measures proposed when delivering the Bottleneck Study as the completion of the assignment.

- *Milestone 3: Discussion Note on the Results of the Analysis*

2.4.4 Elaboration phase

Based on the main findings of the analysis, identification and assessment of infrastructure bottlenecks, operational and administrative issues, Contractor worked out the evaluation methodology for the potential measures to improve bottlenecks on RFC Amber. The results of the Analysis phase and the evaluation methodology was presented and discussed with the ad-hoc WG members at an on-line meeting in July 2020. Participants agreed on the methodology to identify and prioritize potential interventions, came to a common understanding on the different approach to line and node developments. A discussion note integrating the comments and recommendations of the ad-hoc WG members summarised the conclusions of the meeting, the evaluation methodology to be applied in the study.

Proposed measures to reduce bottlenecks both infrastructure and operational & administrative were identified, assessed, and ranked based on impact (i.e. relevance of bottleneck regarding functioning of RFC Amber) and feasibility. The draft bottleneck study was compiled, and the main findings were presented at an online meeting in September 2020 for comments.

The draft study (Milestone 4) integrated the results of the data collection phase, the content of the analysis of bottlenecks also presenting the socio-economic environment and transport trends. The draft study included the approved evaluation methodology considering interdependencies and made recommendations on implementation priority categories of potential measures based on perceived impact and feasibility.

- *Milestone 4: Draft Final Study on Bottlenecks along the rail freight corridor Amber (RFC Amber)*

2.4.5 Finalisation phase

In the course of the finalisation phase ad-hoc WG members, the Management Board and the Executive Board had the chance to comment on the results of the elaboration phase to align proposed measures with technical scope of foreseen projects and actual national feasibility concerns. The finalised study considers the final opinions and recommendations of the stakeholders (IMs/AB, RAG/TAG, ExBo, MaBo) and delivers harmonised approach of stakeholders to bottleneck improvements. So, the final study is considered a strategic paper to substantiate future interventions for improvement, to support efficient functioning of competitive RFC Amber.

The final Bottleneck Study was approved by the Management Board in mid-December 2020.

- *Milestone 5: Final study on Bottlenecks along the rail freight corridor Amber (RFC Amber)*

3 Objectives of the Study

Bottlenecks means firstly sections where the main infrastructure elements fail to facilitate service quality level corresponding to the line function required by demand or potential traffic. Such failure thus interferes with future growth of railway transport. Elimination of bottlenecks is possible with major developments or very often with technical interventions of smaller scale or with organisational changes.

Technical parameters of the infrastructure will be assessed qualitatively too. The identification of infrastructure bottlenecks is supported by GIS based processing and graphic presentation (data presented on maps). This allows illustrative and effective assessment of main features as required by ToR (basic TEN-T and TSI requirements like 740 m train length, 22.5 ton axle load, 100 km/h speed, ERTMS or electric traction, but also other parameters, e.g. 8.0 t/m loading performance, P400 intermodal semi-trailers along the line sections and no. of 740m long electrified freight train tracks, capacity and waiting time at the major service points and stations), and also allows apperception of missing or conflicting data.

On the other hand, capacity problems different from infrastructure bottlenecks obviously exist in the corridor too. Administrative and/or operational deficiencies, characteristics causing inadequate capacity supply or ineffective use of the infrastructure can be described and assessed in a qualitative manner. It means that we can give a descriptive account of the current status of such features to the extent of exploring logical links and underlying causes heavily relying on the data from the competent organisations.

The main objective of this Study is twofold:

- to identify and assess bottlenecks – infrastructure capacity, line standards and operational issues alike – that compromise functionality or spoil competitiveness of RFC Amber in consideration of current and future demand relying on the findings of the TMS.
- to assess and propose potential measures to improve such bottlenecks for efficient rail freight operations on the corridor

The Study covers all railway lines of RFC Amber providing an in-depth understanding of the compliance of the corridor infrastructure with TEN-T minimum requirements, and bottlenecks in terms of capacity and line standard.

The Study identifies potential measures for infrastructure and operational improvements for efficient rail freight operations along the corridor and evaluate the measures in a structured form highlighting interdependencies.

All in all, the Study is expected to give a comprehensive evaluation of the bottlenecks supported with GIS based maps, of the potential measures, and as such, it is designed to support future decisions to be made by member states, IMs on improving line infrastructure or operational efficiency. In addition, the Study is expected to facilitate cross-border co-ordination and prioritisation of efforts to enhance competitiveness of rail freight on the corridor.

4 Brief introduction of RFC AMBER

4.1 Corridor governance, organisation

Rail Freight Corridor Amber is a cooperation of the five railway Infrastructure Managers SŽ-I (Slovenia), GYSEV and MÁV (Hungary), ŽSR (Slovak Republic) and PLK (Poland) and the Hungarian Rail Capacity Allocation Office VPE. These six partners representing the four corridor member states (Poland, Slovak Republic, Hungary and Slovenia) are jointly managing and developing the Rail Freight Corridor in line with Regulation (EU) 913/2010 concerning a European rail network for competitive freight and Commission Implementing Decision 2017/177 with a view on meeting growing customer expectations and improving the conditions for efficient, competitive, sustainable and reliable rail freight.

The Regulation (EU) No 913/2010 defines the corridor governance structure on two levels. The establishment of the RFC Amber organizational structure was a crucial measure for creating the corridor:

- The Executive Board that is the top-level body assigned to the corridor.
- The Management Board that is the main operative body of the corridor.

Organizational units of RFC Amber are illustrated in the following schematic structure:

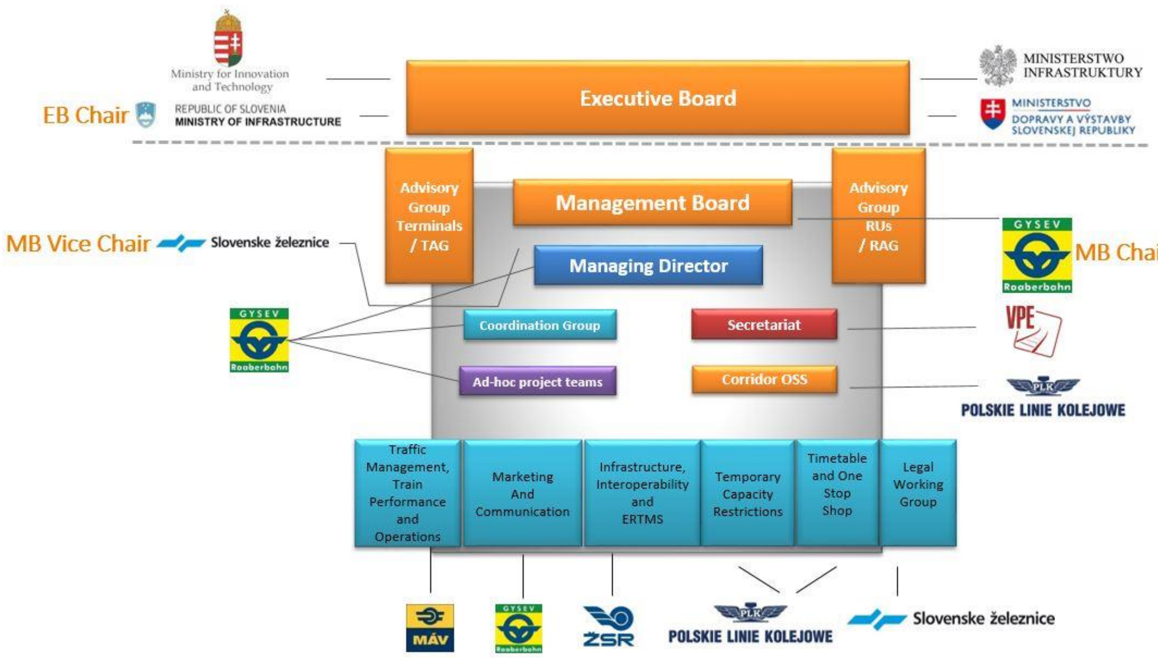

Figure 8: Organizational units of RFC Amber (source: rfc-amber.eu)

IMs and AB delegating representatives to the Management Board and other entities of RFC Amber:

- PKP PLK – PKP Polish State Railways (PKP Polskie Linie Kolejowe Spółka Akcyjna) – IM, Poland

- ŽSR – Railways of the Slovak Republik (Železnice Slovenskej Republiky) – IM, Slovak Republic
- MÁV – MÁV Hungarian State Railways Limited Company by Shares (MÁV Magyar Álllamvasutak Zrt.) – IM, Hungary
- GYSEV – Raab–Oedenburg–Ebenfurter Eisenbahn AG / Győr-Sopron-Ebenfurti Vasút Zrt. – IM, Hungary & Austria
- VPE – VPE Rail Capacity Allocation Office (VPE Vasúti Pályakapacitás-elosztó Kft.) – AB, Hungary
- SŽ-I – Slovenian Railways-Infrastructure (Slovenske železnice-Infrastruktura, d.o.o.) – IM, Slovenia

For the sake of corridor establishment and considering the volume and the types of tasks, the MB decided to set up also other corridor bodies (e.g. Advisory Groups, C-OSS office) as well as the Coordination Group, a Secretariat and six Working Groups to support its work.

To represent the users of the rail freight services, the MB of RFC Amber approved the set-up of the RFC Amber Railway Undertaking Advisory Group (RAG) and the Managers and Owners of the Terminals Advisory Group (TAG).

4.2 Topology of the Corridor

The network of the Rail Freight Corridors (RFCs) densely covers the Central-European area that is served by RFC Amber. The Corridor connects the port of Koper in the Adriatic in Slovenia and the border crossing of Poland and Belarus in Terespol to their hinterland, on the territory of Slovenia, Hungary, Slovak Republic and Poland. The lines of RFC Amber connect the major cities of the countries involved, such as Ljubljana, Sopron, Budapest, Bratislava, Žilina, Košice, Kraków and Warsaw. In total, the corridor includes 3744 km railway lines considering the several branches, connecting lines and including the planned (future) principal and diversionary routes to Warsaw. The total length of the principal route sections is 3077km.

The following maps represents the topology, line categories of RFC Amber and it shows the neighbouring TEN-T network, too. The majority of the Corridor is part of the TEN-T core or comprehensive network[1], in each country. However, there are several sections (connecting lines or planned, future sections) that are part neither of the TEN-T core, nor the comprehensive network of the EU, as shown on the TEN-T maps of the European Commission below (green lines are the TEN-T, orange is RFC Amber, purple is planned high-speed rail).

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[1] *REGULATION (EU) No 1315/2013 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 11 December 2013 on Union guidelines for the development of the trans-European transport network and repealing Decision No 661/2010/EU*

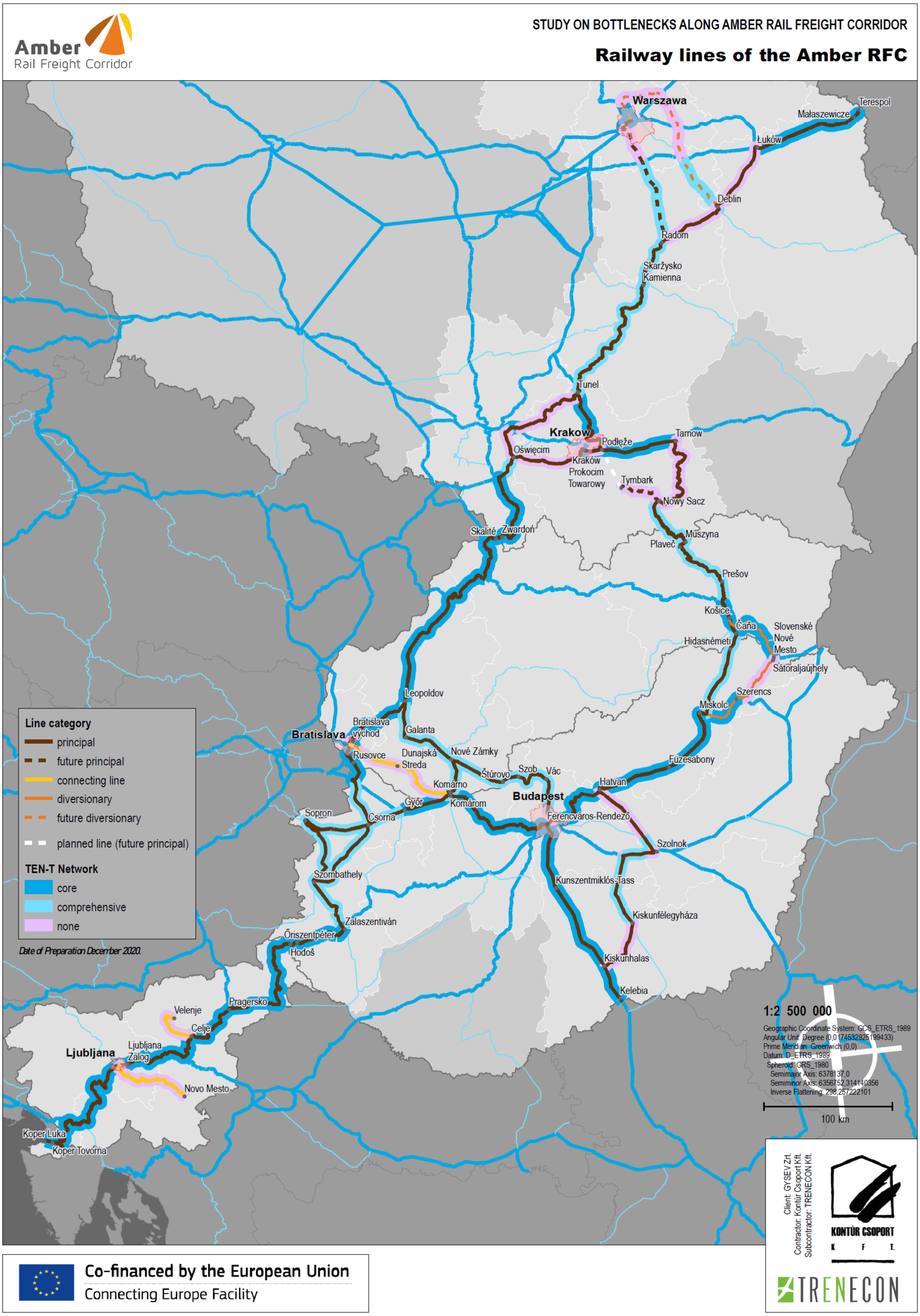


Figure 9: Railway lines of RFC Amber by line category and network role, including TEN-T network

4.3 National and operational borders

Along the corridor, as four countries are covered, several border crossings operate: two locations at the Polish-Slovak border, Zwardon (PL) – Skalité (SK) and Muszyna (PL) – Plaveč (SK); five at the Slovak-Hungarian border, Rusovce (SK) – Rajka (HU), Komárno (SK) – Komárom (HU), Štúrovo (SK) – Szob (HU), Čaňa (SK) – Hidasnémeti (HU) and Slovenské Nové Mesto (SK) – Sátoraljaújhely; and one at the Hungarian-Slovenian border, Őriszentpéter (HU) – Hodoš (SL). Each are inside the Schengen area of the European Union therefore traditional customs and border control is not done; the change in the country of operation and the railway operator requires administrative and very often physical activities both from infrastructure managers and railway undertakings. Additionally, as in Hungary there are two infrastructure managers, operator is also changed at Győr and Zalaszentiván (GYSEV and MÁV network).

Administratively the Corridor ends at the external borders of the EU member states: Terespol in Poland (border with Belarus) and Kelebia in Hungary (Serbian border) are the entry points to the territory of the EU while the oversea connection of the Corridor is the port of Koper in Slovenia.

4.4 Nodes (urban nodes, marshalling yards)

Nodes are listed in CID, also marked on e.g. CIP as nodes/junctions and handover points. Generally, many stations are considered node.

In the Bottleneck Study, the following are differentiated:

- Urban nodes (major cities and agglomerations) are important locations in terms of population, train traffic, trade and economic activities. Additionally, high passenger traffic, complex development requirements are present. Urban nodes are defined by TEN-T regulation.
- Operational nodes have special role by handling freight train traffic. They are consequently primarily the marshalling yards and the border stations/points. Efficient train handling and appropriate capacity is needed for efficient corridor operation.
- Terminals, ports etc. are not nodes of the RFC in themselves. These are, however, the sources and destinations of cargo. Last mile is important to offer high level of service, good connection to the corridor.

Based on TEN-T regulation and data of RFC Amber (from CID), the following nodes can be identified:

NODE	TEN-T regulation						Additional information	
	urban node	airport	inland port	maritime port	RRT	border crossing to neighbouring countries	marshalling yards (RFC Amber CID)	RFCs
SLOVENIA								
Koper				x			x (Tovorna)	5,6,10,11
Ljubljana	x	x			x		x (Zalog)	5,6,10,11
Celje							x (Tovorna)	5,6,11
HUNGARY								
Budapest	x	x	x		x		x (Ferencváros, Soroksári út r.)	6,7,9,11
Győr			x				x (Rendező)	6,7,9,11
Komárom			x				x (Rendező)	6,7,9,11
Miskolc					x		x (Rendező)	6,11
Sopron					x		x (Rendező)	6,7,9,11
Kelebia						x		11

NODE	TEN-T regulation						Additional information	
	urban node	airport	inland port	maritime port	RRT	border crossing to neighbouring countries	marshalling yards (RFC Amber CID)	RFCs
Hegyeshalom							x	7,11
Hatvan							x (Rendező)	6,7,11
Szolnok							x (Rendező)	6,7,9,11
Szombathely							x (Rendező)	11
SLOVAK REPUBLIC								
Bratislava	x	x	x		x		x (Východ)	5,7,9,11
Komárno			x				x (zr.st.)	7,9,11
Košice		x			x		x	11,9
Leopoldov-Šulekovo					x			5,11
Žilina					x		x (Teplička)	5,9,11
Nové Zámky							x	7,11
Štúrovo							x	7,9,11
Prešov							x	11
POLAND								
Katowice *	x	x			x			5,8
Kraków	x	x			x		x (Nowa Huta, Prokocim Towarowy)	11
Warszawa	x	x			x		x (Praga)	8,11
Małaszewicze / Terespol		x			x	x	x	8,11
Jaworzno Szczakowa							x	(5,) 8,11
Kielce Herbskie							x	11
Skarżysko Kamienna							x	11
Tarnów							x (Filia)	11

**Katowice is not on the RFC Amber lines but listed in CID*

Table 12: Nodes of RFC Amber proposed to be considered in the Bottleneck Study

4.5 Common Sections: overlapping and parallel RFCs

RFC Amber overlaps with some other RFCs, namely:

- **RFC5** - Baltic-Adriatic Rail Freight Corridor that connects the seaports in Poland and the Slovenian and Italian ports with their hinterland in Czech Republic, Slovak Republic and Austria. It overlaps with RFC Amber at the Katowice-Žilina-Leopoldov-Bratislava section in Poland and Slovak Republic and at the Pragersko-Zidani Most-Ljubljana-Divača-Koper section in Slovenia.
- **RFC6** - Mediterranean Rail Freight Corridor that runs from Algeciras in southern Spain to Záhony at the Hungarian-Ukrainian border, crossing France, Italy, Slovenia and Croatia. It overlaps with RFC Amber at several sections: at Pragersko-Zidani Most-Ljubljana-Divača-Koper in Slovenia (also with RFC5, see above), at Pragersko-Hodoš-Zalaszentiván in Slovenia and Hungary and at Budapest-Miskolc also in Hungary.
- **RFC7** - Orient/East-Med Rail Freight Corridor that connects the Baltic Sea and North Sea ports and the Black Sea and Aegean Sea, through the countries Germany, the Czech Republic, Austria, Slovak Republic, Hungary, Romania, Bulgaria and Greece. It overlaps with RFC Amber at several sections, too: at Nové Zámky-Szob-Budapest and at Bratislava-Rajka-Hegyeshalom in Slovak Republic-Hungary, at Nové Zámky-

Komarno-Komárom in Slovak Republic and at Sopron-Csorna-Győr-Komárom-Budapest in Hungary.

- **RFC8 –** North Sea-Baltic Rail Freight Corridor starts at the North Sea ports in Germany, the Netherlands, Belgium and runs in west-eastern direction to Poland, including Terespol at the Polish-Ukrainian border. It overlaps with RFC Amber at the Lukow-Terespol section in Poland.
- **RFC9** Rhine-Danube Rail Freight Corridor is the main east-west link in continental Europe along the Main and Danube rivers from Germany to the Black Sea. The overlapping sections include the Kysak-Košice-Slovenské Nové Mesto in the eastern part of the Slovak Republic and the Žilina-Svrčinovec section on the other branch. The corridor was completed with the extension of the Győr-Komárom-Budapest line in Hungary that overlaps with RFC Amber as well.
- **RFC10** – RFC Amber also has overlapping section with the Alpine - Western Balkan Rail Freight Corridor running from Austria through Slovenia to Slivengrad in Bulgaria at the Turkish border. This is the section of Pragersko-Zidani Most-Ljubljana.

As the list indicates, the area covered by RFC Amber is densely served by both north-southern and east-western connections. The network is quite heterogenous in terms of technical parameters and interoperability, though.

Figure 10: Rail Freight Corridors of the area (source: RNE)

Besides the fact that the corridors have joint sections, they are competitors to each other at some points, too, considering that there are parallel routes available between the same regions or economic hubs of the countries involved. The main competitors that offer alternative corridor route to RFC Amber is the RFC Baltic-Adriatic, and to a smaller extent RFC Mediterranean.

The RFC Baltic-Adriatic runs from Poland to the Adriatic ports, proposing alternative route for the Slovakian-Hungarian part of RFC Amber in Czech Republic and Austria. Its main bottlenecks are determined by the Alps and the agglomeration of the major Central-European cities such as Vienna and Bratislava, it offers, however, an attractive alternative route for freight forwarding between Poland and the Adriatic.

The RFC Mediterranean gives alternative routes of RFC Amber via the Croatian rail network (from the port of Rijeka) and other lines of the Hungarian network from the Adriatic to the Slovak border.

4.6 Legal framework, sector guidelines

The White Paper issued by the Commission on 28th March 2011 under number COM (2011) 144 (Roadmap to a Single European Transport Area – COM/2011/144) is one of the most important European transport policy paper basically defining the transport strategy of the Union for the 2030-2050 period. It calls for the establishment of a Single European Transport Area by eliminating barriers between modes and national systems, pursuing minimum service standards implementing a homogeneous transport infrastructure, preferably with uniform technical parameters.

The objective of European transport policy is to promote the establishment of a transport system that ensures high-quality mobility, thereby contributing to the improvement of the quality of life, to economic development in the increase of competitiveness. The paper claims that CO2 emission of transport shall be reduced by 2050 to 60% of that in 1990 and the performance of multimodal logistic chains (increasing rail freight service share) is of key importance. However, this emission target has been revised and a more ambitious one for transport has been set recently, The Green Deal Communication (European Green Deal) released in December 2019 by the Commission as a strategic roadmap for the long-term sustainable development of the EU has a strong focus on environmental and climate issues. A transport related endeavour of the paper is accelerating the shift to sustainable and smart mobility. Its specific targets for transport include a 90% GHG emission reduction by 2050 which can be reached by higher share of environmentally friendly railway transport. "*As a matter of priority, a substantial part of the 75% of inland freight carried today by road should shift onto rail and inland waterways. This will require measures to manage better, and to increase the capacity of railways…*"[2].

For competitive rail freight transport on that fully liberalised market the EU defined nine competitive European freight corridors (Regulation (EU) No 913/2010) that was later extended to eleven claiming the good quality railway infrastructure, consistency and continuity of infrastructure along the corridor is a precondition for competitive international rail freight service. The freight corridors require good coordination between member states and infrastructure managers, adequate links to other modes of transport in order to contribute to policy objectives. In 2012 the EU established a single European railway area (Directive 2012/34/EU) claiming that the integration of the transport sector is essential for

[2] COMMUNICATION FROM THE COMMISSION COM(2019) 640 Brussels, 11.12.2019

the completion of the internal market, and railways need to be improved also to move towards sustainable mobility. To achieve efficient and competitive railway transport, fair competition of railway undertakings is ensured and rules on management of infrastructure, setting charges and allocation of capacity and rail transport activities are set.

The Technical Specifications for Interoperability (TSI) were designed and published to set the standards for each subsystems of the railway system to ensure interoperability of national systems, safety, reliability, technical compatibility, accessibility. Requirements for infrastructure TSI compliance, interoperability on the TEN-T network (for core and comprehensive network elements by 2030 and 2050) shall be met according to Regulation (EU) No 1315/2013 to establish seamless, sustainable mobility of persons and goods for all regions of the EU (single transport area) with the implementation of projects with common interest.

The Forth Railway Package was introduced in 2016 to boost competitiveness and thus completing the single European railway area. Its technical pillar is aimed at reducing administrative burden on railway undertakings, improving interoperability (reducing national rules on railway safety, creating one-stop-shop a single entry-point for all applications, interoperable ERTMS).

By establishing the Connecting Europe Facility (Regulation (EU) No 1316/2013) the EU made financial commitments to accelerate investments in trans-European networks that supports among others, the implementation of the single railway area, creation of efficient infrastructure networks, among others to reduce bottlenecks, enhance cross-border interoperability of railways.

The ERA (European Union Agency for Railways) was established to contribute to the implementation of EU policy objectives, functioning of the single European railway area and facilitate cooperation among member states. The institutional, legal framework ensure efficient harmonisation, multimodal integration for single market.

RailNetEurope (RNE) set up by infrastructure managers, allocation bodies in 2004 is an international umbrella organisation that help to meet the challenges of international rail sector and promote rail traffic in Europe in collaboration with ERA. RNE provides support, develop harmonised processes, compiles handbooks, issues guidelines, develops IT tools to help members and market players in information exchange, enhancing business processes. The services and activity of RNE contributes to the performance of rail freight corridors, their operational performance.

The Sector Statement "Boosting international rail freight" (2016) representing the interests of a range of market players made a commitment to enhance competitiveness of RFCs and identifies the issues, focus areas to be addressed in the field of capacity availability, operational efficiency, competitiveness (reliability, dialogue with RUs). Good functioning, better performance of RFCs can make a great contribution to the achievement of transport policy and sustainability goals of the EU.

Relevant legislation:

- Interoperability Directive (Directive (EU) 2016/797)
- REGULATION (EU) No 913/2010 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 22 September 2010 concerning a European rail network for competitive freight
- Directive 2012/34/EU establishing a single European railway area
- Commission Delegated Decision (EU) 2017/2075 replacing Annex VII to Directive 2012/34/EU

- DIRECTIVE 2001/14/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 26 February 2001 on the allocation of railway infrastructure capacity and the levying of charges for the use of railway infrastructure and safety certification
- REGULATION (EU) No 1315/2013 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 11 December 2013 on Union guidelines for the development of the trans-European transport network and repealing Decision No 661/2010/EU
- REGULATION (EU) No 1316/2013 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 11 December 2013 establishing the Connecting Europe Facility.
- Commission Regulation (EU) 2015/995 and its future revision: Technical specification for interoperability for operation and traffic management. Member States have the legal obligation to develop their National Implementation Plans and report on the progress regarding achievement of OPE TSI compliance.
- Regulation (EU) 2019/554 amending Annex VI to Directive 2007/59/EC with regard to language requirements for train drivers
- Commission Implementing Decision amending the multiannual work programme 2014-2020 on the financing of the Connecting Europe Facility -Transport sector 12 April 2019 C(2019) 2743 final
- DIRECTIVE (EU) 2016/798 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 11 May 2016 on railway safety
- Ministerial Declaration: Rail Freight Corridors to boost international rail freight (TEN-T RFC conference, Rotterdam, 21st June 2016)
- Frameworks for Capacity Allocation (Decision of the Executive Board of Amber Rail Freight Corridor adopting the Framework for capacity allocation on the Rail Freight Corridor)

RNE handbooks, guidelines:

- Handbook for international path allocation
- Handbook for International Late Path Request Management
- Handbook for Ad-Hoc Request Management
- Handbook for International Path Modification Management
- Handbook for International Path Alteration Management
- TCR Guidelines (Guidelines for Coordination / Publication of Planned Temporary Capacity Restrictions for the European Railway Network)
- PCS Process Guidelines
- RNE Framework for setting up a Freight Corridor Traffic Management System
- Guidelines for the cooperation and communication between Traffic control centres 2014
- Guidelines for C-OSS concerning PaP and RC Management
- Guidelines for Train Performance Management on Rail Freight Corridors
- Handbook for International Contingency Management – ICM Handbook, RNE

Sector Statements

- Boosting International Rail Freight - Sector Statement, on RFC, 20 May 2016
- Continued efforts to boost international rail freight Outlook on the ‘Sector Statement’ 6 December 2018

5 Infrastructure characteristics on RFC Amber

In harmony with the Regulation (EU) No 1316/2013 of the European Parliament and of the Council, establishing the Connecting Europe Facility, bottleneck means a physical, technical or functional barrier which leads to a system break affecting the continuity of long-distance or cross-border flows and which can be surmounted by creating new infrastructure, or substantially upgrading existing infrastructure, that could bring significant improvements which will solve the bottleneck constraints.

In terms of infrastructure, bottleneck can be referred to as line sections or infrastructure elements where the requirements of efficient and interoperable train forwarding are not met. The requirements against which infrastructure and the deficiencies (bottlenecks) are generally assessed are the train length, axle load, speed, ERTMS, electrification, gradient, loading gauge and axle load or linear load bearing capacity.

5.1 Railway corridor infrastructure requirements

The essential requirements of the infrastructure can be summarised as safety, reliability and availability, technical compatibility and accessibility – interoperability in one word.

Technical specifications for interoperability (TSI) define the technical and operational standards which must be met in order to satisfy the 'essential requirements' and to ensure the 'interoperability' of the European railway system. TSIs also set out expected performance levels. While the TSI apply to the entire TEN-T Network, including core and comprehensive network in the case of new construction and modernisation, the TEN-T Guidelines (Regulation (EU) 1315/2013, (Article 39(2a)) provides for the compliance of the core network elements with the basic line parameters to be met by 2030 in correspondence with the White Paper on Transport of the European Union.

TSIs are intended to foster the development of a single European railway system and therefore they apply to all mainline railways within the European Union. The formal definition of interoperability in the Interoperability Directive 2008/57/EC is "*the ability of the rail system to allow the safe and uninterrupted movement of trains which accomplish the required levels of performance*".

Interoperability requirements means the minimum infrastructure requirements along the corridors (primarily compliance with the TEN-T line parameters). The requirements depend on the traffic characteristics of the line. However, considering the efficiency of the freight transport, the most important parameters for freight trains are in line with the TEN-T Guidelines:

- Traction mode: full electrification
- Train length: possibility to run 740m at least (along the lines incl. stations to handle trains and manage traffic)
- Axle load: at least 22,5t (i.e. in combination with 8,0 tons/m meter-load requirement: UIC Line Class D4)
- Line speed for freight trains: at least 100 km/h
- Signalling: full deployment of ERTMS

Based on RFC Amber RAG interviews, some additional parameters should be met to make the train forwarding efficient and competitive for RUs:

- Intermodal loading gauge: P/C 400 (possibility to forward hi-cube containers and semi-trailers without restrictions)
- Maximum gradient: ≤12,5 ‰ (less is favourable as it highly influences train length and/or locomotive performance)

The line section parameters of RFC Amber are assessed against these characteristics, requirements.

5.2 Issues of the general route structure, network topology

5.2.1 General routing issues

As network bottlenecks are considered such bottlenecks which are related to the (geographical) structure of the network of lines designated to the RFC, rather than the state of the infrastructure per se. A corridor section may very well provide an infrastructure of high standard, possibly even fulfilling or being close to fulfilling the TEN-T and TSI requirements but may require trains to make major detours due to the routing of lines or may require trains to change travelling direction due to the lack of connecting curves.

These network bottlenecks may not always be easy to eliminate in a foreseeable future, since the geographical alignment of railway lines can often not easily be changed. Nonetheless it appears relevant to identify these network bottlenecks, so that they can be taken into account in the long-term plans for the development of the railway networks. To some extent this is also the case already (see also chapter 1.5.2), but not all of these bottlenecks are fully addressed yet by current infrastructure plans.

Corridor sections in RFC Amber constituting network bottlenecks, in the sense of the above definition, are the following:

1. Eastern Slovenia – Western Hungary: between Pragersko and Szombathely the rail distance is with 207 km almost 75% longer than the distance as the crow flies (119 km).
2. When looking at the sections in the two countries separately, the rail distance Pragersko – Hodoš/Őriszentpeter border is with 110 km ca. 60% longer than the distance as the crow flies (68 km); the rail distance between Hodoš/Őriszentpéter border and Szombathely is with 98 km ca. 92% longer than the distance as the crow flies (51 km).
3. Southern Poland: Between Podłęże (near Kraków) and Nowy Sącz the rail distance is with 147 km 158% longer than the distance as the crow flies.
4. Western Hungary – Slovakia: Freight trains between the Slovenian-Hungarian border and key destinations in Southern Slovakia (Dunajská Streda) have to change their travelling direction up to three times – in Zalaszentiván, Komárom and Komárno – over a distance as the crow flies of only ca. 130 km.

Naturally, relief and other terrain and natural characteristics also influence the topology and parameters of the RFC Amber lines, the alignment (curve radiuses) and track gradients are determined at these areas, in the mountainous regions of Southern Poland and North-Eastern Slovakia (by the Carpathian-mountains) and in Southern Slovenia (by the Alps).

The above issues weaken the competitiveness of rail freight towards other transport modes, but also have the potential to weaken the competitiveness of the route via RFC Amber versus alternative routes. Thus, measures to maintain and strengthen the competitiveness of RFC Amber should take into account its current network bottlenecks.

5.2.2 Line topology and route structure

Especially, in the middle section of the corridor between the Hungarian-Slovenian border and Southern Slovak Republic trains need to change travelling direction several times within relatively short distances; between Hodoš at the SI-HU border and Dunajská Streda in Slovak Republic – an important source/destination of traffic on the corridor – trains have to change their travelling direction three times over a straight-line distance of less than 160 km, in Zalaszentiván, Komárom and Komárno, and twice (in Zalaszentiván and Bratislava) when travelling via Rajka. Each change of travelling direction involves time losses and a number of operational processes: requires uncoupling of locomotives, locomotive turnrounds, re-coupling and (simplified) brake tests, leading to considerable time losses. This situation reduces the competitiveness of the corridor. The situation could be solved by building triangle tracks. One, in Zalaszentiván, is already planned, but not implemented yet.

Similar locations are present in Poland, at e.g. Tunel, where train direction change is needed at some origin-destinations, however, not on the routes of the main traffic flows (minority of the trains need to be reversed actually). In Slovenia, at Celje tovorna and Ljubljana, there is also a need for direction change towards the connecting lines of the RFC Amber (to Velenje and Novo Mesto). But on the one hand the connecting lines are not electrified therefore locomotive change is imperative, on the other hand there are no direct trains typically to these lines hence the composition of trains is done on the junctions.

Further north along the corridor rail traffic is hampered by the fact, that there are only relatively few rail border crossings across the Slovak-Polish border, which are located far apart, and the track alignment is rather curvy and of relatively low standard. This is partly related to the historical genesis of the rail network in the region concerned. It would be important to overcome these historically inherited limitations in order to fully exploit the potential of rail freight between Poland and Slovak Republic respectively this part of RFC Amber.

RFC Amber connects to the Euro-Asian rail landbridges with interfaces to the broad gauge-system (1520 mm) at three locations, Terespol (PL) and Košice (SK) and additionally at Sławków Euroterminal (PL) where a long wide gauge rail line ends in Poland. Train operations include transshipment of cargo which is a time consuming and costly activity affecting the mode choice of shippers.

These special locations are mapped together with stations, marshalling yards and border crossings.

5.3 Assessment of current line infrastructure parameters

The parameters of the RFC Amber lines are rather heterogenous, partly due to different national standards applied when the infrastructure had been built (long before the EU interoperability objectives were defined), partly due to different network role, age and condition of the infrastructure. All in all, only a small proportion of the corridor currently fulfils the TEN-T and TSI requirements – and only a part falls under the TEN-T and TSI obligations since more than 500 km line of the RFC Amber lines are not part of the TEN-T network.

In the following chapters the major parameters are presented and assessed against the EU declared requirements and also the Railway Undertakings expectations.

5.3.1 Traction, power supply

Traction for freight is a key parameter, electrification has significant advantages on train forwarding efficiency. Diesel traction is severely disliked compared to electric traction. RUs usually and, if it is possible, choose routes that are electrified even if the route is longer (in length or in transport time as well).

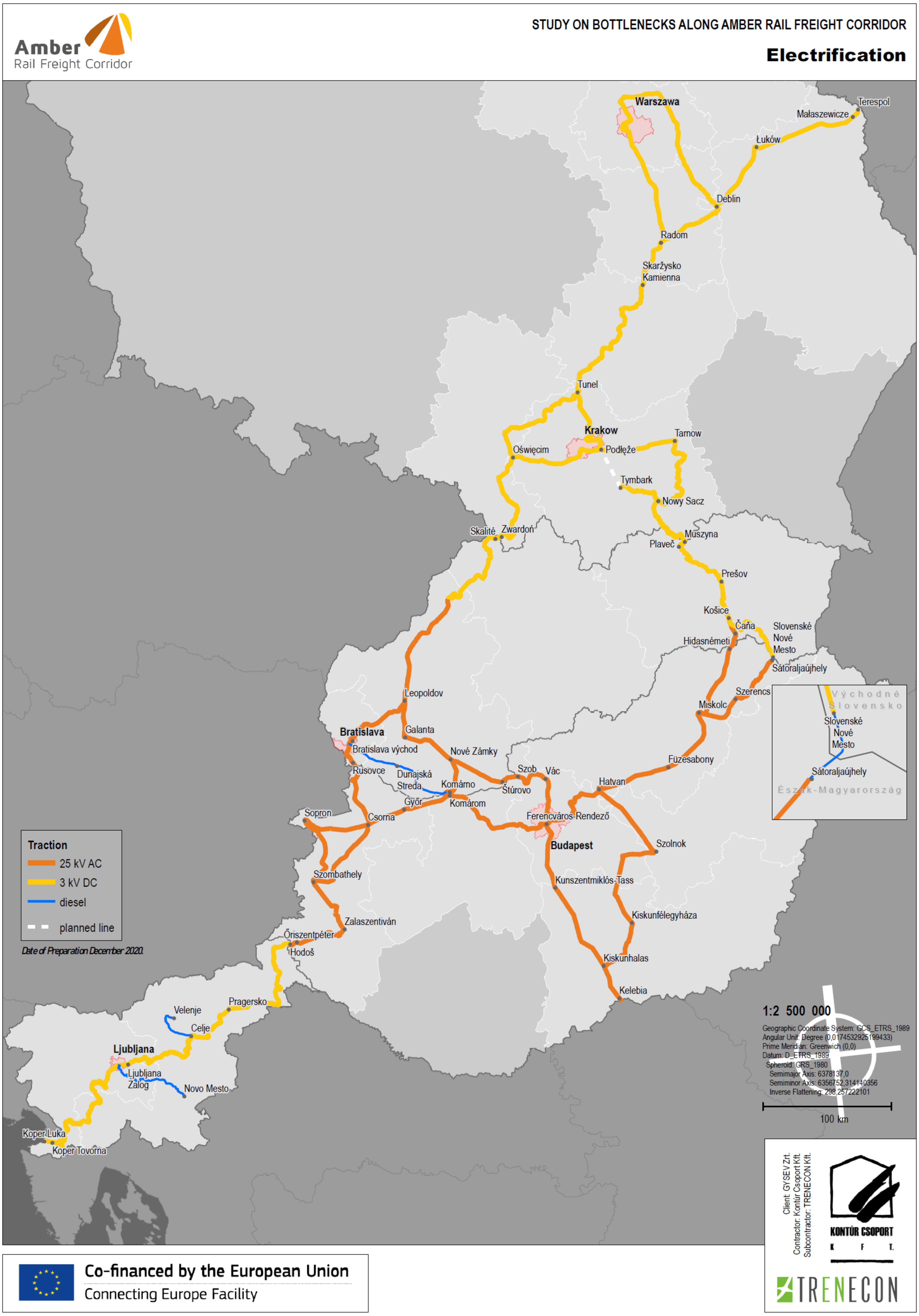


Figure 11: Traction along RFC Amber

As shown, majority of RFC Amber is electrified, and it is 100% applicable to the principal routes of the corridor. The non-electrified sections are as follows:

- Komárno – Dunajská Streda – Bratislava Nové Mesto in Slovak Republic that is a connecting line of app. 92 km, serving mainly the industrial area and terminals at Dunajská Streda,
- Slovenské Nové Mesto – Sátoraljaújhely at the Slovakian-Hungarian border that is a diversionary route, length of the diesel traction section is only app. 2 km,
- Celje – Velenje and Ljubljana – Novo mesto lines of Slovenia, both are connecting lines of 38 and 76 km separately, serving primarily two important factories of the Slovenian economy.

These diesel traction sections, as connecting or diversionary lines, do not hinder directly the train forwarding possibilities along RFC Amber but make the service on connecting lines' logistics facilities and train re-routing less efficient (traction change is needed).

However, it is an additional and also important issue that there are two power systems used in the member states: 3kV DC and 25kV AC. Poland, partly Slovak Republic (in northern and eastern areas) and Slovenia use the 3kV DC current and south-western Slovak Republic and Hungary the 25kV AC. This requires loco change at traction borders or rather using bi-traction locos by railway undertakings, also reducing the efficiency of train forwarding (higher rolling stock and personnel costs, higher train forwarding times).

5.3.2 Number of tracks

As described, there is no direct requirement for the number of tracks along the TEN-T network or the RFC lines. It has, however, significant impact on the capacity and on the traffic management possibilities which makes this parameter important in terms of level of service and train forwarding time or speed (i.e. priority issues of freight trains in urban areas).

On RFC Amber, 2073 km is double track section in total, that adds up to 55% of the lines. Double track is built mainly on the sections where the total train traffic is high, mainly due to frequent passenger train services; consequently, the double track sections are on lines around urban nodes, having significant suburban importance, or between the major cities, serving long distance traffic. By nature, the double track sections overlap, however, not exclusively, the TEN-T (core) network of the member states.

Some sections are planned to be upgraded, including building of a second track, to improve capacity, e.g., Budapest-Kelebia, Koper-Divača , Győr-Sopron; besides, the new Podłęże - Tymbark section, future principal line in southern Poland is planned to be double track, too.

The number of tracks is in connection with available capacities, all double track lines has more than double capacity compared to single track lines and its flexibility is much higher in the traffic management.

Even though capacity problem is more common on single track sections, due to generally higher traffic on double lines the free capacity is also limited at some points. The problem is only moderate in general, though, except some sections, most crucially on the Ljubljana-Divača section in Slovenia (see capacity issues in chapter 6.1)

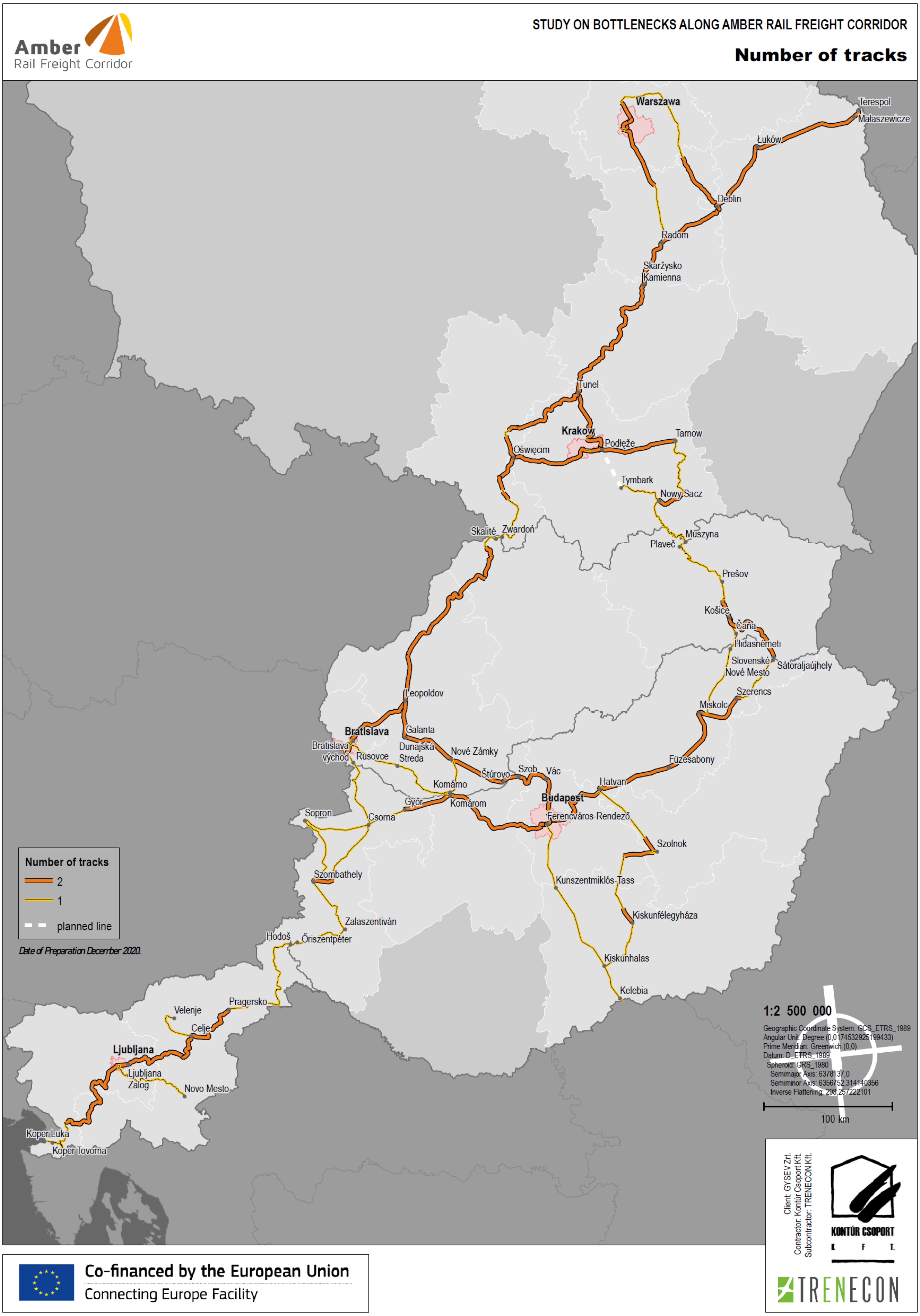


Figure 12: Number of tracks along RFC Amber

5.3.3 Train load category

The favourable parameter is UIC D4 category that means 22.5 tons/axle load and in parallel 8 tons/meter linear load bearing capacity of the track.

The Load Classes are as follows:

UIC axle load classification	A	B	C	D
Load per axle, t	16 t	18 t	20 t	22.5 t
Linear load, t/m				
5.0 t/m	**A**	**B1**		
6.4 t/m		**B2**	**C2**	**D2**
7.2 t/m			**C3**	**D3**
8.0 t/m			**C4**	**D4**

Table 13. Axle load classification

Newly constructed or reconstructed line sections are usually built to fulfil this requirement, older infrastructure, however, often allows lower train load.

In total, only 971 km, 26% of RFC Amber allows D4 axle category. If we also consider D3 category, allowing 22.5 tons/axle and 7.2 tons/meter, categories D3 and D4 add up to a total of 2100 km (56% of total RFC Amber network).

Most impacted, disadvantageous sections of RFC Amber in terms of load bearing capacity are:

- in Poland, majority of the corridor is D3 (22.5 tons/axle but lower linear load), except in the southern regions; the Tymbark-Nowy Sącz section is out of operation currently, the seriously deteriorated line allows lower than 16 tons/axle (planned to be fully reconstructed, though),
- in Slovak Republic, only the Dunajská Streda-Bratislava line section is lower than 22.5 tons/axle
- in Hungary, the situation is the opposite, only some sections are D3-D4, the eastern and southern lines (Hatvan-Miskolc-Hidasnémeti some sections of the Miskolc-Sátoraljaújhely section, Hatvan-Cegléd-Kiskunhalas diversionary route and Budapest-Kelebia) are mainly 20-21 tons/axle only, with the option to run 22.5 tons axle load trains as a special consignment with speed restrictions in most cases, and it has the same value on the main line of the western branch of RFC Amber, namely the Rajka-Szombathely-Zalaszentiván route,
- in Slovenia, the corridor is fully appropriate for 22.5 tons/axle, except the two connecting lines to Velenje and Novo mesto.

Consequence of lower allowed axle load results in lower train loading limits, therefore worse, less efficient utilisation of rolling stock. The lower axle load causes more wagons to use, compiling longer trains – if train length is not limited on the line which is also a common problem for RUs.

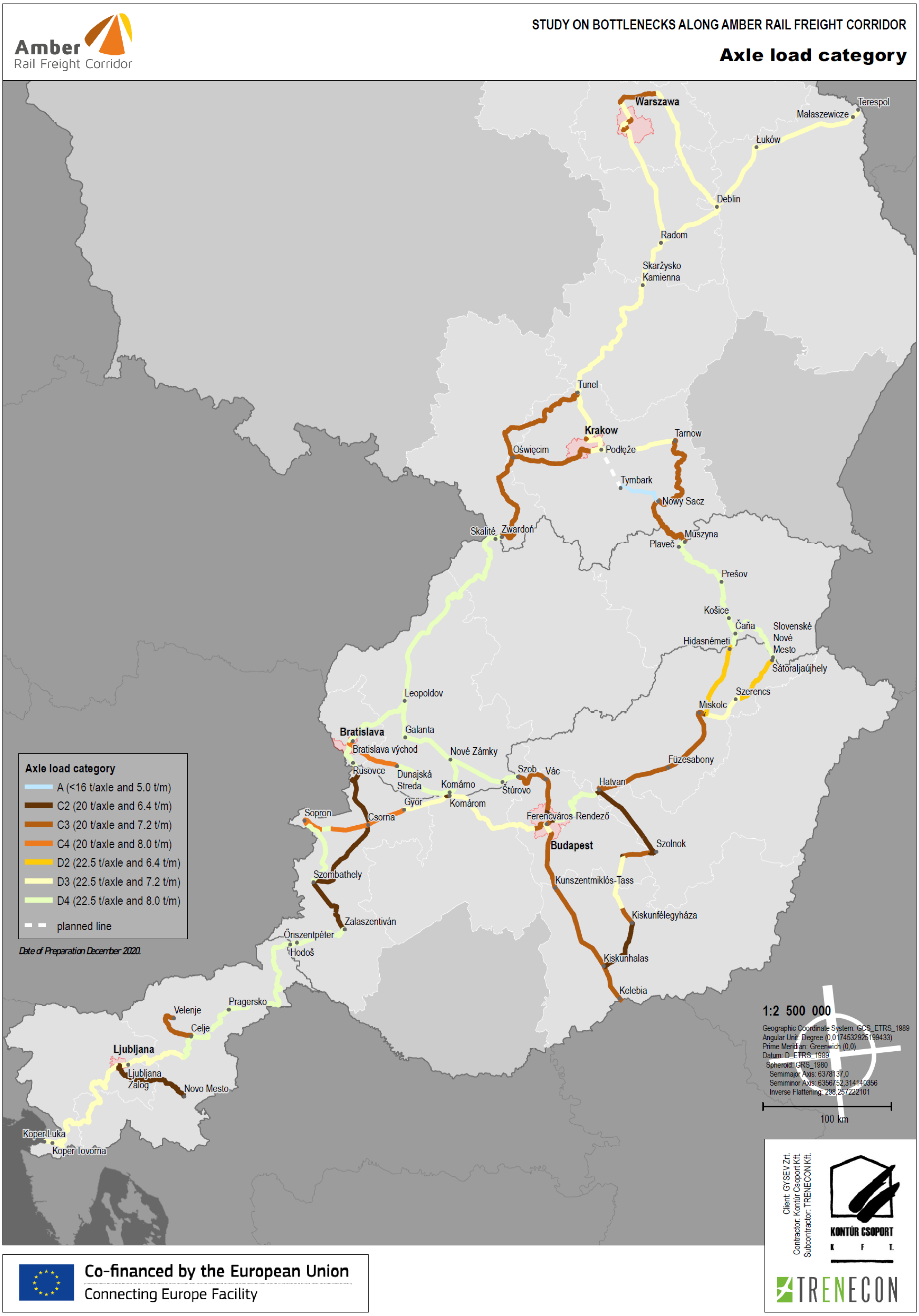


Figure 13: Axle load category along RFC Amber

5.3.4 Gradient of track and maximum train length

The inclination of the track is also a factor of efficiency for the freight train operators (railway undertakings) as a steeper line or route needs shorter and lighter trains to be composed or employing additional locomotive for the highest gradient sections. Both option results in additional freight forwarding cost for users of the infrastructure. TSI defines <12.5‰ gradient as a maximum but even 9‰ can be too high for RUs; ideal situation would be below 4.5-5‰.

The maximum gradient can be, however, considered as a 'hard constraint' on the network. It can be changed only by appointing new, diversional routes, tunnels or a new line section to be built on an alternative route having lower inclination.

Most impacted, disadvantageous sections of RFC Amber are influenced by the Carpathian Mountains and the Alps in the southern end:

- in Poland, strongly on the southern line sections, south from Bielsko-Biala, Tarnów, the section Kraków Bonarka-Oświęcim, these are the steepest sections of the Corridor, climbing often by 20-25‰; planned section from Podłęże to Tymbark is planned to be a much preferable alignment in terms of gradient, too,
- on the connecting lines in Slovak Republic, from Zwardon-Skalité border towards Žilina (28‰, at some point); and the eastern branch of the RFC almost fully (Plaveć-Kosice-Slovenské Nové Mesto), being 15-20‰ steep at some point,
- Hungary is typically flat terrain, majority of the corridor lines are below 9‰, except Vasvár-Pácsony section (13.6‰) and the Zalaegerszeg-Őriszentpéter/Hodoš line towards Slovenia (short sections are also problematic, e.g. at Sopron-Rendező station approach track, but these can be considered as local issues),
- in Slovenia, the Divača-Koper section, that has, being single track connection to the Adriatic port, capacity problems otherwise, is 20‰ (the second track is therefore will be constructed on new alignment, many tunnels, to avoid high gradients),

Only approximately one fourth of the 3744 km total length of RFC Amber is lower than 4.5‰ that would be ideal for RUs. Further statistics are not made of this parameter, however, as the steeper direction (higher gradient) of the line was always considered and longer sections are used in the GIS mapping software that present the data on maps, the steep section is always much shorter than the section in the GIS (sometimes only in one or two places on the entire section in the map).

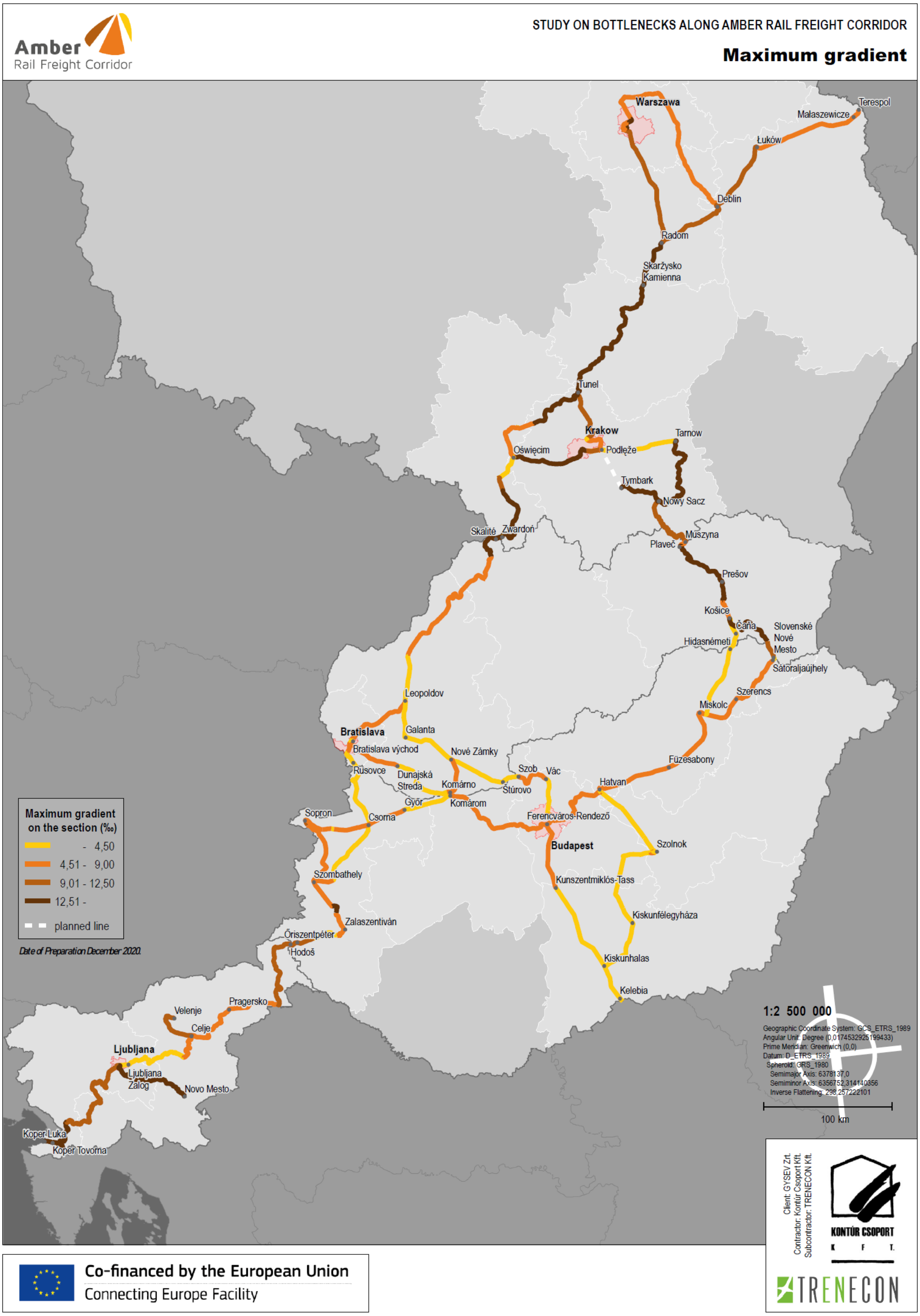


Figure 14. Maximum track gradients along RFC Amber

As mentioned, this parameter has direct impact on maximum weight and maximum length of trains, influencing the efficiency of train forwarding (additional locomotive or train division is needed).

Therefore, the maximum length of train, being also a TEN-T requirement (740m as a minimum), is presented here, together with gradients.

It is to be noted, that cargo companies highlight that a train length of 740 m is still sub-optimal. In many cases even longer trains would be preferable or efficient that underlines the importance of implementing at least 740 m train length along the corridor.

Based on the Network Statements published by IMs, the sections that allows more than 740m long trains to run cover approximately 28% of the corridor (1062 km) only. Majority of the Corridor, 3285km (88% out of the 3744km total length) allows >600m train length, though, except the below listed sections.

These are the most impacted, disadvantageous sections of RFC Amber (map is shown on next page):

- those that were mentioned at the gradient at southern Poland and northern Slovak Republic, crossing the Carpathian Mountains; on Polish sections the terrain and alignment allow a train length of lower than 400m on the Bielsko-Biala-Zwardoń and Tymbark-Nowy Sącz sections,
- in Slovak Republic, Dunajská Streda-Komárno section where the max. train length is below 300 m – this section is hardly appropriate for efficient freight train forwarding,
- in Slovenia, Ljubljana-Pragersko section, being a core element of the Amber and also other RFC corridors, is restricted to 570-600m train length and the beforementioned Divača-Koper section to 525m. Besides, connecting lines to Velenje and Novo mesto are applicable for only 450-460m long trains.

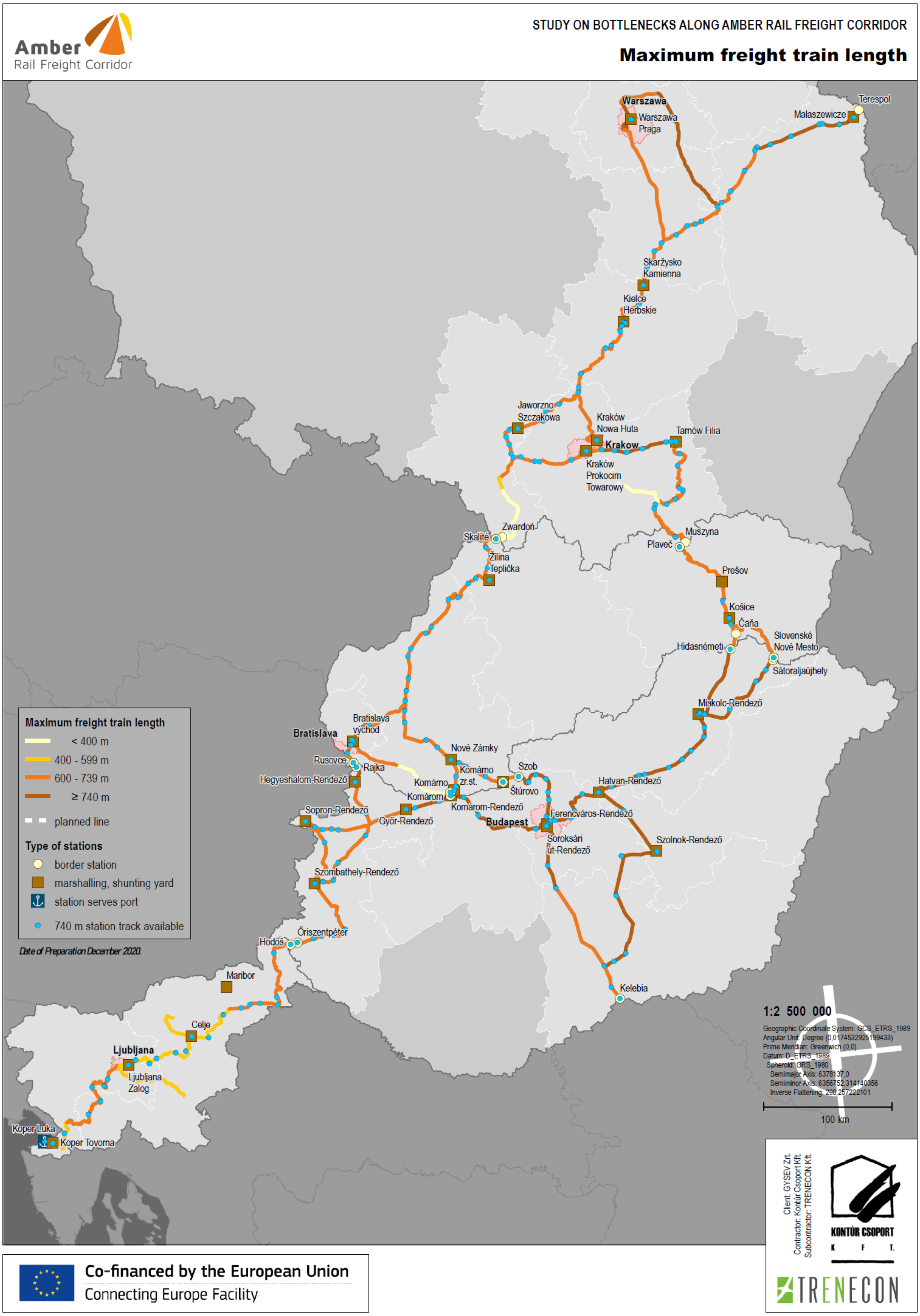


Figure 15: Maximum train length along RFC Amber

The train length is also a major parameter for stations along the lines as traffic management and capacity often requires freight trains to stop to allow train overtaking or crossing in opposite direction. If there is no available capacity of at least 740m long stations tracks (with appropriate load bearing capacity, power supply etc.), freight trains cannot be allowed on longer sections. This results significant waiting times at major nodes (marshalling yards, stations) or at the border crossings.

Stations are presented in chapter 7.5.

5.3.5 Train speed

Line speed and restrictions are presented together in this point. Regarding line speed, TEN-T requires 100km/h as a minimum; this would be acceptable and appropriate for railway undertakings, too (other factors that significantly influence transport speed and time are generally more important and determinant). Note, that punctuality of trains is of priority for customers over line speed.

In total, 2253km of the RFC allows not less than 100km/h speed for freight trains, what adds up 60% of the lines. As map on the next page presents, line speed itself is not significant issue in Slovak Republic and Hungary, majority of the lines are (considering design speed!) allows a competitive speed for freight train operators.

This is not the case in Slovenia and Poland, partly due to the impact of the terrain and alignment, as mentioned previously at e.g. train length:

- in southern Poland, primarily impacted by the Carpathian Mountains, the train speed is generally below 80km/h (south from Katowice and Tarnów), and this is also the case north from Radom, towards Warsaw, on the planned (future) principal line,
- similarly, in Slovenia, terrain of the eastern Alps influence track alignment, gradient and curves first of all, causing that the Koper-Divača section appropriate for 75km/h, the connecting lines only for 60-65km/h.

To add information on the actual speeds on the infrastructure, not only what was designed and authorized, the second map below shows the restrictions that are valid currently along the Corridor lines, focusing on those limits that can be considered "permanent" (meaning not temporary restriction), meaning that they are in force for a long period and included in timetables (as classified by infrastructure managers). The restrictions are divided to and presented using two categories: 'justifiable' and those that 'needs elimination', based on the reason behind. First category contains reasons of track geometry or local facility (such as a scanning station); second category is due to e.g. bad technical condition of the track or object, limited visibility at road crossing and missing train management system at some point.

Deteriorated infrastructure, bad condition of the track causes very often serious speed limits, 20-40km/h is common. These problems on the infrastructure needs elimination by infrastructure managers as soon as possible. As informed by ŽSR Slovakian Railways, permanent speed limit is not in effect on the Slovakian network, speed restrictions due to unsatisfactory track conditions are removed rather promptly. However, permanent speed restrictions caused by the layout, track geometry are also present on Slovakian network e.g. between Žilina and Žilina zriaďovacia stanica (marshalling yard) where there is 40km/h limitation.

These types of limitations are much more expensive and complex to reduce or relieved, the transport time reduction along RFC Amber could profit from their elimination, too.

Note for the map on restrictions presented below: by nature, speed limits are usually valid only on short sections of the lines (at an object or a structure, at stations, e.g. on the switching zone, in a curve etc.), not the full sections included in the GIS software.

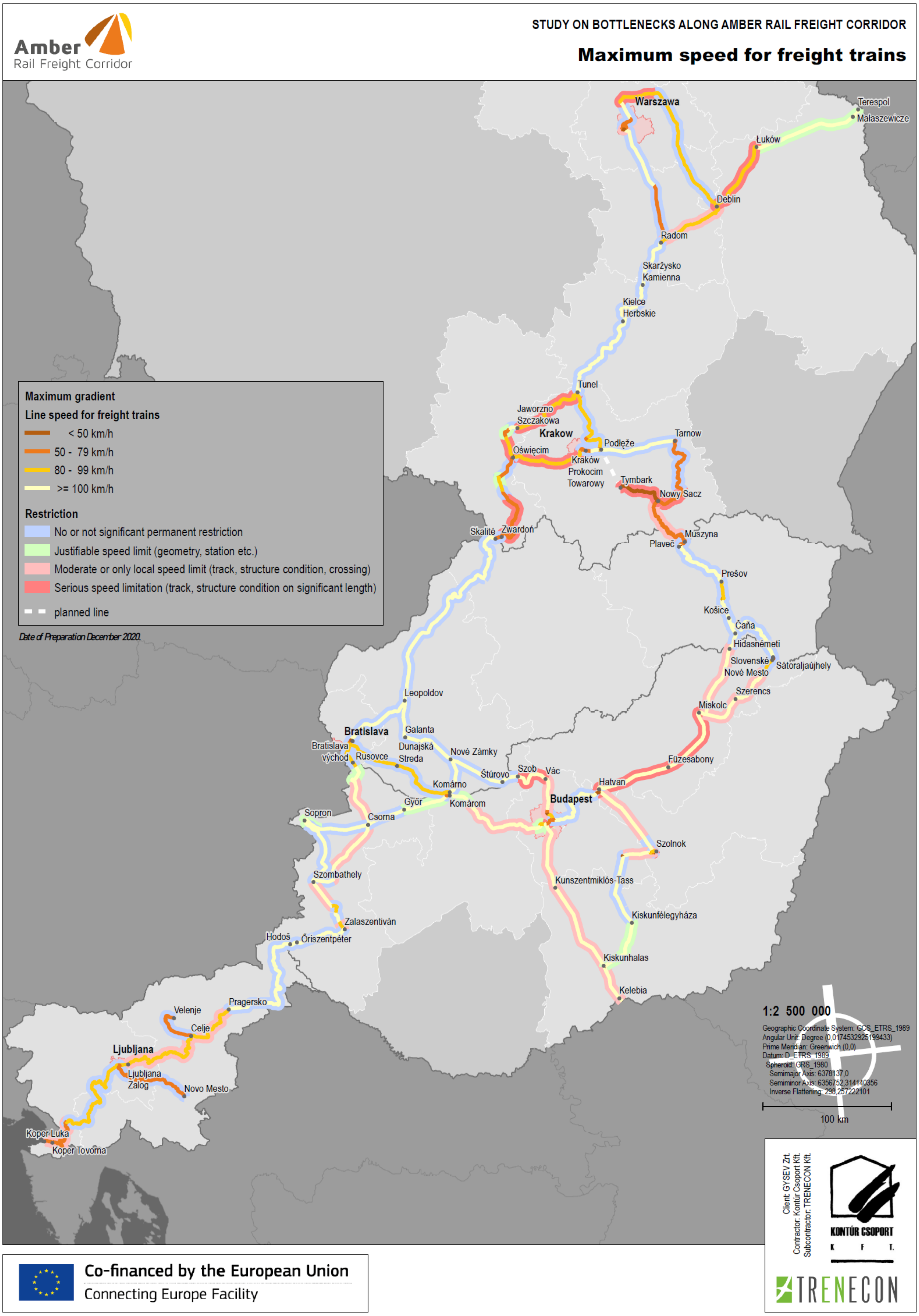


Figure 16: Line speed for freight trains and the speed restrictions along RFC Amber

5.3.6 Train control and ERTMS

ERTMS System Required Specifications (SRS) is one of the specific technical requirements of TSI. The vision of interoperable rail network in the EU requires the installation of ETCS (European Train Control System) along the trans-European lines, including on-the-line equipment and on-board ones on the locomotives. Currently ETCS Level 1 and Level 2 are in use, communication platform for the latter is GSM-R (GSM-railways). It is frequent in the member states that GSM-R is installed along the lines and ETCS L2 is deployed in a later phase only. Build or version of the ETCS system is not homogenous either that can also cause compatibility issues between sections or countries.

TEN-T guideline requires ETCS to be used to ensure interoperability, however, as it will be mentioned later, RUs do not require or demand ERTMS as a priority, at least until other infrastructure parameters decrease their operational efficiency much more. Besides, as national systems are usually also required to be installed and used on their rolling stock, it inefficiently supports interoperability and setup of the single European rail area from their perspective.

As the map below shows, minority of the RFC Amber lines are equipped with operational ETCS and GSM-R. The coverage is best on the Slovenian network, where ETCS L1 is installed from Koper to Hodoš; and in Slovak Republic, where the Bratislava- Žilina section has also L1 in operation (except for a small segment Púchov – Považská Teplá, where L1 will be in operation by 2023); from Žilina to Čadca L2 is in operation. These sections are those that are overlapped by other RFCs.

However, at many sections there are ongoing projects or short-term plans to install ETCS and/or GSM-R – these are mainly on TEN-T core sections of RFC Amber as financing source is generally the Connecting Europe Facility. The planned projects are included in the table of line bottlenecks and presented in detail in Section 9.2.3.

A future issue can be after the realization of planned developments, however, that there is no homogenous installation plans regarding ETCS L1 or L2 that can also result in difficult adaptation by RUs and failure to achieve interoperability in terms of train management systems. Cause is that at many sections in Poland ETCS L1 is planned to be installed in the future and in Slovenia operating L1 systems also remain in operation in the future, they are not planned to be upgraded. Meanwhile Slovak Republic and Hungary runs L2 system deployment projects solely. The two levels of ERTMS are not fully compatible, i.e. locomotive on-board units for L1 are not L2-ready therefore RUs need multiple OBUs installed for interoperable train operation along the RFC Amber.

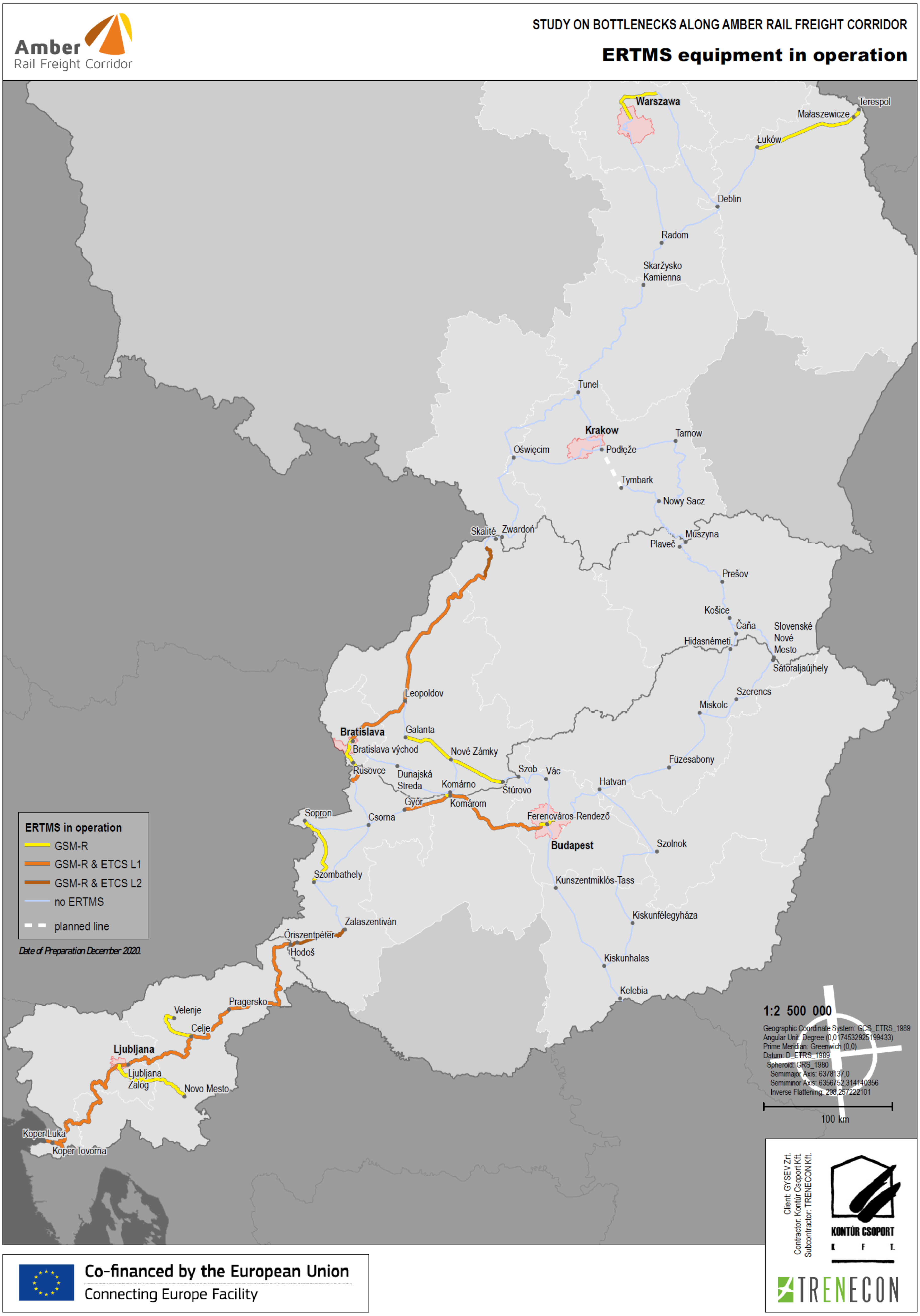


Figure 17: ERTMS systems in operation along RFC Amber

5.3.7 Loading gauge

Based on data collection phase, loading gauge is not specified identically by the IMs, UIC code system is not in standard use either. Therefore, this parameter is assessed based on the requirements of the users.

Considering primary demand from the RU side, as cargo types are changing, the hi-cube containers' requirement would be the minimum to meet. It is 2896 mm/9'6" in height that is 1' higher than the standard container (GA loading gauge is appropriate considering UIC categorisation). As used in the intermodal freight code, P/C 80/400 can be an ultimate minimum requirement to be fulfilled, meaning that a train carrying hi-cube containers can run on the corridor without restrictions.

It is a general issue for RUs in most of the RFC Amber member states, irrespectively of physical clearance or structure gauge of the lines, that both in Poland and in Hungary, although there are no general size restrictions, high-cube (HQ) containers are considered exceptional goods or oversized cargo, consequently ad-hoc permission is required causing administration duties for RUs. In these cases, RUs have to contact IMs or ABs to get the permission for the path.

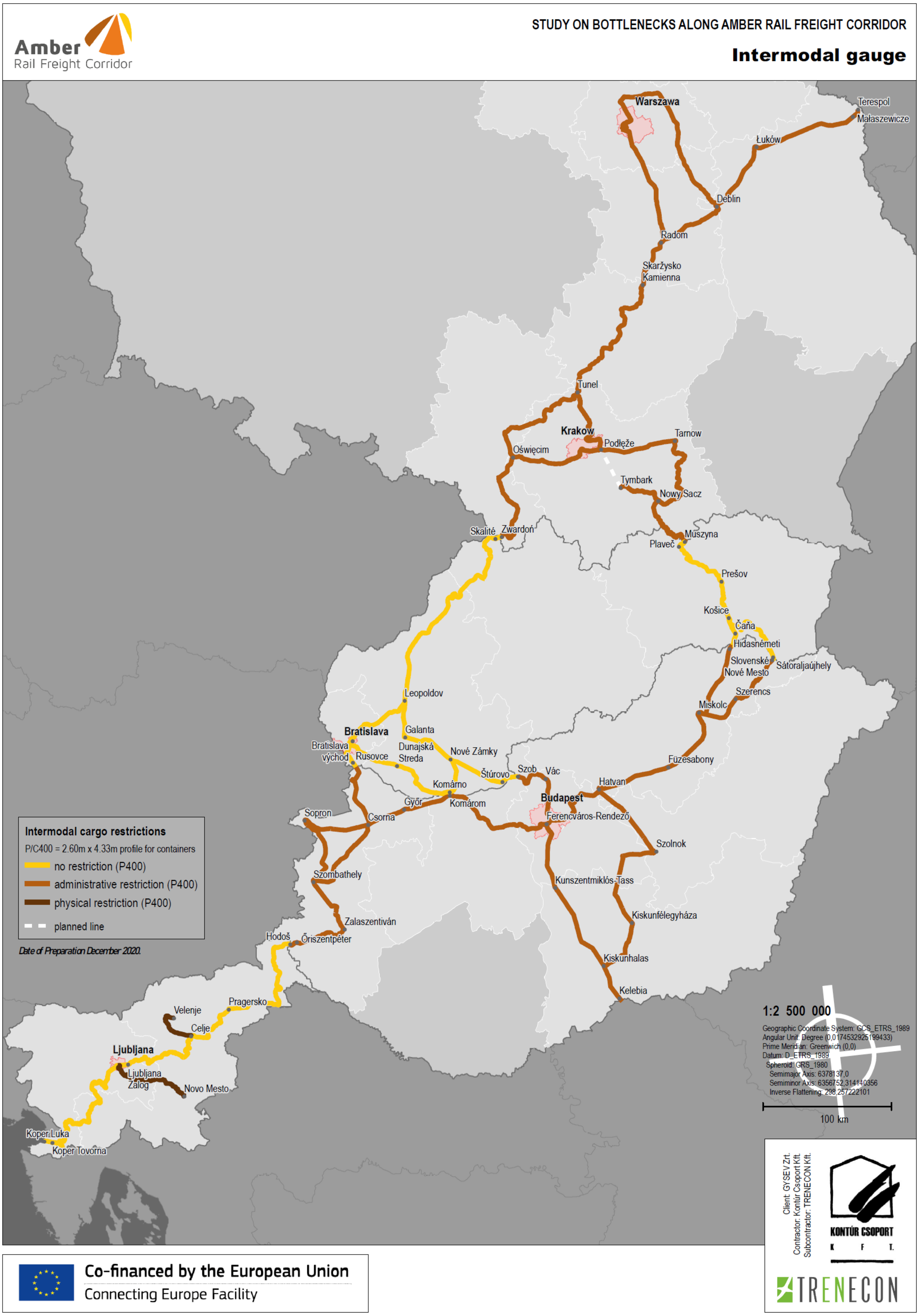


Figure 18: Intermodal gauge along RFC Amber

5.4 Stations, marshalling yards

The RFC consists of many rail nodes, stations, marshalling yards and border crossings that are part of the corridor in everyday operation. Their capacity and parameters highly influence the time demand and reliability of train forwarding and efficiency of traffic management and capacity utilisation.

Marshalling yards are those facilities where there is high capacity is available for train handling (train composition or rearrangement, short term parking or longer-term storage etc.). In this aspect these are the main important stations for traffic management purposes – not only as handling the trains but to solve capacity issues on the network, e.g. by short term parking of the trains for prompt traffic management.

Urban nodes are usually the places of capacity shortage as the freight traffic meets high passenger traffic. It is the case along RFC Amber where the major nodes are the capitals or city agglomeration of the highest importance of the member states, such as Warszawa, Krakow, Bratislava, Budapest and Ljubljana.

The stations are analysed in detail in chapter 7.5.

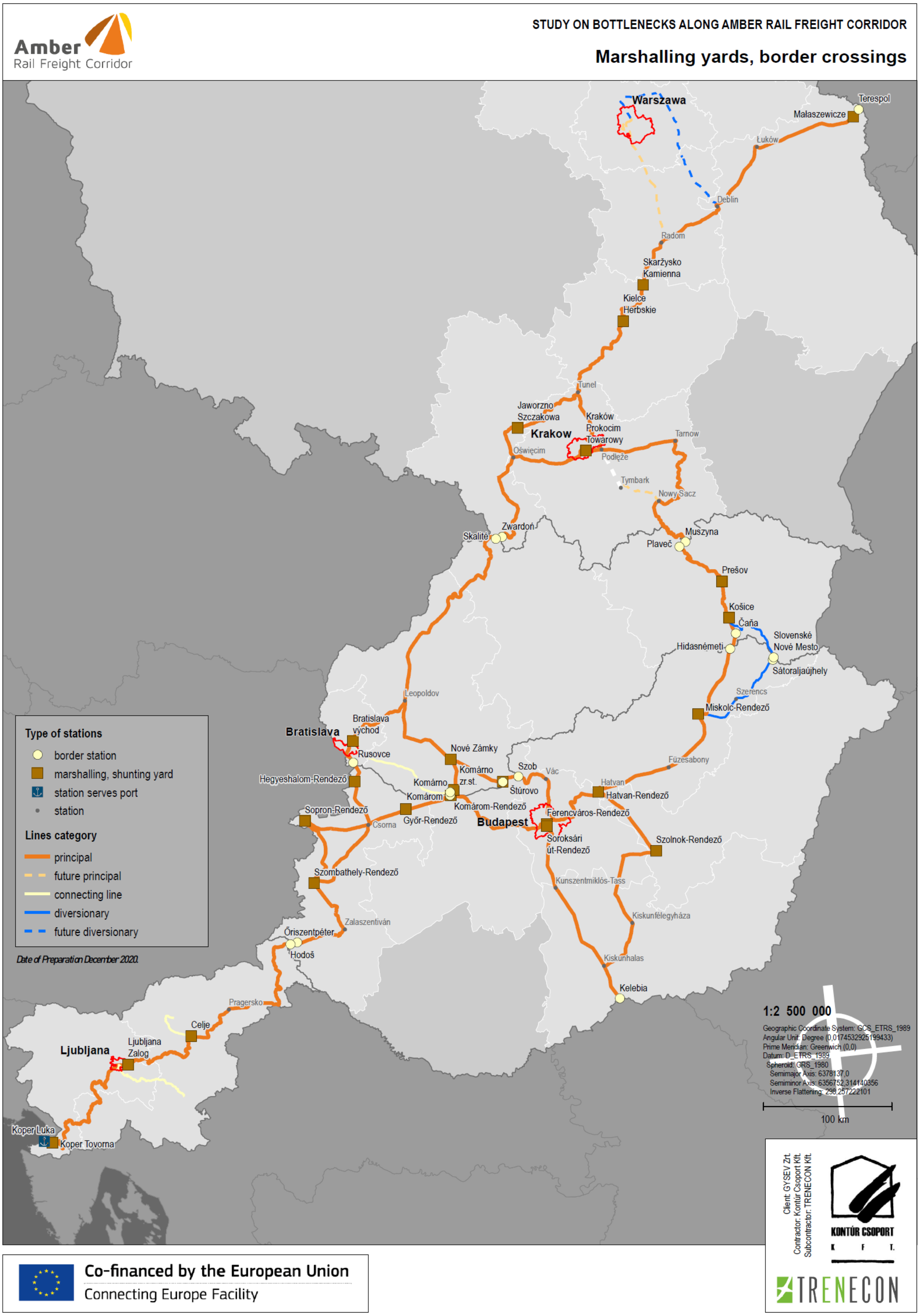


Figure 19: Marshalling and shunting yards, border crossings and the most important stations along RFC Amber

5.5 Terminals and last mile

Terminals are the major locations where cargo is loaded and unloaded from railways – usually from and to road, therefore majority can be considered multimodal terminals. Along RFC Amber, some have port facilities as well. Most important in terms international cargo transportation is the “Southern gate” of the RFC, port of Koper that consists of several individual facilities, handling almost all cargo types and transport modes.

The list of terminals along and in the surrounding of RFC Amber is as follows (not each of them are on the RFC lines as it can be seen on the map later on):

Terminal name	Modes	Types of handled cargo
PKP Cargo Centrum Logistyczne Małaszewicze	Rail, Road	containers, semi-trailers, bulk
EUROPORT Małaszewicze Duże	Rail, Road	containers, swap bodies, semi-trailers, wagons
Terminal przeladunkowy Wólka	Rail, Road	containers, swap bodies, semi-trailers
Zaborze	Rail, Road	bulk
Transgaz S.A.	Rail, Road	gauge tanks
Terminal Kontenerowy Warszawa – PKP Cargo Connect Sp. z o.o.	Rail, Road	containers, swap bodies, semi-trailers
Loconi Intermodal Terminal Kontenerowy Warszawa	Rail, Road	containers, swap bodies, semi-trailers
Polzug Terminal Kontenerowy Pruszków	Rail, Road	containers, swap bodies, semi-trailers
Terminal Kontenerowy Warszawa Główna Towarowa SPEDCONT Sp. z o.o.	Rail, Road	containers, semi-trailers
Terminal Kontenerowy Gliwice - PKP Cargo Connect Sp. z o.o.	Rail, Road	containers, semi-trailers
Terminal Sosnowiec Poludniowy (Spedycja Polska Spedcont Sp. z o.o.)	Rail, Road	containers, swap bodies, semi-trailers
Euroterminal Sławków	Rail, Road	containers, swap bodies, semi-trailers
Polzug Terminal Dąbrowa Górnicza	Rail, Road	containers, swap bodies, semi-trailers
PCC Intermodal - Terminal PCC Gliwice	Rail, Road	containers, swap bodies, semi-trailers
Brzeski Terminal Kontenerowy – Karpiel sp. z o.o.	Rail, Road	containers
Terminal kontenerowy Włosienica	Rail, Road	containers
PCC Intermodal - Terminal Kolbuszowa	Rail, Road	containers, swap bodies, semi-trailers
Lubelski Terminal Kontenerowy	Rail, Road	containers
Erontrans Terminal Kontenerowy w Radomsku	Rail, Road	containers, swap bodies
Loconi Intermodal S.A. Terminal Kontenerowy Radomsko	Rail, Road	containers
Erontrans Terminal Kontenerowy w Strykowie	Rail, Road	containers, swap bodies
Terminal Kontenerowy Łódź Chojny	Rail, Road	containers
SPEDCONT Terminal Kontenerowy Łódź Olechów	Rail, Road	containers, swap bodies, semi-trailers
Bratislava Palenisko	Rail, Road, River	containers, swap bodies, semi-trailers
Bratislava UNS/ Slovnaft	Rail, Road	containers, swap bodies
UKV Terminal Bratislava ÚNS	Rail, Road	containers, swap bodies
Dunajská Streda	Rail, Road	containers, swap bodies, semi-trailers

Terminal name	Modes	Types of handled cargo
Terminál Žilina	Rail, Road	containers
Žilina - Teplička nad Váhom	Rail, Road	containers, swap bodies, semi-trailers
Terminál Košice	Rail, Road	containers, swap bodies, semi-trailers
ŽOS Trnava privat	Rail, Road	no data
Logistics Service Centre Sopron - Sopron Terminal	Rail, Road	containers, semi-trailers, bulk
Railport Sopron	Rail, Road	containers, semi-trailers, bulk
Logistics Service Centre Sopron - Warehouses	Rail, Road	pallet
Terminal ÁTI Győr	Rail, Road	bulk
Port of Győr-Gőnyű	Rail, Road, River, Air	containers, bulk, Ro-Ro, piece goods
Railport Győr	Rail, Road	containers
Budapest Szabadkikötő	Rail, Road, River	containers, Ro-Ro, petroleum
Rail Cargo Terminal - BILK Zrt.	Rail, Road	containers, semi-trailers, bulk
Luka Koper – Port of Koper	Rail, Road, River, Sea	containers
Ljubljana Container Terminal	Rail, Road, RoLa	containers, swap bodies, semi-trailers
Maribor Tezno	Rail, Road, RoLa	containers, swap bodies
Celje	Rail, Road	containers, swap bodies
Sežana	Rail, Road	containers, swap bodies, semi-trailers
Novo mesto	Rail, Road	containers, piece goods
Velenje	Rail, Road	containers, piece goods

Table 14: Terminals in the vicinity of RFC Amber

The terminals are mainly in private ownership, their capacities and the handled cargo volumes are not uniformly and fully available. Focusing on the services and capacities for road-railway mode change, it can be said that the majority of them handle combined cargo primarily (containers, swap bodies, semi-trailers) that is in line with cargo shipping trends where railways have its main potential in the combined sector of cargo forwarding.

Not only the services but the last mile infrastructure is also a very important part of their availability, the connection to the corridor routes (including the private sidings and other private facilities) needs to be met the interoperability requirements.

Considering the density and location of multimodal terminals and the distance from RFC, it is obvious that there are many areas of Poland, Slovak Republic, Hungary and Slovenia that are not well covered by such facilities.

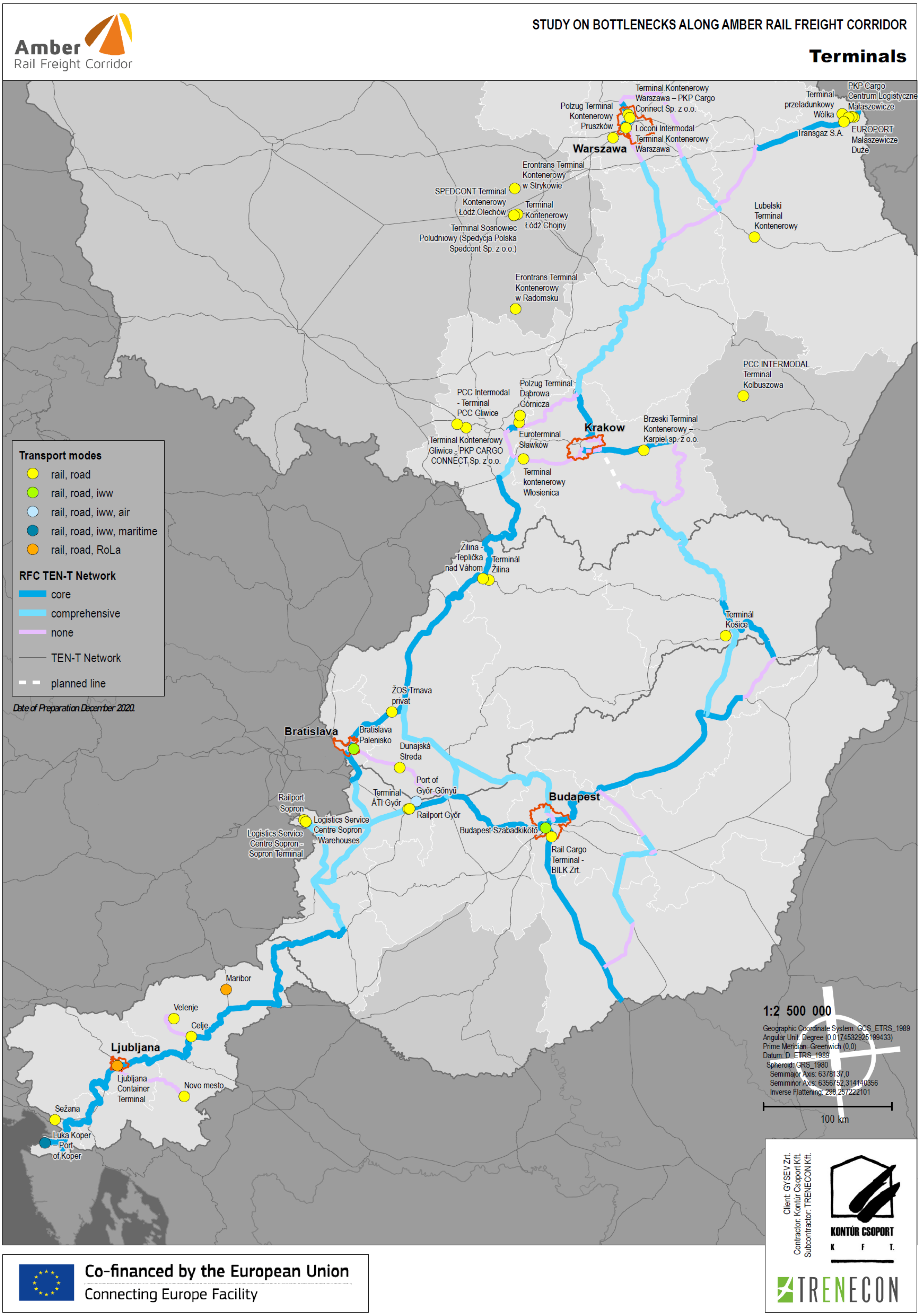


Figure 20: Terminals in the vicinity of the RFC Amber lines

6 Traffic on RFC Amber

6.1 Current traffic characteristics along RFC Amber (freight/transport)

To assess traffic situation on RFC Amber, the following information is used and presented:

- historical rail freight and passenger performances in the RFC Amber member states and the EU
- historical and current train traffic (freight/passenger) on the corridor line sections
- general population and economic trends for the traffic forecasting
- trends in freight transportation and logistics and cargo types on railway
- cargo and transloading forecast for the major terminals, especially Koper)

The traffic data is available for RFC Amber from several sources.

- overall traffic performance indicators are available from national statistics and Eurostat,
- train traffic on the lines was supplied by the Infrastructure Managers that register the train traffic on their network,
- origin-destination data is available from IMs limited to the domestic destinations (to border crossings) and data is restricted to the routes offered in the RFC Amber PaP 2020,
- additional data is available from Railway Undertakings.

The current traffic (based on 2013-2018 datasets provided by Infrastructure Managers) shows that the total train traffic on the sections of RFC Amber slightly increases (20% from 2013 to 2018). The highest traffic lines are in and around Warsaw, Bratislava, Budapest and Ljubljana (urban nodes) where passenger traffic is significant. Where there is an overlapping freight corridor, the freight traffic is typically higher, too.

It can be spotted that there is considerably higher traffic on the western branch of the Corridor, namely the Katowice – Žilina – Bratislava direction, compared to the Krakow – Košice – Miskolc branch.

It is to be noted that international Origin/Destination type traffic data is not available, it is not registered (IMs register traffic on their own network only). However, based on data available from C-OSS manager, RFC trains have minor share in total, regular freight trains are dominant so far.

With the exception for the Koper – Divača and Luków-Deblin line sections, capacity shortage is not crucial issue on RFC Amber: free capacity is available to reserve further train paths. Moderate capacity shortage is present on overlapping sections with other corridors and on suburban lines. It is noted that objective comparison of the different member states' lines and sections is difficult as there is no uniform calculation of capacity utilisation. (Note: sections having capacity shortage is not necessarily identical to congested sections as it is defined by EU terminology.)

The traffic forecast of the BS will rely on the already available data sources and forecasts, such as Transport Market Study of RFC Amber (TMS) for the short term; on long-term, GDP forecast and population projections can be used, primarily the EU "Reference Scenario". Traffic forecast can be based on GDP in general thank to the correlation between these two parameters (however, global trends impacting freight traffic distort the correlation).

In fact, internal trade in all RFC Amber states exceeds the total trade volumes with third countries. For short term, a modest but steady growth on Amber is supposed through 2026. However, impact of COVID19 pandemic – a major unseen occurrence in 2020 – on the economic and general transportation demand changes is a new development.

The ambitions of European Union set a significant change in the courses of the last decade, when road transport became dominant, by aiming to reach 30% of rail freight mode share by 2030 (supposing a land freight transport market growth of 30% by 2030).

In the meantime, modal share is wished to change from 15% in 2010 to 18% in 2050. This would result in 84% growth of rail freight transport through 2050.

Forecast assumes that EU policy objectives for TEN-T network will be accomplished as planned.

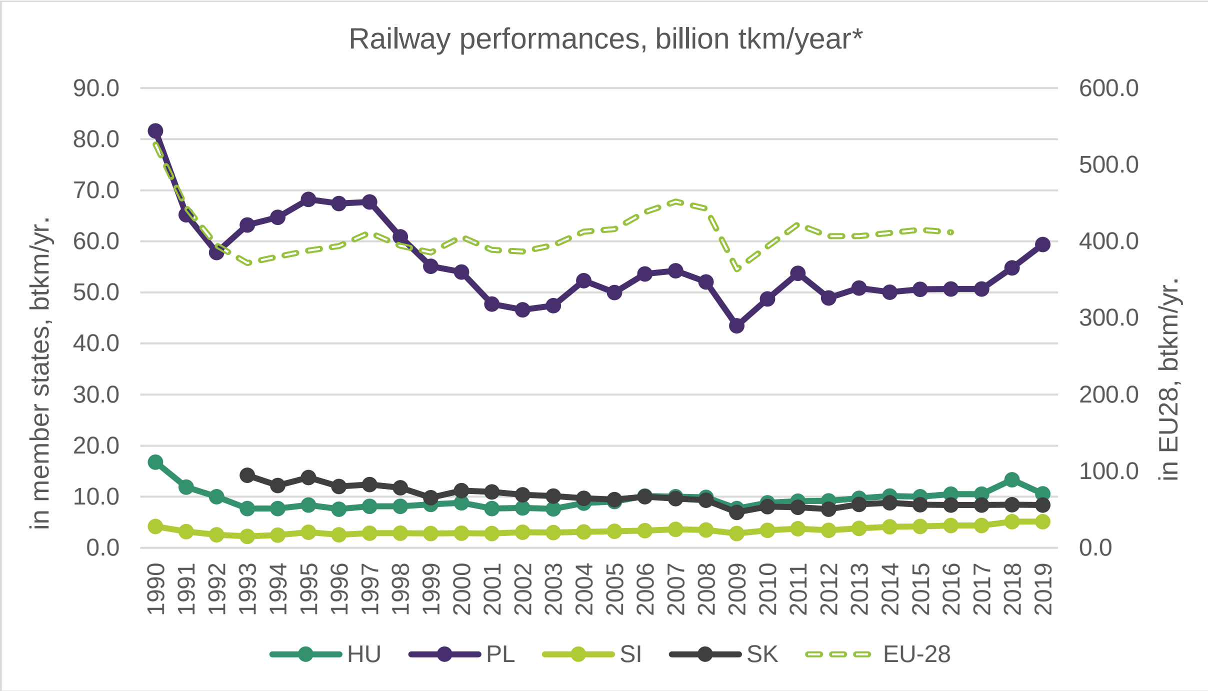
Over the EU-scale trends, regional differences can be considered when defining and assessing measures:

- Transit freight train traffic can be based on general economic and traffic forecast of the EU,
- Domestic and international freight train traffic can be differentiated by country economic forecasts.

Traffic on RFC Amber sections is forecasted, and future bottlenecks can be spotted by identifying sections having at least moderate problems currently and/or high traffic growth potential is assumed.

6.1.1 Current traffic situation

From the Eurostat, railway performances data in the RFC Amber countries are shown on next figures. As first graph shows, overall performance of railways is rather decreasing over time then stagnating. Except Poland, domestic freight transport performance is not significant, international (import, export, transit) is the dominant, in Slovenia absolutely.



**billion tkm/year on both y axis sides to enable visualisation of national and total figures in the same chart*

Figure 21: Railway traffic overall performances in the RFC Amber member states (source: Eurostat)

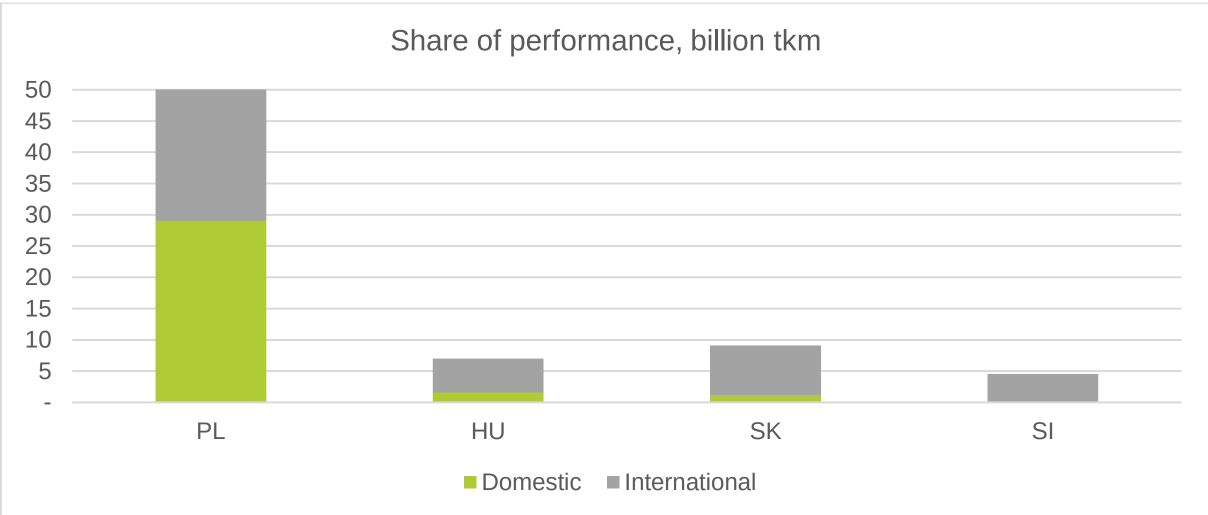


Figure 22: Share of overall performances in the RFC Amber member states (source: Eurostat)

In spite of the general trend, the total train traffic on the sections of RFC Amber slightly increases year by year (considering years where RFC did not exist). The number of freight trains and the total gross ton km data of the RFC Amber line sections are higher by almost 20% in average in 2018 than it was in 2013.

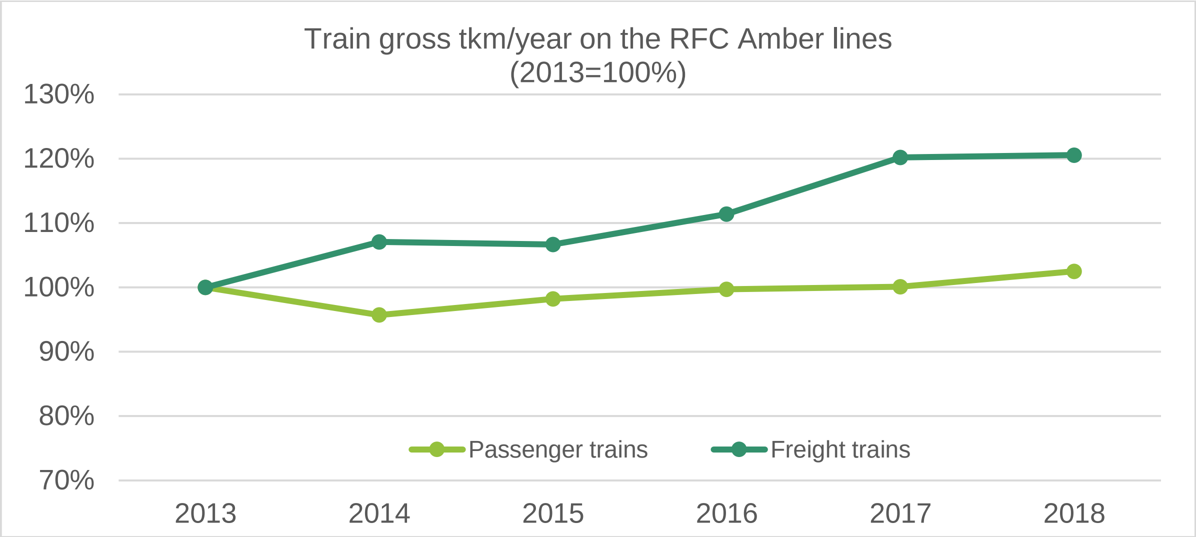


Figure 23: Overall performance on the RFC Amber lines, 2013-2018 (2013=100%)

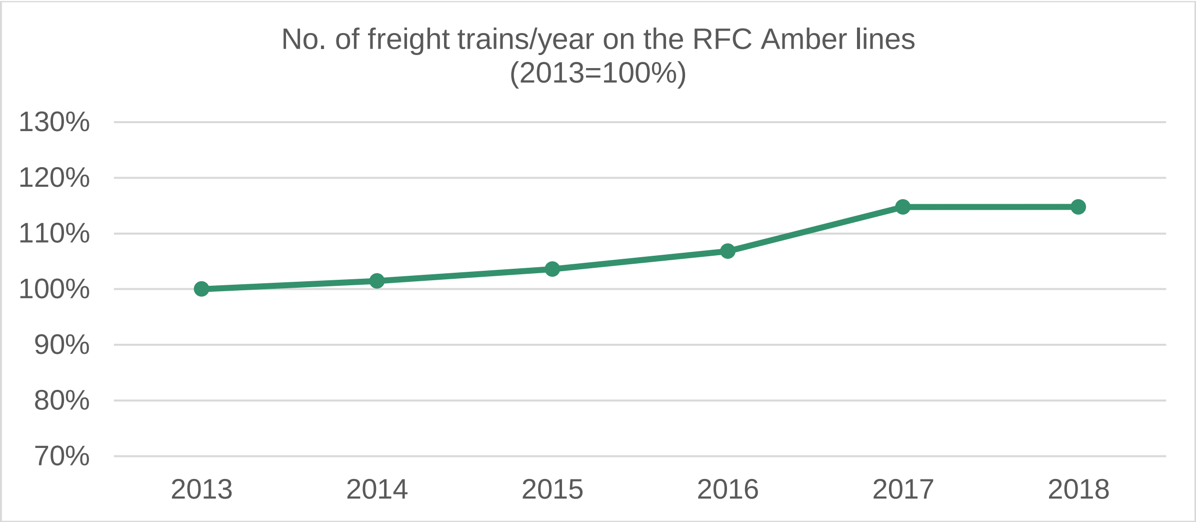


Figure 24: Overall traffic on the RFC Amber lines, 2013-2018 (2013=100%)

As it can be seen by comparing the trends in gross tkm and number of trains, a small increase in train utilisation or efficiency can be supposed, based on the fact that growth rate in annual gross tkm is slightly above the growth rate in the train traffic itself. For the future, in case the train length can be increased to approach the 740 m objective, the same cargo volume would be transported in less but longer trains.

Data on the lines are summarized from the data supply of the IMs for the line sections of the Corridor. The following maps show the traffic situation along the corridor. At first, overall annual train traffic of the lines and sections is mapped, as provided by IMs. The data includes not only freight but passenger and other (e.g. O&M, loco) trains. As the graphic representation of the traffic situation shows, those sections, lines are the busiest that are part of the main transit routes and/or have important role in (primarily suburban) passenger traffic.

Analysing the changes in the overall traffic, see second map in sequence, the trend of a general and slight increase can be seen. However, decrease is shown in eastern Hungary and the sections in southern Poland where the Carpathian Mountains form a natural obstruction.

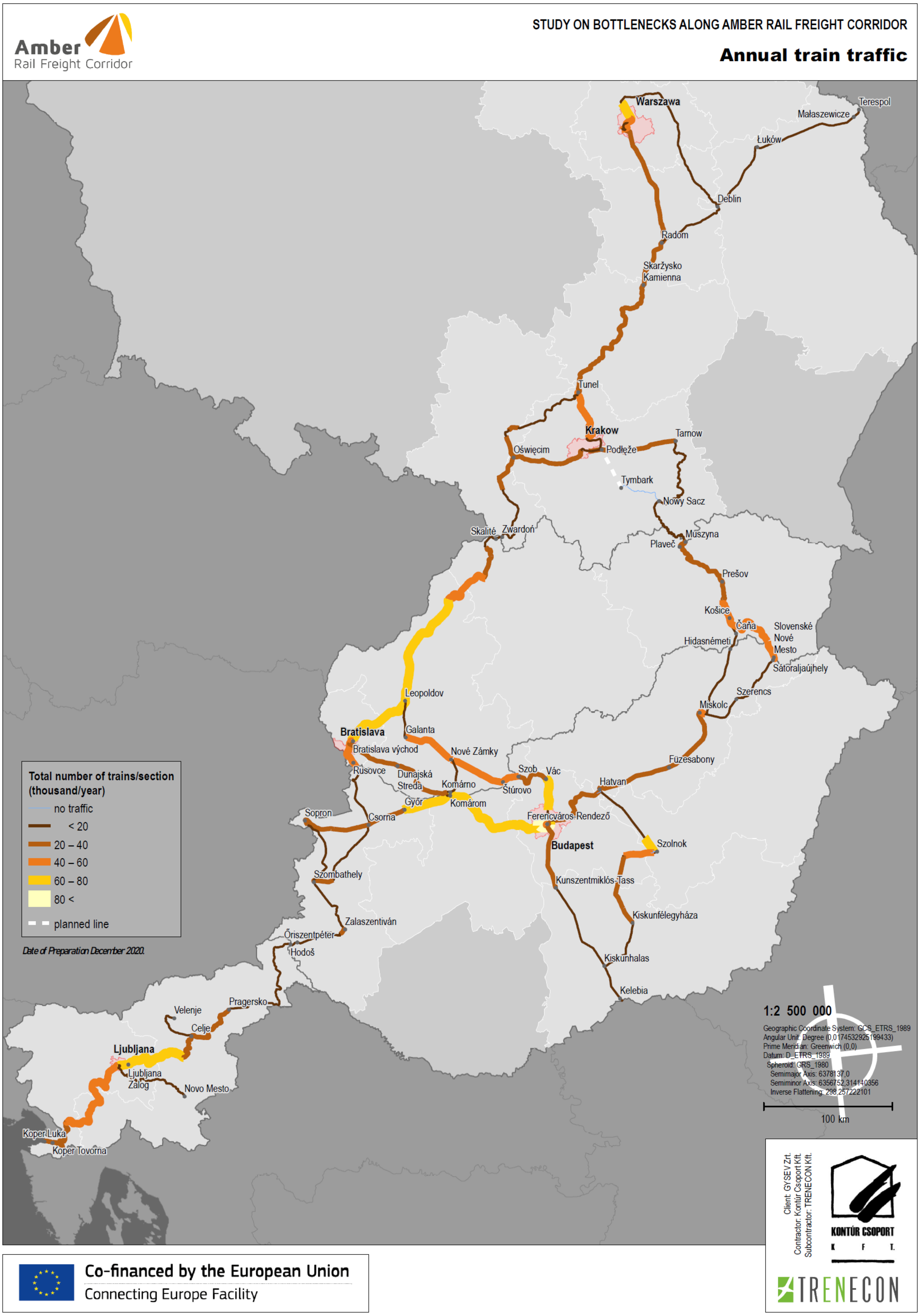


Figure 25: Overall volume of annual train traffic on the RFC Amber lines, 2018

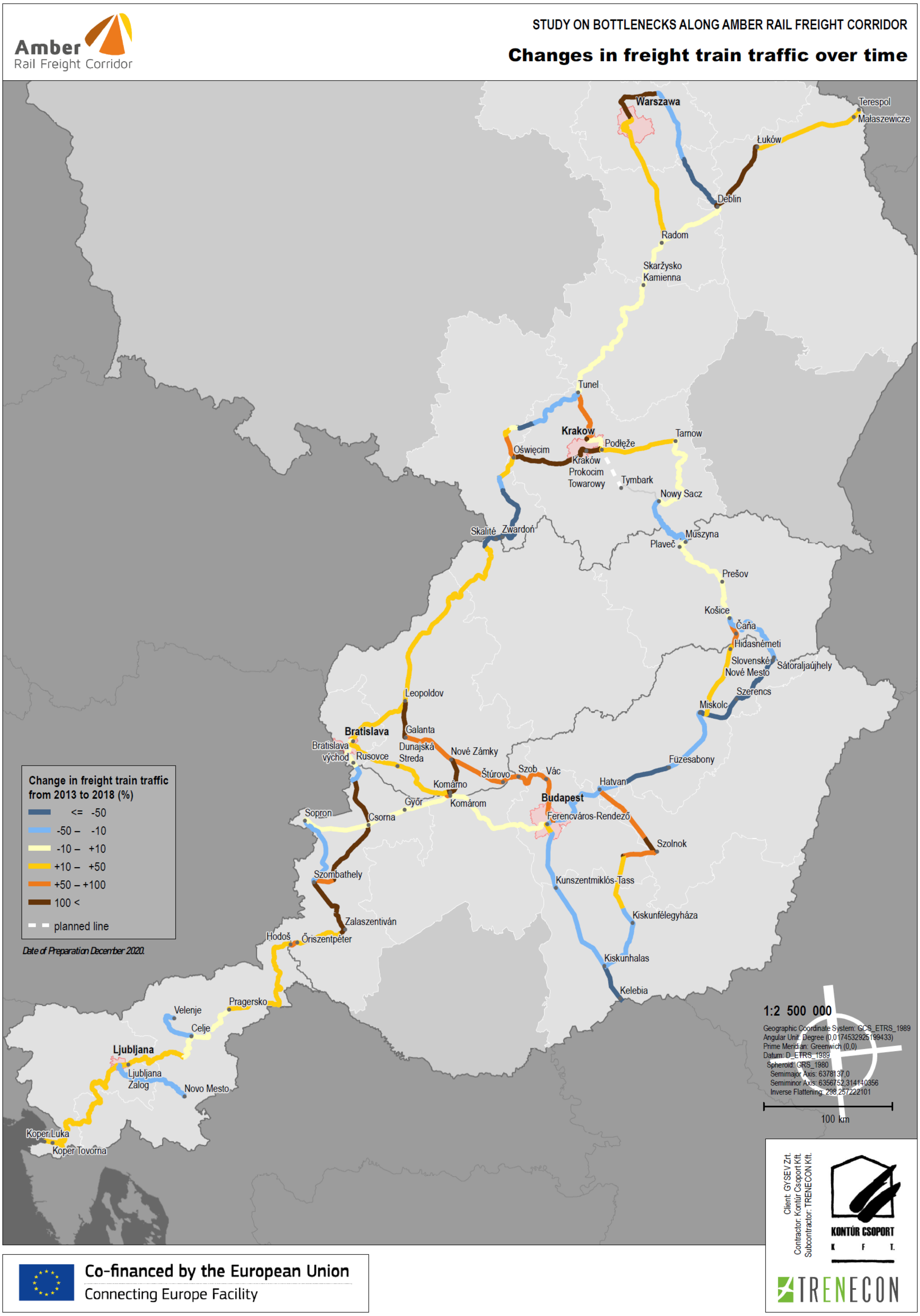


Figure 26: Change in overall volume of annual freight train traffic on the RFC Amber lines from 2013 to 2018

Highest traffic lines are in and around Warsaw, Bratislava, Budapest and Ljubljana where annual number of trains exceeds 60 thousand (even 80 thousand at some sections).

Comparing the countries and branches of the RFC, the main characteristics that can be recognized is the considerably higher traffic on the 'main' route, the western branch of the Corridor. These lines are overlapping with eastern branch of RFC5, connecting Poland to the Mediterranean through Slovak Republic, Czech Republic and Austria. Similar is the case with the Slovenian sections where corridors from Italy, towards not only Hungary but Austria and Croatia are also intertwined.

Share of international (import and export) and transit rail freight traffic is generally significantly higher compared to domestic cargo trains.

The next map shows not only the overall traffic but share of freight as well. As apparent, the 'ends' of the corridor at Koper and Terespol, the proportion of freight trains is quite high. Similar is the case at some lines around Warsaw, Katowice and at the Hungarian-Slovenian border area.

Where number of passenger trains is high due to the line's important role in passenger traffic, the proportion of freight is inevitably lower – even if overall freight volume is high. See second map below where the gross train tons per year is calculated based on gross train km data.

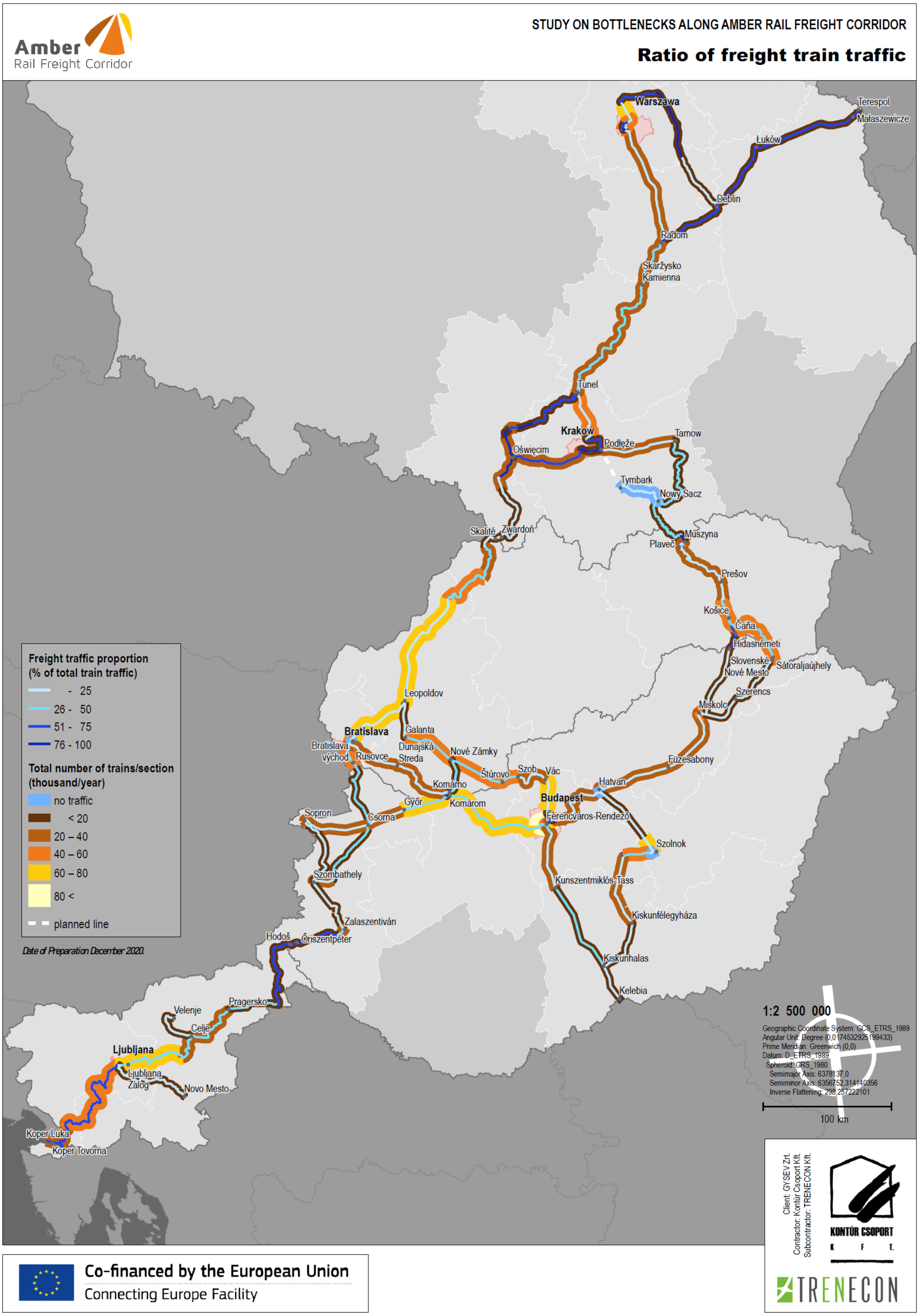


Figure 27: Proportion of freight train traffic on the RFC Amber lines, 2018

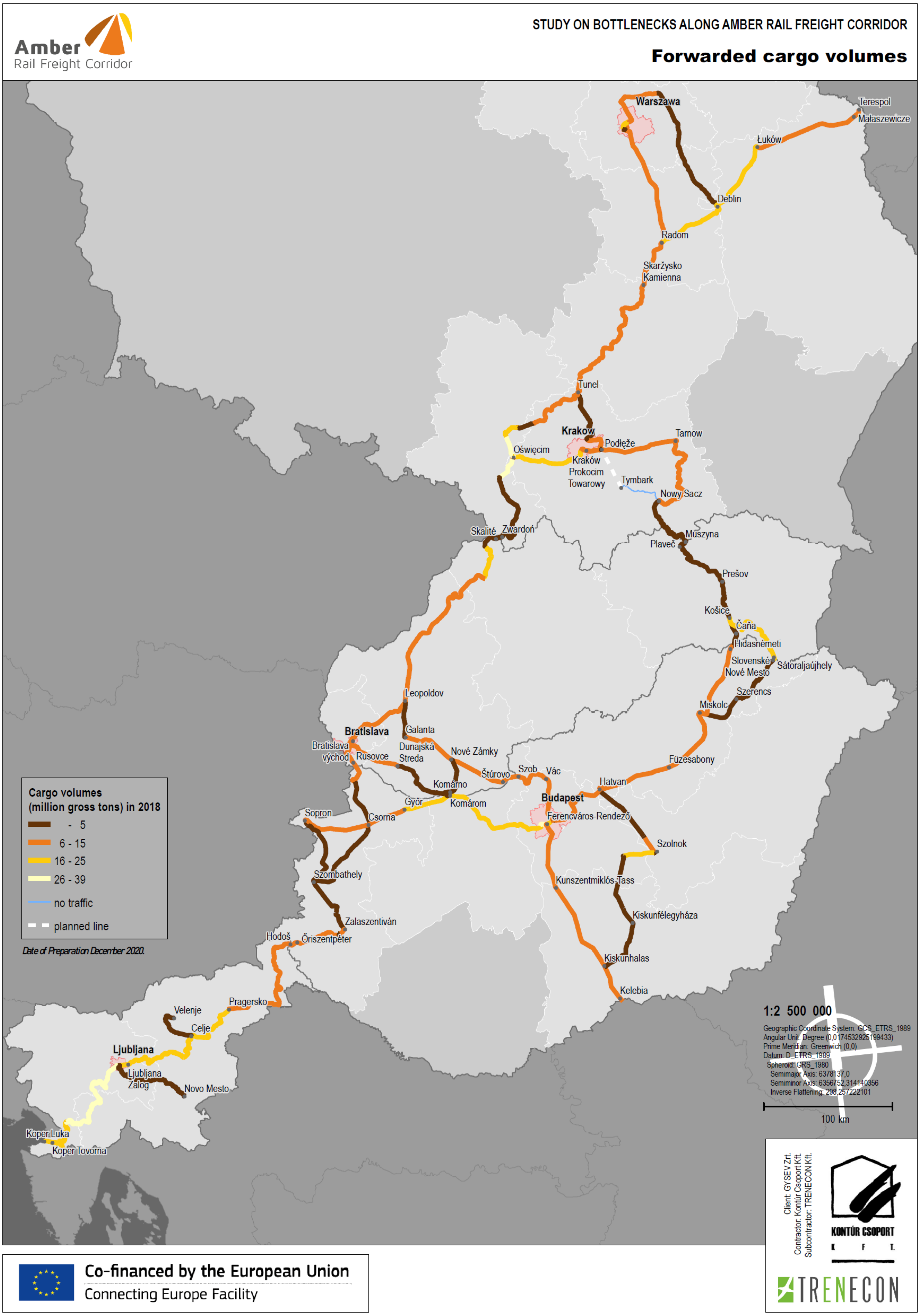


Figure 28: Calculated forwarded gross tons, 2018

6.1.2 Traffic demand compared to RFC Amber supply

In comparison with other RFCs of the EU, RFC Amber offers a relative low capacity. However, the capacity for 2021 is +12% higher than the offered for 2020 timetable.

Offered and booked capacity

Level of service in terms of infrastructure can be described by several parameters, indicators. Demand can be described by traffic volumes but by other attributes as well. KPIs (key performance indicators) of RFC Amber for timetable 2020 and 2021 show that the volume of offered capacity highly exceeds the requests (so far).

RFC Amber offered 28 pre-arranged train paths (PaP) in total in the 2020 timetables, 4.2 million PaP*km*days in total. Considering PaP pre-requests of the 2019/2020 timetable period, approximately 40% of the PaP catalogue offer was pre-booked. The proportion is slightly lower for the 2020/2021 TT period as of June 2020.

Key Performance Indicator of RFC Amber	2019/2020	2020/2021
Volume of offered capacity – PaPs (million path km)	4.2	4.7
Volume of requested capacity – PaPs (million path km)	0.9	0.5
Volume of requests – PaPs (number of PCS dossiers)	11	5
Number of conflicts – PaPs (number of conflicting PCS dossiers)	0	0
Volume of pre-booked capacity – PaPs (million path km)	0.9	0.2

Table 15: RFC Amber KPIs[3]

Based on RUs feedback it is partly attributed to the fact that actual RU preferences cannot be fully considered by the IMs when offering PaPs. as Also, as this is the first year of operation of RFC Amber, the overall capacity offer and request cannot be evaluated objectively – both supply and demand side are in the introductory phase currently. Similarly, the adjustment of PaP routes and departure and arrival times (the RFC timetable) to the actual requests and demand of the freight operators need time; and so does the finding optimum point of RFC capacity allocation and other traffic needs. It is an operative and administrative issue how and to what extent the RU demand (e.g. articulated in capacity wish list) is and can be considered in PaP catalogue planning.

Traffic volumes on PaP routes

International origin-destination traffic data was requested but it is not available at IMs nor at RFC C-OSS manager. IMs could however provide information on the domestic sections of PaP routes. Data shows that very often path request and travel orders lack in these relations. Where trains used the actual path, the traffic at most only some hundreds of trains annually that is not significant compared to overall traffic volumes.

Based on available data, the traffic using solely RFC Amber is low. Unfortunately, international origin-destination traffic flow data is not available at IMs nor at C-OSS.

6.1.3 Line capacity utilisation

All in all, infrastructure is a basement for operation, but level of service is influenced by further important factors. Many of these are in connection with operational and administrative (O&A) issues, see later in chapter 8, but travel time and its reliability is influenced by infrastructure parameters and available capacity, too.

3 RNE Commonly applicable RFC KPIs RFC Amber, June 2020

According to the information supplied by IMs and ABs, with the exception for the Koper – Divača line, capacity shortage is not crucial issue on RFC Amber in terms of free capacity for additional freight train paths.

However, it is a common traffic management procedure that freight trains have lower priority to passenger trains, especially in peak times in suburban-urban areas. As RFC Amber connects several very busy urban areas and also overlaps with other rail freight corridors, having higher train traffic generally, the issue of capacity shortage should be considered when compiling the measures to boost rail freight and to make Amber more competitive.

As presented on the following map, free capacity is available on the majority of the Corridor.

There is intermittently serious capacity shortage in northern Poland (Luków-Deblin) and on the section towards Koper port (Koper-Divača) is practically no free capacity at all. Several other sections have moderate capacity shortage, mainly on the overlapping sections with other corridors but freight train path can be granted for RUs with minor flexibility or difference to the requested.

Considering that the calculation methodology of capacity utilisation differs from IM to IM, the map does not represent percentages but descriptive categories from ‘sufficient capacity’ (means no capacity problem) to ‘very serious capacity shortage’. Of course, where available, the categorisation considers the average capacity utilisation (threshold values of 60, 80% and 100%) but the data is not comparable directly.

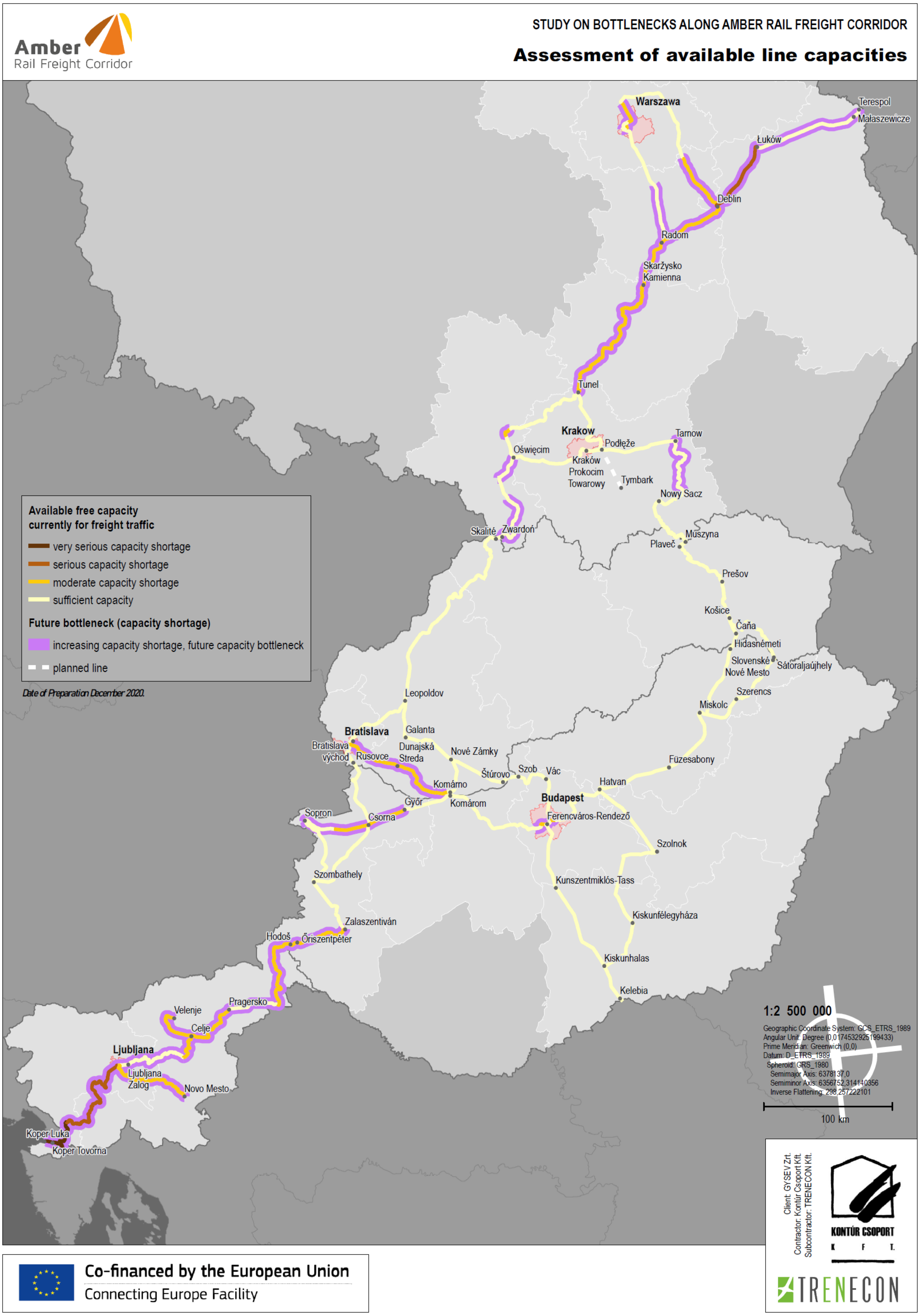


Figure 29: Capacity utilisation and foreseen capacity bottlenecks along RFC Amber

6.1.4 Average speed of train forwarding

Average train speed, as a direct indicator of level of service, influences operational efficiency and costs of the railway undertakings through the need and management of rolling stock and human resources. (The shorter the transport time, the less is the necessary number of locomotives, wagons and personnel for operation.)

Scheduled transport times for the 2020 PaP routes as reported by the C-OSS (Corridor one-stop-shop) manager are shown in the table. Using the route length and time the average 'theoretical' transport speed can be estimated as follows:

from	to	route length (km)	scheduled transport time of path (min.)	calculated avg. speed (km/h)
Małaszewicze (PL)	Košice (SK)	733.3	1224	36
Małaszewicze (PL)	Ferencváros (HU)	1003.6	1652	36
Warszawa (PL)	Žilina (SK)	613.5	1071	34
Žilina (SK)	Koper (SI)	844.6	1622	31
Nové Zámky (SK)	Ferencváros (HU)	130.4	307	25
Leopoldov (SK)	Kelebia (HU)	358.0	842	26
Žilina (SK)	Hatvan (HU)	406.8	744	33
Kelebia (HU)	Koper (SI)	928.6	1851	30
Nové Zámky (SK)	Szombathely (HU)	219.8	447	30
Dunajská Streda (SK)	Szombathely (HU)	208.1	414	30
Košice (SK)	Miskolc-Rendező (HU)	149.3	342	26
Slovenské Nové Mesto (SK)	Miskolc-Rendező (HU)	87.4	225	23
Nové Zámky (SK)	Komárom (HU)	36.9	72	31
Košice (SK)	Kelebia (HU)	433.4	705	37

Table 16: Scheduled train transport times in the 2020 PaP (source: C-OSS of RFC Amber)

As presented, calculated average speed is mainly between 25 and 35 km/h. Supposing that this includes stops (due to crossing a border or due to capacity shortage at some point of the network), the average speed can still be considered low compared to other RFCs in western-EU. Additional information from RUs is that it occurs sometimes that actual transport time of non-corridor train path for similar destinations is lower than the PaP offer.

KPIs (key performance indicators) are compulsory published by RFC managers, first set is already available for Amber. The O/D pair calculation of average planned speed reveals that at section with border crossing the PaP speed is considerably lower which suggest long process or unnecessary waiting times at borders. Looking at the average speeds of PaPs in western countries it can be claimed that transport on RFC Amber is, in general, not competitive in terms of train speed, balanced development of the infrastructure is to be implemented (an objective of the EU transport policy). On RFC5 the planned speeds of PaPs often exceed 60 km/h and overwhelmingly close to 45 km/h – and they are improving over time. The Slovenian section from Koper to the Austrian border has an average planned speed of 38.9 km/h which is the same for the Slovenian section of RFC Amber. The RFC Mediterranean (RFC6) PaPs demonstrate somewhat lower but still better speeds, e.g. 40 km/h for the 1374 km Milano-Záhony and Koper-Záhony section alike for the TT2021.

Presumably, causes for lower PaP speeds on RFC Amber compared to other corridors are diverse. One is supposedly in connection with the line infrastructure, the generally lower line speeds and the more frequent speed restrictions compared to Western-Europe; other is the capacity of the lines compared to the utilisation, where not only the state of the infrastructure (i.e. signalling systems) has significant impact but the number of open line tracks, density of freight train parking tracks are important parameters, as well as the priority of the corridor trains on the network (compared to passenger trains and also to other corridor trains); besides, the high process/(unnecessary) waiting time at the borders add up to a lower transport speed from origin to destination.

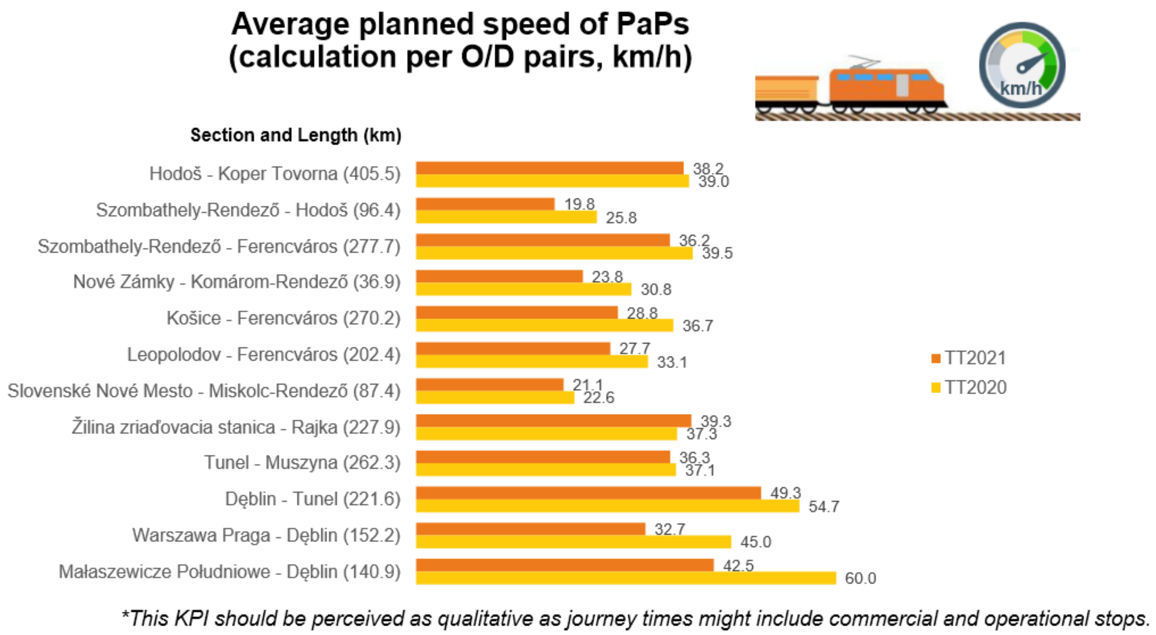


Figure 30: Average planned speed of PaPs (source: RNE Commonly applicable RFC KPIs, RFC Amber, June 2020)

The following table outlines some infrastructure and operational characteristics along the PaPs included in the KPI report.

PaP route included in planned speed KPI	route length (km)	PaP average speed in 2021 (km/h)	Border crossing	Dwelling time minute	Estimated length of poor quality section	Max speed <50 km/h	Speed restriction estimated length
Hodoš – Koper Tovorna	405.5	38.2	no	-	few kms	20 km	Moderate 40%
Szombathely-Rendező - Hodoš	96,4	19.8	Őriszentpéter/ Hodoš (incl. traction change at the border)	37' / 70'	50%	-	Moderate 30%
Szombathely-Rendező - Ferencváros	277.7	36.2	no	-	30%	-	Moderate 70%
Nové Zámky – Komárom Rendező	36.9	23.8	Komárno / Komárom	n.a. / 199'		-	-
Košice - Ferencváros	270.2	28.8	Hidasnémeti / Čaňa	381' / n.a.		-	Serious 50% moderate 25%
Leopoldov - Ferencváros	202.4	27.7	Štúrovo/Szob	265' / 8'		-	Moderate 10%
Slovenské Nové Mesto – Miskolc-Rendező	87.4	21.1	Slovenské Nové Mesto / Sátoraljaújhely (incl. traction change at the border)	n.a.	few kms diesel*	-	Moderate 80%
Žilina zriaďovacia stanica - Rajka	227.9	39.3	Rusovce / Rajka	n.a. / 285'		-	-
Tunel - Muszyna	262.3	36.3	Muszyna	-	50%	50 km	Serious 25% moderate 25%
Dęblin - Tunel	221.6	49.3	no	-	25%	-	Moderate 25%
Warsawa Praga – Pilawa – Dęblin	152.2	32.7	no	-	20%	40 km -	Serious 15%
Malaszewicze Poludniowe - Dęblin	140.9	42.5	no	-	50%	-	Serious 50%

*the short diesel section at the border area requires change of locomotive or use local diesel traction assistance

Table 17. Main characteristics along the PaPs included in the average planned speed KPI

The technical condition of the infrastructure has a considerable effect on the speed of RFC PaPs. The low line speeds are caused supposedly by the long sections having poor infrastructure quality (low speed and frequent restrictions) and also the border crossings or traction changing points can increase travel time, and in the meantime decrease planned speed of the trains (and their planned paths).

The poorer planned speed KPI values for 2021 compared to 2020 values, especially the less competitive speeds, are attributed mostly, as interpreted by capacity allocation bodies, to unscheduled track possessions as a result of poor track conditions which impacts the reliability of RFC Amber. On the other hand, offered capacity can better meet RU requirements, the „wish list” – resulting in higher reserve ratio – where international trains have been running for some time.

All in all, decreasing transfer time along RFC Amber – using infrastructural and operational measures – is one of the main objectives in making the rail freight transportation and concretely the Amber corridor more competitive. It is a goal against road transportation and also against the other rail freight corridors.

6.2 General economic trends (GDP and transportation)

6.2.1 Correlation between economic and transportation performances

Economic performance, GDP growth and demographic changes in any region or country have fundamental impact on both passenger and freight transport needs and mobility potentials. The changes in traffic performance are subject to the economic developments of the wider region. The correlation between the GDP growth and rail freight transport has been demonstrated by the data provided in the „EU Reference Scenario, 2016 – Energy, transport and GHG emissions, Trends to 2050”.

So, it can be claimed that transport performance and its development in time are largely subject to the general economic trend and changes in population. The size of the population, consumption patterns and trends have a direct impact on freight transport; in countries where growing population obviously consumes more the transport needs, the volume of goods to be transported will increase. In the case of goods with high rail affinity the growing demand will show, if adequate, competitive rail freight service that is available for freight train operators (RUs).

6.2.2 Population projection

Current population trends in the EU suggest that overall population remains stable with a very modest decrease through 2060 (see Eurostat table below). According to other sources EU population is projected to increase over coming decades up to 2050, although with declining growth[4] rates, which is driven by the slow population growth of larger, more developed western member states. In these countries where the natural growth is relatively stable, considerable migration surplus from and outside the EU is foreseen. On the other hand, the Eurostat forecast figures show material decrease of over 10% in Central-Eastern Europe including the RFC Amber countries for the next 40 years. It is attributed to the currently negative natural increase and extensive migration loss which are expected to continue. The lowest rate of reduction is foreseen for Slovenia, while the total population of the four RFC member states currently amounting to 55 million is expected to drop by over 10% until 2060. This decline in population results in a lower demand for goods and transport

[4] *EU Reference Scenario, 2016*

alike. In essence, the most characteristic demographic trends of the Union apply to these states: the life expectancy at birth increases (by an average 6 years until 2050) and the decrease is coupled by the steady aging of the population (the ratio of age group over 65+ will be over 28% by 2050).

Growth by decade	2020	2030	2040	2050	2060	total decrease 2020-2060
EU - 27 countries (from 2020)	100,0%	100,5%	100,0%	99,1%	98,1%	97,7%
Slovenia	100,0%	99,8%	98,9%	98,4%	96,9%	94,1%
Hungary	100,0%	97,8%	97,4%	97,5%	97,4%	90,4%
Slovak Republic	100,0%	99,3%	97,1%	96,7%	95,6%	89,2%
Poland	100,0%	98,5%	96,7%	96,4%	96,0%	88,1%
Total of RCF Amber countries	100,0%	98,5%	97,0%	96,7%	96,2%	88,9%

Table 18: Population growth forecast (Eurostat)

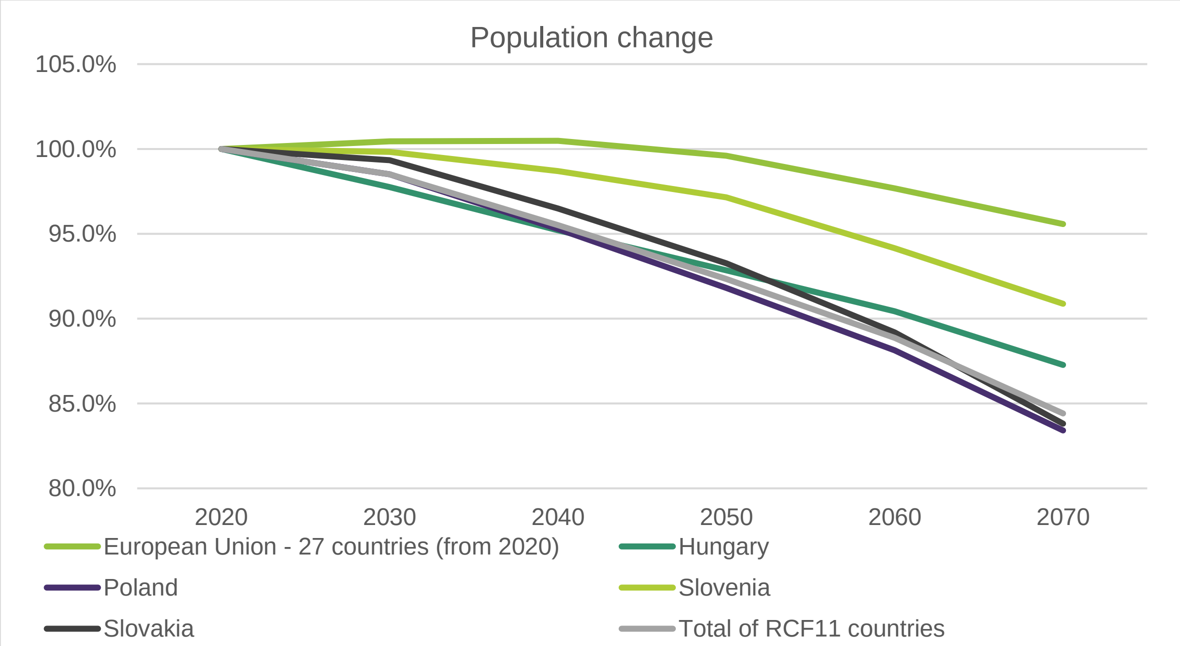


Figure 31: Population change forecast, 2020=100% (Eurostat)

6.2.3 GDP forecast

It is a widely accepted and proven observation that freight transport performance and general economic growth correlate, the volume of transported goods and its contribution to GDP develop proportionately with GDP growth. So, the GDP growth of the four member states of RFC Amber – in addition to population change affecting consumption and trade – is discussed as the basis for estimating the future transport volumes on RFC Amber.

GDP per capita is expected to have a relatively moderate but steady growth rate in the European Union. In 2019 the economy was projected to grow by 1.4% and 1.2% in the EU27 and in the euro zone countries, respectively while in Germany which is the largest trade partner of the Central-European region, the economy in fact, was not expanding. In the meantime, the Central-European countries have been demonstrating the highest growth rates in the Union while Hungary in 2019 e.g. had a growth rate of 4.5% far exceeding the EU average. The OECD considered the Slovak Republic with a growth rate of 3.8% to be one of the fastest growing economy outpaced by Poland with a 4% growth rate which is by now the sixth largest economy in the EU. The direct consequence of such a robust growth is the steadily increasing volume of freight transport.

At the same time, due to the close interdependencies of national economies, global integration and economic co-operations, the trade and transport development are largely affected by general, EU level and global economic prospects. The sources consulted for the medium/long term forecast could not take into account the economic consequences of the COVID 19 pandemic and economists have very different perception of its impact, the rate and duration of the upcoming recession. They predict a recession period worse than that in 2008-2009 with various rates of GDP decrease by region and country, mostly with a recovery period of several years.

Despite of the above average growth in the concerned states the current differences in economic performance within the Union are expected to last, the catching up of less developed countries to the Union average is not foreseen but a slight increase of the GDP/capita gap is forecasted. Although, the Central-Eastern Europe countries and among them, Hungary have demonstrated economic growth higher than the EU average in a row of several years it is not probable that this trend can be maintained because the factors of competitiveness like e.g. the availability of workforce and skilled professionals or level of productivity. The OECD forecast for the concerned countries show a GDP growth rate close to the OECD average in the long run (see table below).

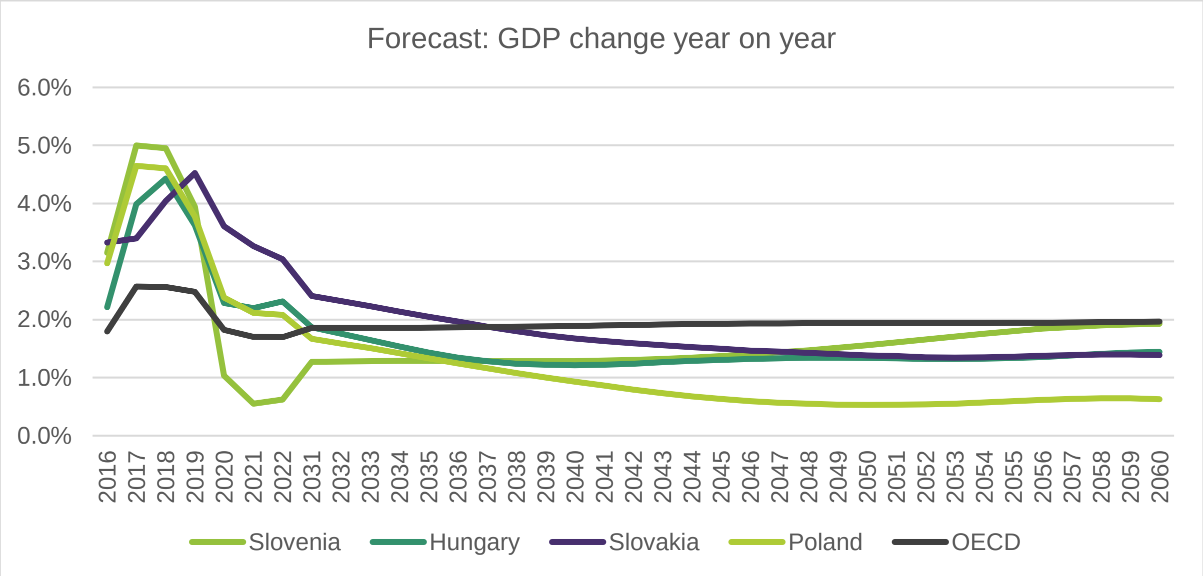


Figure 32: Annual GDP growth rate (real GDP)[5]

In the twenties the economic growth of the RFC Amber countries is well above the average except for Slovenia but shows a considerable slow-down by 2030. Between 2040 and 2050 it is only Slovak Republic that will have an economic performance close to OECD average castor Slovenia's economy will demonstrate a somewhat higher annual growth rate in that period. (Note that COVID-19 is not considered in this OECD forecast)

[5] *Measured in USD at constant prices and Purchasing Power Parities (PPPs) of 2010 – source: https://data.oecd.org/gdp/gdp-long-term-forecast.htm*

	2020	2030	2040	2050	2060	2020-2060
Slovenia	100,0%	10,7%	13,6%	14,9%	19,5%	**72,7%**
Hungary	100,0%	25,1%	15,5%	13,8%	14,5%	**88,3%**
Slovak Republic	100,0%	31,8%	22,1%	16,0%	14,6%	**113,9%**
Poland	100,0%	21,6%	13,7%	6,7%	6,1%	**56,5%**
OECD	**100,0%**	**19,4%**	**20,3%**	**21,0%**	**21,3%**	**110,9%**

Table 19: GDP forecast: GDP change by the decade (OECD)

The impact of the COVID-19 pandemic is obviously not considered in the above forecast however, it is expected to reduce GDP growth rates in the short term and the economic performance of the countries will resume in the mid-term. According to the IMF[6] the global economy will experience a 3 percent decrease in 2020. Assuming, that the pandemic fades and policies (fiscal, monetary, financial market) are effective and economic activity normalises, a growth rate of 5.8 % was expected by IMF next year. It is also claimed that a worse scenario – lingering, prolonged crisis – cannot be excluded either, though. The paper claims that “there is extreme uncertainty around the global growth forecast. The economic fallout depends on factors that interact in ways that are hard to predict...” Such concerns are truly reflected by the double-hit scenario of the OECD forecast published in June which assumes a much larger global recession of over 7.5% and a slower economic recovery of 2.8% in 2021 for the double-hit scenario[7].

The sever impact of COVID-19 on regional economic growth is shown by the IMF GDP projections. The economy of emerging markets and developing economies, in general is expected to reduce by 1 % in 2020 while the economy of China with a considerable decrease (5.5% in 2019) slows down to a modest increase of 1 percent. The Euro Area is expected to get into a recession with an average growth rate of -7.5% however, in year 2021 an annual percentage change of 4.7% is projected.

Since the second wave of the pandemic hit in the fall the double-hit scenario of the latest OECD Economic Outlook is considered the most relevant and presented hereunder for the concerned countries (see Figure 33).

The OECD indicates less favourable rates for 2020 (double hit scenario): 3.7% and 11.5% reduction in China and the Euro Area, respectively. Of the RFC Amber countries, the Polish and Slovenian economies are assumed to be hit the least, however all four economies are expected to shrink around 10% in 2020 which is a far more dramatic reduction than that anticipated upon the first wave of the pandemic.

The recovery is also slower than was assumed earlier. After the average drop of 7.6% of the overall world economy (according to the IMF the global economy decreases by 4.4%), the Euro Area is expected to grow by 3.5%. After the massive decline, less robust growth is expected for the RFC Amber countries in 2021. The economic expansion forecasted for 2021 ranging from 2.4% to 1.5% reflects the strong carry-over effect and are largely subject to the macroeconomic policy response to the outbreak adopted by the individual countries.

[6] World Economic Outlook, IMF, April 2020, https://www.imf.org/en/Publications/WEO/Issues/2020/04/14/weo-april-2020

[7] OECD ECONOMIC OUTLOOK, June 2020

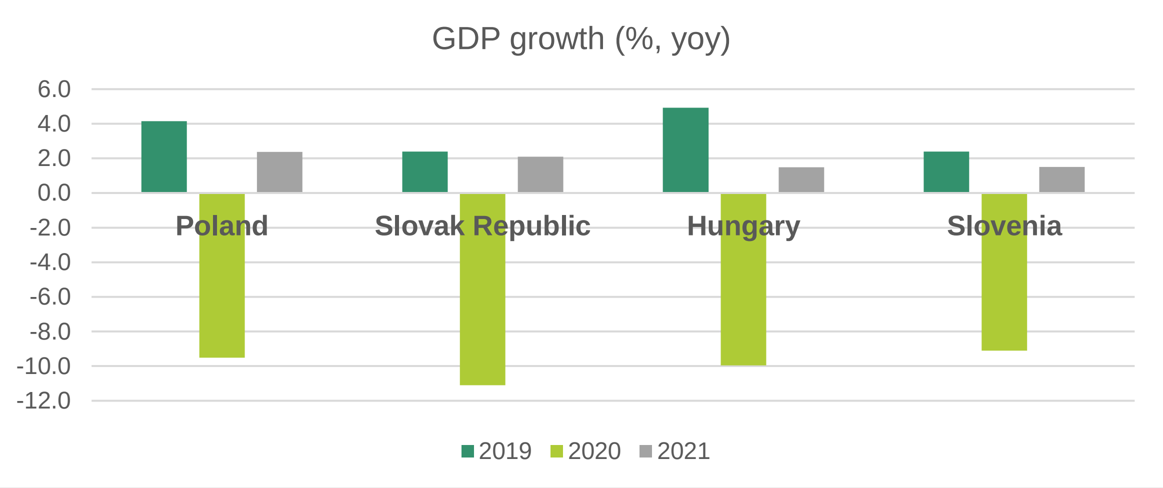


Figure 33: GDP growth rate forecast in the RFC Amber countries after the COVID-19 pandemic (% year on year)[8]

In China – whose economy has been on a decelerating trend before the virus – the GDP declined by 6.8% year-on-year in the first quarter of 2020, reflecting the severe damage caused by the outbreak. This sharp drop in the economic activity is now followed by fast recovering of industrial production, however gradual recuperation is expected in general, as e.g. the trade performance, export drops sharply by 10% this year and demand is anticipated to remain below the pre-pandemic period.

In terms of Europe, the Central-European region including the Amber counties have recently been outperforming the western EU economies considerably which provides a firm bases for recovery.

According to the EU Reference Scenario (2016), the projections on EU GDP show relatively low growth rates in the short to medium term. In the longer term, EU GDP growth is projected to increase at an average rate of 1.5% per annuum. The larges growth rate through 2050 is projected for Hungary close to 65% and the lowest for Slovenia barely exceeding 52%. The annual average potential GDP growth rate in the EU is projected to remain quite stable over the long-term.

By 2050 the GDP of the four countries is projected to increase by about 60 percent with a modest annual growth rate between 1.0 -1.4 % from 2030.

GDP, 1000 m€	Prognosis			Annual avg. change in %	
	2020	2050	% of 2020	'20-'30	'30-'50
Slovenia	40,9	62,13	152,1%	1,6	1,3
Hungary	117,1	192,32	164,2%	2,2	1,4
Slovak Republic	89,0	142,70	160,3%	2,7	1,0
Poland	492,5	793,50	161,1%	2,4	1,2
EU28	**14 549,9**	**22 526,05**	**154,8%**	**1,4**	**1,5**

Table 20: GDP projection in 1000 m € (at 2013) and annual change

The composition of the EU GDP continues to show the current trends with high and increasing shares of private consumption followed by investments and government

[8] OECD ECONOMIC OUTLOOK, June 2020

consumption. Private consumption continues to account for the largest part of GDP in the EU up to 2050. [9]

China's future economic performance (and that of other larger economies) is not to be ignored when the prospects, the volume of international transport to the port of Koper (or via landbridge, Terespol e.g.) is estimated. According to a PwC study (2017) China's projected share of world GDP at PPPs by 2050 will reach 20%.[10]

The figure below reveals that as opposed to the stable but modest growth of the EU27 that the economic growth rate in the Far-East (in China and India in particular) will substantially drop in the upcoming decade. Although the growth rate continues to decline, the overall expansion of these economies is still higher than that of the EU. (Note that such projections do not consider the recent crisis)

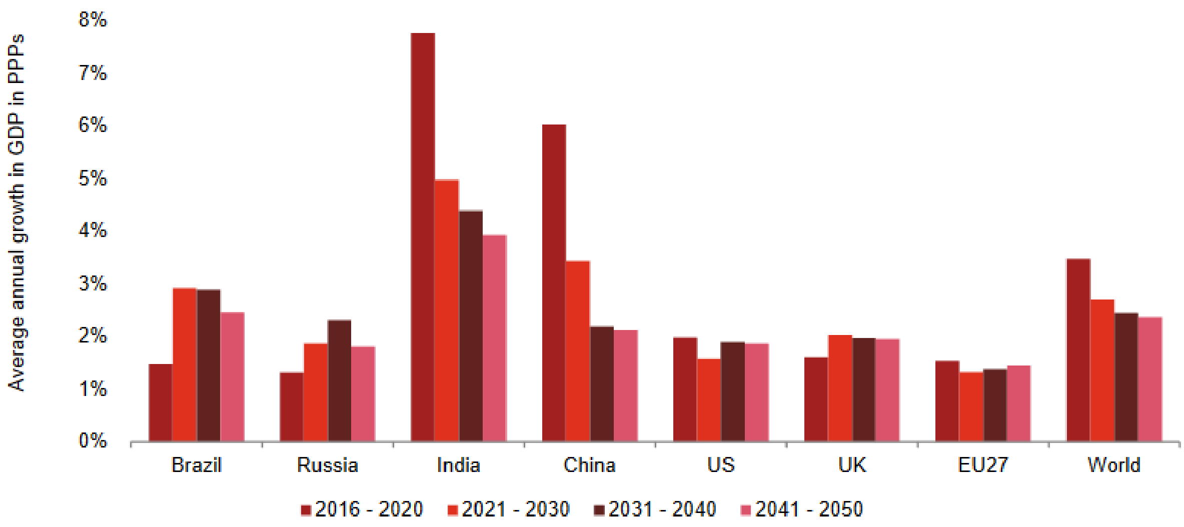


Figure 34: Projected annual economic growth profiles for the largest economies[11]

6.2.1 General goods transport and rail freight forwarding trends

The volume of freight transport is mostly subject to the GDP change of a given country. Nevertheless, due to the globalisation of the production and trade, global trends are even more impacting the freight traffic to and from seaports distorting the above direct correlation.

The importance of internal market of European Union is highlighted by the fact that the internal trade (total export and import volumes) in all RFC Amber states exceeds the total trade volumes with third countries (see figure). The proportion of intra EU trade is among the highest in Hungary, Czech Republic and Slovak Republic and it dominates trade in Slovenia too.

[9] *EU Reference Scenario, 2016*
[10] *The World in 2050, PwC Report 2017 - https://www.pwc.com/gx/en/issues/economy/the-world-in-2050.html*
[11] *The World in 2050, PwC Report 2017 - https://www.pwc.com/gx/en/issues/economy/the-world-in-2050.html*

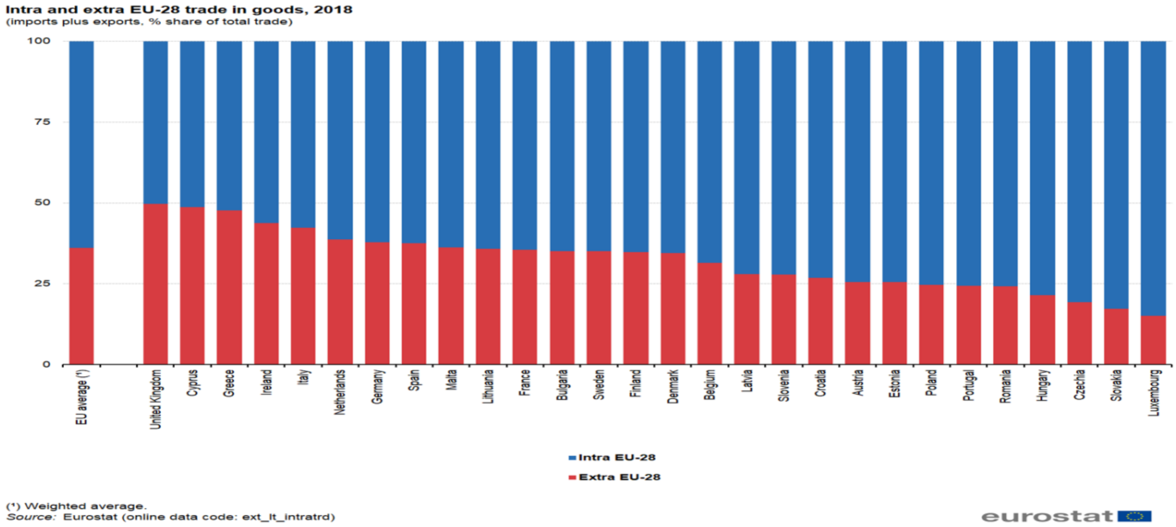


Figure 35: Share of intra and extra EU28 trade by country (%), 2018

The three largest global players of international trade include the EU28, China and the USA (see figure). The overall volumes of goods traded (export and import) in the EU28, China and the USA were almost the same in 2017. Market players[12] claim that transport volumes form overseas significantly dropped in the first four months of 2020 due to the corona virus crisis (e.g. container cargo to Rotterdam reduced by 25%, similarly, airfreight from China has been heavily impacted too). It is claimed that the share of rail freight has increased in the period of restrictions and it will be maintained after the pandemic as customers are getting more environmentally conscious and will seek more cost-effective ways of transport, so rail seems to be a good alternative. However, railway undertakings have to be more flexible, administrative procedures at borders need to be improved and infrastructure parameters e.g. in the north-south axis lines in Poland requires upgrade to enable competitive speed and running of longer trains too. On the other hand, low fuel prices may boost road transport when the transport restrictions are eased.

[12] *Webinar "Intermodal Poland during the corona crisis", RailFrieght.com*

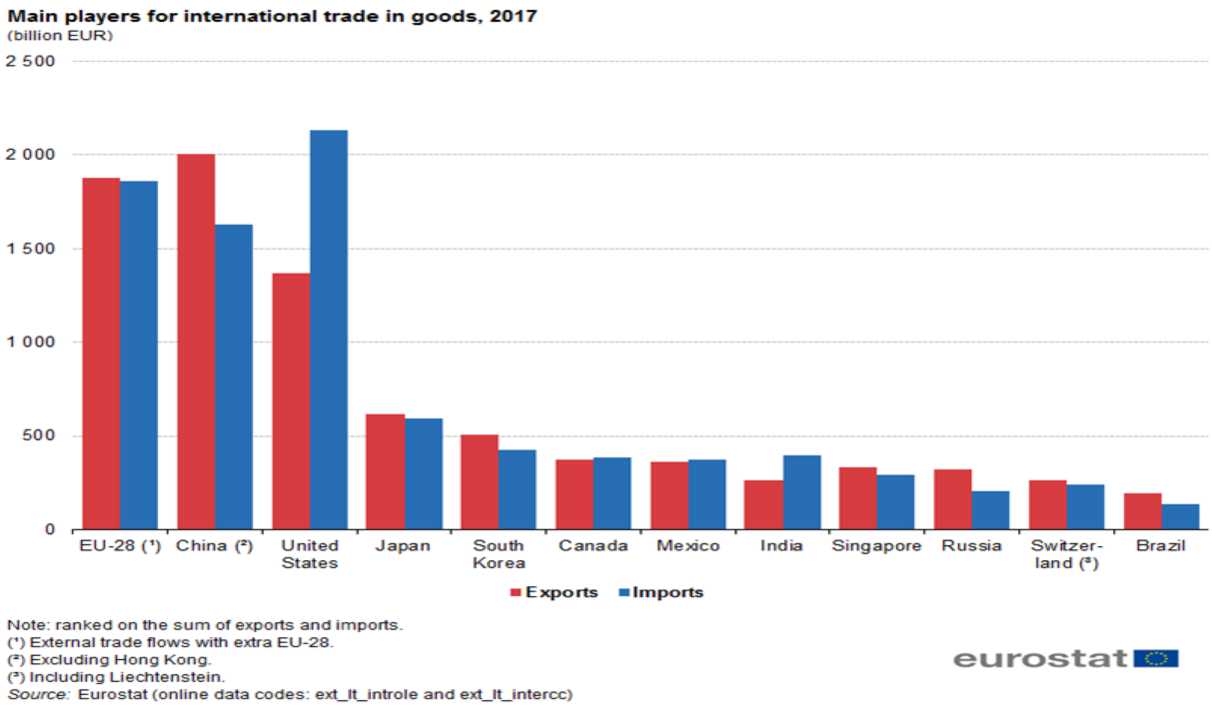


Figure 36: Main players in international trade, 2017

In 2018, almost one fifth of the import (19.9%) to the EU28 originated from China securing the first position for China in the list of EU importers. The share of the United States in import to the EU28 was some two thirds (13.5%) of that of China. Global increase of e-trade has boosted the import contributing to China's the USA's dominance in the import market.

„Transport activity shows significant growth, with the highest increase during 2010-2030, driven by developments in economic activity. Transport investments (expenditures related to transport equipment) steadily increase over time but maintain a relatively stable share of GDP (i.e. between 4% and 4.5% of GDP throughout the projection period)"[13]

6.3 Future traffic (2030 and 2050 projections)

6.3.1 Traffic forecast on RFC Amber lines

Demand analysis relies on the Corridor Transport Market Study (TMS) for short term. The TMS gave an account of the traffic demand and forecasted future transport volumes to support corridor justification. However, the Market Study forecast ends with year 2026 and stands on a prognosis before current economic crisis due to COVID-19 pandemic worldwide that justifies correction in its results. In medium- and long-term, forecast can rely on international, general economic trends (including general economic and social indices, transport performances, foreign trade figures from e.g. Eurostat), structural developments, demand growth of the logistics industry (considering e.g. transport modes, routes, types of goods) and other relevant factors.

[13] *„EU Reference Scenario, 2016 – Energy, transport and GHG emissions, Trends to 2050" (https://ec.europa.eu/energy/en/news/reference-scenario-energy)*

Consequently, traffic forecast is prepared using:

- Qualitative and quantitative analysis of current and historic transport demand – particularly freight transport – based on statistics (official such as Eurostat and RFC Amber IM data supply, too) and findings of previous surveys,
- Short term forecast of the Transport Market Study (TMS) through 2026; however, the forecast trend has been revised on the basis of the latest OECD GDP forecasts for 2020 and '21 due to the economic impacts of the COVID-19 pandemic (considering actual values and the recent forecasts),
- General economic, social and transportation trends on medium- and long-term forecasts, applying for 2030 and 2050 (in coherence with the time horizon of the EU White Paper on Transport), based on OECD and EU forecasts and also considering the impacts of the foreseen changes of the (railway) infrastructure on railway transport efficiency (e.g. longer trains).

The traffic forecast relies on the already available data sources and forecasts, such as Transport Market Study of RFC Amber (TMS) for the short term; on long-term, GDP forecast and population projections can be used, primarily the EU "Reference Scenario". Traffic forecast can be based on GDP in general thank to the correlation between these two parameters (however, global trends impacting freight traffic distort the correlation).

In fact, internal trade in all RFC Amber states exceeds the total trade volumes with third countries. For short term, a modest but steady growth on Amber is supposed through 2026. However, impact of COVID-19 epidemic – a major unseen occurrence in 2020 – on the economic and general transportation demand changes is a new development.

The ambitions of European Union set a significant change in the courses of the last decade, when road transport became dominant, by aiming to reach 30% of rail freight mode share by 2030 (supposing a land freight transport market growth of 30% by 2030).

In the meantime, modal share is wished to change from 15% in 2010 to 18% in 2050. This would result in 84% growth of rail freight transport through 2050.

Forecast assumes that EU policy objectives for TEN-T network will be accomplished as planned.

Over the EU-scale trends, regional differences can be considered:

- Transit freight train traffic forecasts can be based on general economic and traffic forecast of the EU,
- Domestic and international freight train traffic forecasts can be differentiated also by country economic forecasts.

Traffic on RFC Amber sections are forecasted – future bottlenecks can be spotted by identifying sections having at least moderate problems currently and/or high traffic growth potential is assumed.

Short term trends

RFC Amber short-term traffic forecast for 2026 was presented in the Transport Market Study (TMS). TMS outlines three growth scenarios for freight transport and RFC AMBER freight transport through 2026, all three showing a modest but steady growth in gross million tonne-km for RFC Amber. The realistic scenario forecasts 38% growth of RFC Amber transport volume from 2019-2026 reaching as much as 51 million gross tonne-km. This growth rate considerably exceeds the projected 21% growth in total freight transport.

The increasing trend of transport performances can be assumed on the basis of the prognosis – though current developments in global economy due to the virus pandemic may cause major decline in overall trade volumes and demand for logistics in the short term.

Such „optimistic" increase of rail freight transport is not supported by the EU Reference Scenario, 2016 (see above) or declining share of railways suggested by other studies for the longer run.

The European land freight transport market will grow by 30% by 2030. Today, 18% of transport operations (in terms of ton-km) have been performed by rail indicating the high affinity to road which is a major challenge for railways. Goods with a high rail affinity will likely see a negative trend with a compound annual growth rate of -1.1% for goods suitable for full train services and -0.5% for goods suitable for single wagon services (through 2025). The ambition is to reach 30% of rail freight model share by 2030 to prevent negative effects of transport growth.[14] Efforts to support rail transport, however, suggest that the general cargo volume increase can partly be shifted to rail in case the rail freight service is able to provide adequate quality and capacity (reliable, timely train runs, demand driven supply)

Of course, the forecast in the Transport Market Study ignores the economic impact of the COVID-19 crisis which is expected to hit the global economy quite hard this year. So, taking into account the assumption above we have revised the short-term forecast scenarios for total freight traffic. Considering the global recession in 2020 and the rate of recovery for next year provided by OECD Economic Outlook the growth rate of the three scenarios have been changed. The year 2020 volumes in the pessimistic, realistic and optimistic scenarios are assumed to show at least -12, -10 and -8 percent decline on year 2020 and a steady annual growth of 0 (stagnating economy), 1 and 2 percent is anticipated respectively starting in 2021. The linear trend lines in the figure show that the 2019 freight traffic performance will resume in 2022 in the realistic scenario and will not be reached before 2025 in the pessimistic scenario.

Long term trends

Freight transport activity by all modes is projected to triple in 2050 (base scenario), closely tracking the growth of global GDP. Rail accounted for 7% of global freight activity in 2017 and 5% is projected in 2050 (rail growing less than shipping and road freight transport). The modal share of rail in surface freight (i.e. excluding shipping) falls even more notably, from 28% 2017 to 23% in 2050. European rail freight activity reaches more than 550 billion tonne-kilometres in 2050 (43% up from 2017), but the rate of growth is lower than in all other main freight regions. By 2050, China, India, Russia and the United States continue to account for about 80% of global freight rail activity. Minerals, coal and agricultural products account for the bulk of total freight rail activity.[15]

In the EU Reference Scenario 2016 the projections show an increase in the total freight transport activity by about 58% (1.2% p.a.) between 2010 and 2050. [16] As regards rail freight, it features the highest growth among the inland freight transport modes (84%, equivalent to 1.5% p.a.) and **increases its modal share from 15% in 2010 to 18% in 2050**. The significant increase in rail freight transport activity is mainly driven by the completion of

[14] *30 by 2030 Rail Freight strategy to boost modal shift, White Paper - European Rail Freight Vision 2030*

[15] *IEA The Future of Rail, Opportunities for energy and the environment, Technology report — January 2019*

[16] *EU Reference Scenario, 2016*

the TEN-T core and comprehensive network which are expected to improve the competitiveness of the mode.[17] A well above average growth of freight transport activity in the RFC Amber countries is envisaged (see table, source EU Reference Scenario, 2016). The expansion of freight performance in general and rail freight alike is the highest in Slovenia and Poland through 2030. Rail freight transport activity in Slovenia is expected to increase by at an outstandingly high rate of 3.6-3.9% in the next two decades presumably as a result of transit transloaded in the Port of Koper.

								Annual % change in the forecasted decades		
Freight transport (Gtkm)	**2020**	**2025**	**2030**	**2035**	**2040**	**2045**	**2050**	**'10-'20**	**'20-'30**	**'30-'50**
Slovenia	15,2	17,8	20,0	21,9	23,6	25,1	26,7	3,3	2,8	1,4
Hungary	37,8	41,6	45,2	48,4	51,1	53,3	56,0	1,1	1,8	1,1
Slovak Republic	26,1	29,0	32,1	34,3	35,7	36,6	37,3	1,8	2,1	0,8
Poland	227,5	258,2	286,2	308,2	328,1	341,8	350,3	3,0	2,3	1,0
EU28	**2 980,8**	**3 220,3**	**3 457,5**	**3 631,0**	**3 802,0**	**3 937,3**	**4 050,6**	**1,5**	**1,5**	**0,8**
								Annual % change in the forecasted decades		
Rail freight transport (Gtkm)	**2020**	**2025**	**2030**	**2035**	**2040**	**2045**	**2050**	**'10-'20**	**'20-'30**	**'30-'50**
Slovenia	4,9	6,1	7,1	8,0	8,8	9,5	10,3	3,6	3,9	1,8
Hungary	10,7	12,2	13,6	14,8	15,9	16,9	17,9	2,0	2,4	1,4
Slovak Republic	9,7	11,2	12,7	13,8	14,6	15,1	15,4	1,8	2,8	1,0
Poland	60,7	69,2	76,7	82,3	86,8	90,4	92,1	2,2	2,4	0,9
EU28	**482,2**	**533,0**	**580,3**	**618,9**	**662,5**	**694,7**	**723,6**	**2,0**	**1,9**	**1,1**

Table 21: Freight transport projection in the RFC Amber countries (Gtkm) (EU Reference Scenario, 2016)

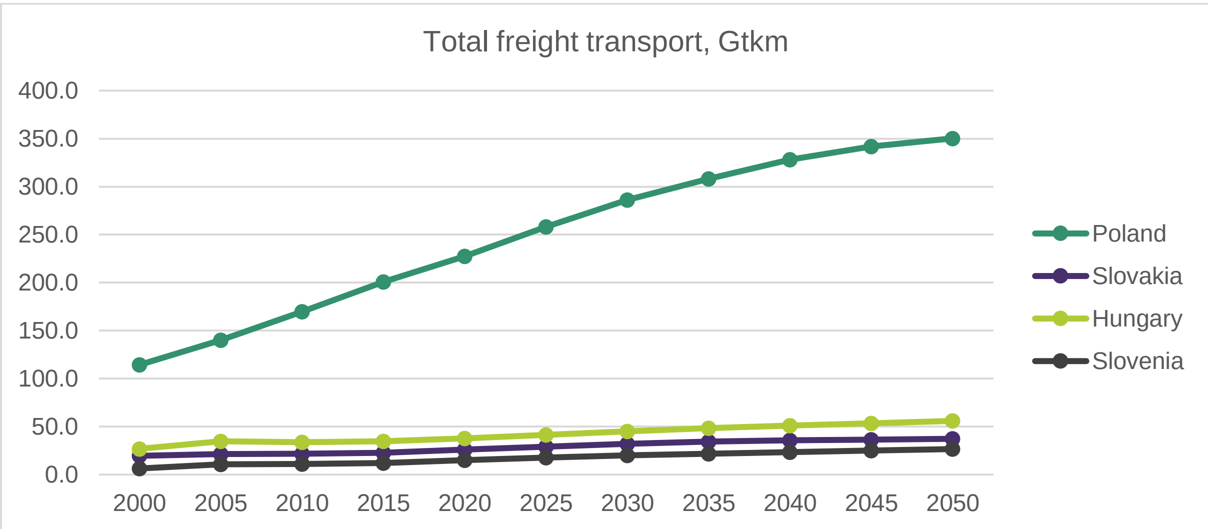


Figure 37: Development of total freight transport in the RFC Amber countries (EU Reference Scenario, 2016)

[17] *EU Reference Scenario, 2016*

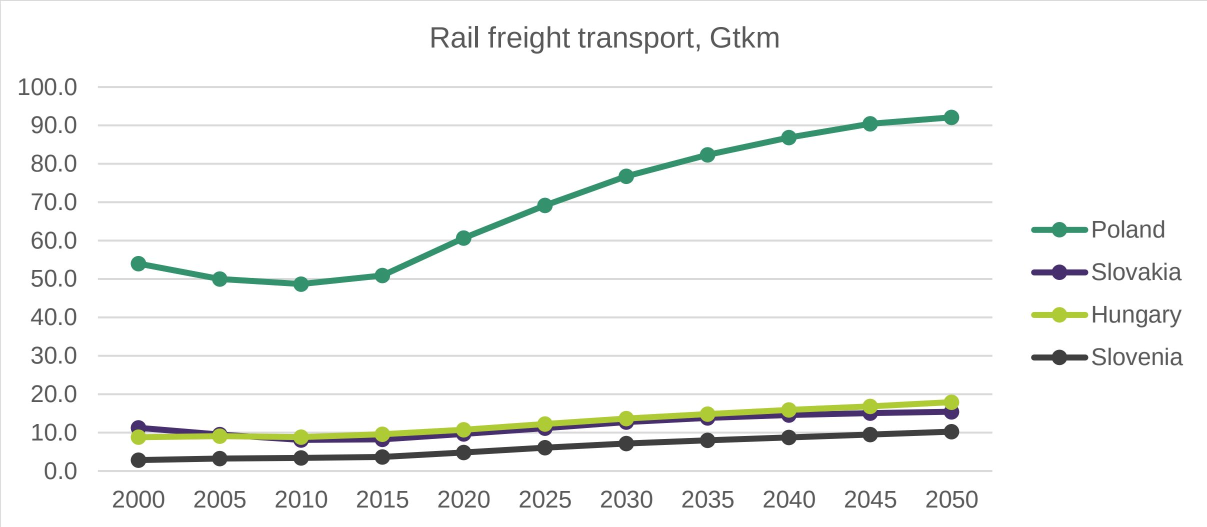


Figure 38: Development of rail freight transport in the RFC Amber countries (EU Reference Scenario, 2016)

As a result of envisaged railway network interventions, the capacity of freight trains can be enhanced with better infrastructure parameters; a single train can carry higher volumes of goods, so the increase of transported cargo volumes will not be in linear correlation with the growth in the number of trains; rail transport service is expected to be favoured by freight train operators in the future.

Forecast to identify future bottlenecks

Based on previously described inputs and considerations, TMS short term forecast needs correction due to the impacts of pandemic on the economy and on the freight transportation. To support this, OECD and other international data on actual and expected GDP correction in 2020-2021 is available (based on actual data from first half of 2020). Similar correction in rail freight performances can be applied, resulting in the following forecast in rail freight performances by member states (base year is 2018 as that is the available statistics for RFC Amber currently):

RFC, tonkm, 2018 base	2018	2019	2020	2021	(…)	2030	(…)	2050
Slovenia	100%	102,4%	93,1%	97,3%		113,1%		196,4%
Hungary	100%	104,9%	94,4%	101,8%		118,4%		157,7%
Slovak Republic	100%	102,3%	90,9%	95,9%		111,6%		145,0%
Poland	100%	104,1%	94,2%	98,0%		114,0%		143,1%
			COVID corr.					

Table 22: Railway performance forecast by member states to short, mid and long term

In medium- and long-term, a transportation efficiency change can be supposed due to the fact, that the infrastructure developments and EU TEN-T objectives can allow running longer and heavier trains on many destinations. This correction is applied in the 2030-2050 period, as follows (efficiency change based on 2018 train parameters):

- 10% by 2030
- 15% by 2040
- 20% by 2050

This results in lower development in number of freight trains compared to the above presented ton km performance.

RFC, no. of trains, 2018 base	2018	2019	2020	2021	(…)	2030	(…)	2050
Slovenia	100%	102,4%	93,1%	97,3%		102,9%		163,7%
Hungary	100%	104,9%	94,4%	101,8%		107,6%		131,4%
Slovak Republic	100%	102,3%	90,9%	95,9%		101,5%		120,9%
Poland	100%	104,1%	94,2%	98,0%		103,6%		119,2%
			COVID corr.					

Table 23: Train traffic forecast by member states to short, mid and long term

6.3.2 Expectations towards rail freight transport

It has to be highlighted that considerable increase of rail freight activity on the RFCs is subject to scheduled implementation of infrastructure developments on core and comprehensive network sections improving parameters to comply with TEN-T requirements. The forecast assumes that Union policy objectives for TEN-T network will be accomplished as planned.

Punctuality and reliability as well as high network access charges are the most important factors determining the competitiveness of rail freight transport[18]. To meet user expectations the infrastructure conditions (railway and logistics) need to be ensured in the first place.

Earlier, price (access charge) was a dominant factor, however, today punctuality and reliability are in the focus. These days freight transport is preferred if trains run by the schedule, service is reliable at reasonable cost, relative flexibility is ensured while the actual length of travel time – with the exception of some specific types of goods – is less important.

Currently, experience proves that infrastructure managers often fail to satisfy RFC requirements, RFC paths do not enjoy preferential treatment, capacity restrictions are very often not harmonized, and overregulation adversely effects RUs' activity. As a consequence, reliability cannot be ensured, the expansion of rail freight market is jeopardised.

6.3.3 Main types of cargo

Role of combined transport

Regarding the global logistics trends, it can be expected that the combined transport volumes remain on a steady rise, unlike the general rail freight volumes which have been almost the same for the last ten years. Since 2005, combined transport traffic volumes increased by 50 per cent. Compared to 2015, the figures rose by 7.2%. And the future looks bright: the expectation is that in the next two years, the volumes increase by around 10 per cent.

The lion share of combined transport in Europe is unaccompanied, and the key driver for growth is international traffic. Cross-border movement has grown by 81 per cent since 2005, and 12 per cent since 2015. The total volume of combined transport traffic amounted to 22.5 million TEUs in 2017. The rail leg is on average around 800 kilometres.

For freight rail, a key opportunity is to closely connect with other transport modes and to insert these optimally within the logistics supply chain - intermodal integration.

[18] *According to a user survey prepared for the masterplan on the Hungarian section of the RFC Mediterranean, 2018, TRENECON*

Containerisation and standardisation of the size of freight loading units are essential to facilitate door-to-door intermodal solutions in conjunction with road.

The increased volume of transported goods and implementation of rail developments in accordance with the union policy goals supporting the share of rail freight transport suggest that the demand for rail freight service will increase steadily. Container (and swap body) transport by rail has been growing with some fluctuation in all four countries (source: Eurostat):

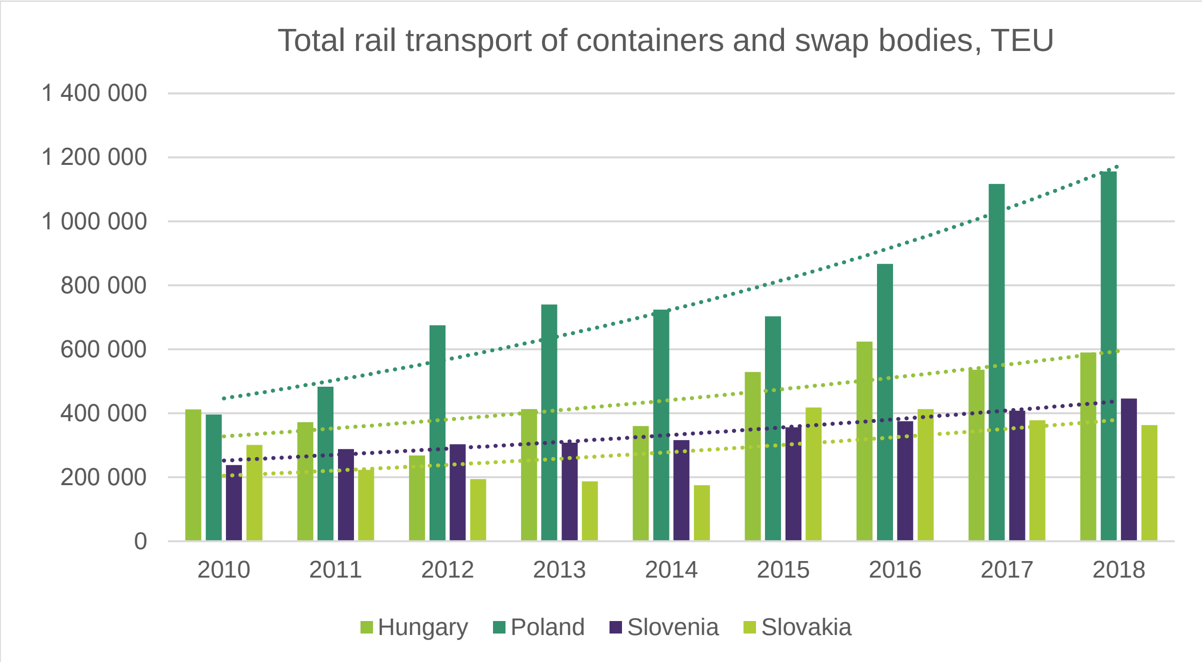


Figure 39: Total rail transport of containers and swap bodies in the RFC Amber countries (TEU)

The majority of container rail freight transport is international transport – except for Poland where close to two thirds account for domestic transport. As opposed to total international container traffic transit traffic seems to be marginal in Slovenia while transit accounts for almost 40% in Hungary.

	international/total %	transit/total %
Slovenia	89%	4%
Hungary	61%	38%
Slovak Republic	87%	6%
Poland	30%	24%

Table 24: Share of international and transit traffic in container transport, 2018

Also, considerable and steady growth in traffic has been observed and foreseen from both the ports of Koper and Pireus (GR) as a result of expanding container traffic from China. The increase of rail freight transport will be strengthened by the improvement of rail services (improved infrastructure parameters) and thus, the modal shift from road transport.

Slovak Republic has secured a competitive edge when establishing container terminals and transloading terminals absorbing traffic even today from Hungary. Transport of swap bodies, semi-trailers (the so-called huckepack transport) has been gaining ground (e.g. in

Austria), however without the establishment of intermodal logistic centres at large rail nodes close to high traffic industrial zones this technology cannot be viable.[19]

Other types of goods

International and transit rail freight transport is expected to grow mostly attributed to expanding transport of agricultural produces and chemical industry products in addition to container traffic. Also, the growing demand for building industry materials and the growth of automobile industry, electronics industry is anticipated to boost rail freight market.

On the other hand, a moderate decrease in the transport of fossil fuel products and coal due to slackening industrial production is foreseen, however the transport from e.g. Russia in the Poland – Belarus axis remains robust and stable.

6.3.4 Links of RFC Amber outside the European Union

Port of Koper

Southern European ports as Piraeus, Koper, Trieste and Barcelona have been growing significantly. In some cases, this can be explained by the investments made by the Chinese governments was part of its Belt and Road initiative. Due to such investments, these ports could become strong alternative gateways into Europe. The port of Koper saw a high increase in general container throughput (51.8%) and in rail freight transportation (33.4 %) in the period 2013-2017.[20]

The Port of Koper is one of the main seaports in Southern Europe providing a wide range of logistics services, connection to several corridors (RFC Baltic-Adriatic, RFC Mediterranean and RFC Amber). It has the full spectrum of terminals including container and Ro-Ro terminals and has been expanding transloading, storage capacities. Its vision is to be the leading operator of port services in the Adriatic which suggest fast growing rail cargo transport (today accounting for two thirds of cargo transport) to and from the port in the future with container throughput showing the most dramatic increase reaching over 38% in 2017 (911 528 TEU) By 2020, the capacity of the container terminal was planned to be increased to 1.3 million TEU per year.[21]

The Transport Market Study of RFC Amber envisaged good transport potentials for the automotive and machine industry to and from the port of Koper on the Amber Corridor.

Container traffic between Poland and the Slovenian port of Koper has reached a new milestone. In 2018, Baltic Rail delivered 13,464 TEUs of goods, demonstrating a volume increase of 30 per cent compared to 2017. All types of cargo showed volume increase on the Wroclaw – Katowice/Ostrava – Koper route. The main share was secured by the electronic and automotive industries.[22] Baltic Rail forecasts that the volumes will continue to increase this year and container traffic will reach a figure of 17,200 TEUs.

The Euro-Asian landbridge

At the same time, it is an explicit endeavour to increase the share of direct railway transport of goods from China to Europe bypassing the long sea route and avoiding a change of

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[19] *According to a user survey prepared for the masterplan on the Hungarian rail line no. 80, Budapest – Miskolc – Nyíregyháza – Záhony, a section of the RFC Mediterranean, 2018, TRENECON*

[20] https://www.railfreight.com/intermodal/2019/02/11/can-ports-as-piraeus-koper-and-trieste-win-the-hinterland-volumes/

[21] *Transport Market Study, RFC Amber, 2018*

[22] https://www.railfreight.com/tag/port-of-koper/

transport mode. However, transloading operations are required even on the Euro-Asian Landbridge, due to different track gauges.

RFC Amber connects to the Euro-Asian rail landbridges with interfaces (transshipment terminals) to the broad gauge-system (1520 mm) at three locations: Terespol (PL), Slawkow (PL) and Košice (SK). In terms of volume, Terespol dominates international traffic as an entry and exit point of Euro-Asian rail traffic to and from the EU. In 2018 approximately 6,300 trains[23] crossed the border between Belarus and Poland with the majority using the Terespol link of the New Silk Road using the terminals in Małaszewicze and Brest.

Euro-Asian rail traffic constitutes an important growth potential for rail freight on RFC Amber in the future. It is indicated by infrastructure capacity expansion plans. According to some sources the Polish Railways (PKP) are planning to expand the Terespol station by 10 broad-gauge 1520 mm railway lines. The infrastructure will be adapted to heavy trains with lengths up to 1050 m and loads of 25 tons per axle.[24] Major efforts to improve the Euro-Asian rail routes are in progress east of the EU, both in connection with Russian Railway RZDs “Transsib-in-7-days”-program as well as in the context of the Chinese Belt-and-Road-initiative, gradually improving and establishing further route options.

Budapest – Belgrade corridor

Kelebia station is the railway station and border crossing in southern Hungary, border with Serbian Republic. The station is administratively also the end station of RFC Amber as the (TEN-T core) corridor leaves the territory of the European Union here.

Line is under development currently to increase capacity and level of service on the Budapest-Belgrade railway corridor (including building of second track); as a result of the investment, Kelebia border station will be upgraded as well. The handover station is Subotica that is also under reconstruction.

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[23] *source: Report on rail transport market operations in 2018, UTK Warsaw 2019*

[24] *source: https://asstra.com/press-centre/news/2019/12/balancing-the-rail-link-between-europe-and-china-with-asstra/*

7 Identifying infrastructure and capacity bottlenecks

7.1 Definition of bottlenecks

Required service level and quality on the railway network elements largely depends on the function of the network such as freight or passenger transport focus of the particular line. High quality railway service can meet both quantitative and qualitative demands of passenger or freight transport.

The basic approach for corridor bottlenecks is worded in Regulation 1316/2013 of the EU „*… a physical, technical or functional barrier which leads to a system break affecting the continuity of long-distance or cross-border flows and which can be surmounted by creating new infrastructure, or substantially upgrading existing infrastructure, that could bring significant improvements which will solve the bottleneck constraints*".

In terms of **infrastructure**, bottlenecks are deemed to be the parameters of the main infrastructure elements that fail to ensure interoperability and TEN-T requirements for core network. Such failure thus interferes with future growth of railway transport.

Identification of the location of such bottlenecks (capacity constraints manifested in delays or use of alternative path) will be possible primarily on the basis of data provided by IMs (and from available documents, databases) in a consolidated excel file compiled by the Contractor, the content of which is based on the available documents like CID, TMS, Network Statements. Contractor reviews available documents, data till mid-April, submits a structured, consolidated data request on infrastructure (including last mile) to IMs followed by a request for additional traffic data at the end of April. IMs are requested to provide feedback in the first week of May for common understanding while data are expected by the end of May. After identifying missing data Contractor addresses the IMs for a second round of data provision in the first half of June and conducts consultations with IMs (skype interview, questionnaire) to interpret data and operational and traffic management information. A fundamental approach to that is the relationship between the current traffic and the available capacity.

Technical parameters of the infrastructure will be assessed qualitatively too. The identification of infrastructure bottlenecks is supported by GIS based processing and graphic presentation (data presented on maps). This allows illustrative and effective assessment of main features as required by ToR (basic TEN-T and TSI requirements like 740 m train length, 22.5 ton axle load, 100 km/h speed, ERTMS or electric traction, but also other parameters, e.g. 8.0 t/m loading performance, P400 intermodal semi-trailers) and also allows apperception of missing or conflicting data.

On the other hand, capacity problems different from infrastructure bottlenecks obviously exist in the corridor too. Administrative and/or operational deficiencies, characteristics causing inadequate capacity supply or ineffective use of the infrastructure can be described and assessed in a qualitative manner. It means that we can give a descriptive account of the current status of such features to the extent of exploring logical links and underlying causes heavily relying on the data from the competent organisations.

Railway nodes to be improved (typically in densely populated areas) identified by the IMs and cross-border points with particular procedures in place can be individually analysed. Assessment of the procedures performed at border crossing points along the corridor will primarily focus on time requirement of the specific procedures (e.g. brake test, train check).

In the course of bottleneck classification, the different bottleneck factors are grouped and assessed according to the aspects approved by the Contracting Authority, and a bottleneck matrix will be produced and later discussed with the ad-hoc bottleneck working group and the advisory groups (RAG and TAG) too. Classification can be based on e.g. whether it impacts exclusively freight transport or also passenger transport; whether elimination is subject to infrastructure development or other intervention, what impact it has on traffic or competitiveness and effectiveness. Such factors can be weighed in consideration of current and future function of the line or of the preferences of IMs and other stakeholders.

Approach for the evaluation considers the following:

- Corridor approach will be applied but considering the national priorities (therefore problems are presented by member states)
- User-oriented analysis: train forwarding will be regarded as a service (from train path request to arrival at destination),
- „Competitiveness” and “efficiency” will be evaluated as complex factors determined by the many types of bottlenecks,

7.2 Methodology for evaluation of bottlenecks

The identification and evaluation of bottlenecks is based on the collection and consolidation of data on current infrastructure deficiencies and capacity problems (both factual and qualitative from IMs), including summarisation in tables and graphic representation. Based on traffic forecast, assessment of current and future bottlenecks is done, with emphasis on their impact on competitiveness of the Amber Rail Freight Corridor.

- To support this, the following steps are done:
- Classification of line sections by their relevance (importance) in RFC traffic operation
    - Definition of a compound index of TEN-T compliance
    - Definition of traffic category based on current and forecasted traffic
    - Definition of section relevance
- Proposed interventions on sections
    - Intervention priority of sections
    - Type of intervention to eliminate bottlenecks
    - Feasibility and time frame for realization

The official RFC Amber documents and RFC bodies (e.g. RFC Amber CID Book 5 – Implementation plan, TMS and RAG-TAG) have identified previously the infrastructure bottlenecks along the corridor, however, these did not categorized the issues nor ranked them by impact or importance, nor they forecasted future capacity issues. These are also considered as inputs for bottleneck characterisation and classification.

7.3 Identifying infrastructure and capacity bottlenecks along the lines

Bottlenecks on the infrastructure can be defined by two main parameters:

- Infrastructure bottlenecks are identified by using the compound index (representing the overall state compared to the TEN-T requirements) and the evaluation of the main problematic parameter(s)
- Limited or no free capacity for further freight trains (overall capacity problems are present)

7.3.1 Categorisation of TEN-T compliance using a compound index and capacity issues of the lines

Overall state of the infrastructure parameters

The service level on the line sections i.e. the competitiveness of rail freight service is subject to the above parameters, however they impact perceived service standard differently. The individual infrastructure parameters are not suitable to judge the overall appropriateness of the line sections against the TEN-T requirements. Besides, the relevance of infrastructure parameters for railway undertakings is not identical; for example, train length or axle load are more important than track gradient for their business. Therefore, a more accurate evaluation of the sections in terms of competitiveness (need for improvement) can be made if these factors are compared with actual user expectations. To this end, a compound index has been produced, using the different characteristics described previously.

This compound index is a theoretical and complex manifestation of the combination and weighting of parameters. It has been developed to enable comprehensive but simple comparison of compliance with required corridor parameters – eventually, theoretical comparison of the need for improvement – also taking into account market players' expectations. Each parameter in the compound index is weighted by its importance and a compound index score for individual section has been generated by comparing the actual infrastructure values against the TEN-T minimums. The higher the overall score is, the better the infrastructure is in terms of interoperability and level of service. Note, that it is a theoretical and focused approach and several other factors – such as capacity utilisation, funding source, environmental issues, national priorities, etc. – will and may affect what sections are to be developed.

Market relevance of infrastructure parameters

The RUs, represented by RAG and its spokesperson in the WG meetings, shared with us the priorities mostly influencing the cargo forwarding efficiency on rail and the competitiveness of the Rail Freight Corridors, and RFC Amber in particular.

The following table summarizes the main parameters that has the highest impact on the rail freight sector in terms of infrastructure conditions. The table also gives a brief assessment of the relevance of these parameters by the RUs.

The main infrastructure parameters influencing RU train forwarding efficiency the most and their relevance on RFC Amber are as follows:

- Electrification that is almost complete along RFC Amber but there are differences in the current system applied (25kV vs. 3kV)
- Train length and train load/weight capacity is low on almost 50% of the network
- Line speed is appropriate on more than 60% of the network but restrictions are frequent and traffic management (O&A) problems reduce the circulation speed and reliability of transportation significantly.

Infra parameters	Required min.	Importance for RUs	RU issue	RFC AMBER relevance
Traction	electrified	decisive (route choice)	some sections are diesel and different voltages (25 vs. 3kV) also causes extra cost	93% is electrified but different current systems
Number of tracks	-	not important in itself	only punctuality and capacity matters, number of tracks has indirect impact on this	55% double track
Axle load category	22.5t	important efficiency criteria	D* category needed for modern locos (>21t per axle)	54% is D3 or D4 (22.4 tons/axle)
Maximum gradient	< 9‰	important efficiency criteria	relevant for train gross weight, ideal would be <4.5‰	63% of the corridor is <9.00‰
Max. speed for freight trains	100km/h	important efficiency criteria	average circulation speed is more relevant than line speeds themselves	60% of the corridor is ≥100km/h (considering line speed)
Max. freight train length	740m	important efficiency criteria	train length is core for efficient use of resources	28% is appropriate for ≥740m trains
ERTMS equipment	ETCS	less important criteria	other parameters determine operation efficiency	GSM-R (w. or w/o. ETCS) is installed on 34%
Intermodal gauge	P/C 80/400	important efficiency criteria	high-cube containers' requirement; physical gauge can be an issue, but administrative problems also occur (e.g special permission for HQ container trains)	mainly structures/tunnels can cause restriction but considered exceptional cargo in Hungary, Poland

Table 25: RUs' assessment of main infrastructure parameters affecting rail competitiveness

Calculating compound index scores for sections

We adopted the concept of formulating a compound index for individual sections on RFC Amber lines by scoring the main infrastructure parameters and attaching a weight factor to each of them. By nature, the interest of IMs and RUs aren't always equal. IMs want to take advantages of the rail infrastructure in terms of fix costs and capacity utilisation, while RUs want to ensure economic use of its resources (personal and rolling stock constrains) in accordance with orders and customer needs (lack of flexibility, PaPs use, dwelling time, last mile etc.). The weighting was concluded after a joint discussion with IMs and RUs, taking both parties' proposals, comments into consideration.

The index is an overall indicator of compliance of TEN-T parameters for each line sections of RFC Amber. Its purpose is to make the comparison of the sections possible using one "synthetic" indicator. It shows how the section meets the requirements of the interoperability requirements defined in TSIs and the TEN-T regulation.

The compound index will have an important role in definition and assessment of infrastructure interventions, priorities. The index was calculated by weighted aggregation of the individual infrastructure parameters. Based on the current status, a score was given, according to the following table:

Parameter	Weight	Parameter values and their score in compound index					
max. train length	25%	≥740m	600-739m	400-599m	<400m		
		5	**4**	**2**	**1**		
axle load and linear load	25%	D4 22.5 t/axle 8 t/m	D3 and D2 22.5 t/axle, 7.2 and 6.4 t/m	C4 and C3 20 t/axle 8 and 7.2 t/m		C2 20 t/axle 6.4 t/m	A- <16 t/axle <5 t/m
		5	**4**	**3**		**2**	**1**
line speed	10%	≥100 km/h	80-99 km/h	50-79 km/h	<50 km/h		
		5	**4**	**2**	**1**		
restrictions	10%	No or not significant permanent restriction	Justifiable speed limit (geometry, station etc.)	Moderate or only local speed limit (track, structure condition, crossing)		Serious speed limitation (on significant length)	
		5	**4**	**3**		**2**	
max gradient	10%	≤4.5‰	4.5-9.0‰	9.0-12.5‰	>12,5‰		
		5	**4**	**2**	**1**		
loading gauge	10%	≥P/C400	≥P/C400 but administrative restriction		<P/C400		
		5	**4**		**3**		
ERTMS	10%	GSM-R & ETCS L2	GSM-R & ETCS L1	GSM-R	no		
		5	**4**	**3**	**1**		

Table 26: Parameters included in the compound index

Using the weight and base scores, the compound index score has been calculated for each line section. The results are shown in descending order of the scores in Table 27 demonstrating what line sections hinder efficient freight transport on RFC Amber theoretically the most. Lower index value means poorer conditions and parameters. However, note, that these are relative values which allows only comparison of the actual line sections, not to consider them in an absolute way (as the separate line parameters).

To get a more realistic picture, the current capacity use on the individual sections is also included in the next tables (by member states).

Poland

Line	Section	RFC cat.	TEN-T	Length (km)	Compound index score	Capacity
CHABÓWKA - NOWY SĄCZ	Tymbark-Nowy Sącz	future principal	no	39.5	1.40	No traffic
KATOWICE - ZWARDOŃ	Wilkowice Bystra-Zwardoń	principal	core	46.7	2.00	Sufficient capacity
KATOWICE - ZWARDOŃ	Bielsko-Biała Lipnik-Wilkowice Bystra	principal	core	6.9	2.30	Sufficient capacity
KATOWICE - ZWARDOŃ	Bielsko-Biała Glowna-Bielsko-Biała Lipnik	principal	core	1.8	2.50	Sufficient capacity
KATOWICE - ZWARDOŃ	Zwardoń-Zwardoń (G.P.)	principal	comprehensive	0.4	2.70	Sufficient capacity
TARNÓW - LELUCHÓW	Stróże-Nowy Sącz	principal	no	30.8	2.75	Sufficient capacity
KATOWICE - ZWARDOŃ	Czechowice-Dziedzice-Bielsko-Biała Glowna	principal	core	11.5	2.75	Sufficient capacity
TUNEL - SOSNOWIEC GŁÓWNY	Tunel-Bukowno	principal	no	52.3	2.95	Sufficient capacity
KRAKÓW PŁASZÓW - OŚWIĘCIM	Kraków Bonarka-Oświęcim	principal	no	59.3	2.95	Sufficient capacity
TARNÓW - LELUCHÓW	Nowy Sącz-Muszyna	principal	comprehensive	50.6	2.95	Sufficient capacity
WARSZAWA GŁÓWNA TOWAROWA - WARSZAWA PRAGA	Warszawa Gdańska-Warszawa Praga	future principal	core	4.3	3.05	Moderate capacity shortage
TARNÓW - LELUCHÓW	Tarnów-Stróże	principal	no	56.8	3.05	Sufficient capacity
WARSZAWA GŁÓWNA TOWAROWA - WARSZAWA ALEJE JEROZOLIMSKIE	Warszawa Główna Towarowa-Warszawa Aleje Jerozolimskie	future principal	no	2.7	3.05	Sufficient capacity
KRAKÓW PROKOCIM TOWAROWY PRD - KRAKÓW BONARKA	Kraków Prokocim Towarowy PRD-Kraków Bonarka	principal	no	4.8	3.05	Sufficient capacity
KRAKÓW PROKOCIM TOWAROWY PRD - KRAKÓW BONARKA	Kraków Prokocim Towarowy PRD-Kraków Bonarka	principal	core	3.6	3.05	Sufficient capacity
KRAKÓW GŁÓWNY - MEDYKA	Kraków Prokocim-Gaj	principal	no	4.1	3.15	Sufficient capacity
TARNÓW - LELUCHÓW	Muszyna-Muszyna (G.P.)	principal	comprehensive	7.5	3.15	Sufficient capacity
OŚWIĘCIM - KATOWICE	Oświęcim OWC1-Mysłowice Brzezinka	principal	no	17.0	3.25	Sufficient capacity
BUKOWNO - JAWORZNO SZCZAKOWA	Bukowno-Jaworzno Szczakowa	principal	no	11.7	3.25	Sufficient capacity

Line	Section	RFC cat.	TEN-T	Length (km)	Compound index score	Capacity
DOROTA - MYSŁOWICE BRZEZINKA	Sosnowiec Jęzor-Mysłowice Brzezinka	principal	no	7.2	3.25	Moderate capacity shortage
WARSZAWA GŁÓWNA TOWAROWA - WARSZAWA PRAGA	Warszawa Gkówna Towarowa-Warszawa Gdańska	future principal	no	11.9	3.30	Moderate capacity shortage
ŁUKÓW - RADOM	Łuków-Dęblin	principal	no	61.2	3.30	Serious capacity shortage
KRAKÓW PŁASZÓW - OŚWIĘCIM	Oświęcim-Oświęcim OWC	principal	comprehensive	2.0	3.35	Sufficient capacity
KRAKÓW MYDLNIKI - KRAKÓW BIEŻANÓW	Kraków Prokocim-Kraków Bieżanów	principal	core	1.2	3.35	Sufficient capacity
WARSZAWA ZACHODNIA - KRAKÓW GŁÓWNY	Warka-Radom	future principal	comprehensive	46.2	3.40	Sufficient capacity
ŁUKÓW - RADOM	Dęblin-Radom	principal	no	53.9	3.40	Moderate capacity shortage
ŁUKÓW - RADOM	Dęblin-Radom	principal	comprehensive	2.0	3.40	Moderate capacity shortage
LEGIONOWO - TŁUSZCZ	Legionowo-Krusze	future diversionary	no	31.6	3.45	Sufficient capacity
TRZEBINIA - ZEBRZYDOWICE	Oświęcim OWC1-Oświęcim OWC	principal	comprehensive	1.1	3.45	Sufficient capacity
TRZEBINIA - ZEBRZYDOWICE	Oświęcim OWC-Czechowice-Dziedzice	principal	comprehensive	20.8	3.45	Sufficient capacity
OŚWIĘCIM - KATOWICE	Oświęcim-Oświęcim OWC1	principal	no	0.6	3.45	Sufficient capacity
RACIBOROWICE - DŁUBNIA	Raciborowice-Dłubnia	principal	no	1.0	3.45	Sufficient capacity
OŚWIĘCIM OWC - OŚWIĘCIM OWC1	Oświęcim OWC-Oświęcim OWC1	principal	no	0.5	3.45	Sufficient capacity
WARSZAWA ZACHODNIA - KRAKÓW GŁÓWNY	Radom-Tunel	principal	comprehensive	165.6	3.60	Moderate capacity shortage
WARSZAWA ZACHODNIA - KRAKÓW GŁÓWNY	Tunel-Raciborowice	principal	core	42.5	3.60	Sufficient capacity
PODŁĘŻE R 201 - PODŁĘŻE R 101	Podłęże R 201-Podłęże R 101	principal	no	1.6	3.60	Sufficient capacity
JAWORZNO SZCZAKOWA - MYSŁOWICE	Jaworzno Szczakowa-Sosnowiec Jęzor	principal	core	7.3	3.65	Sufficient capacity
WARSZAWA ZACHODNIA - KRAKÓW GŁÓWNY	Warszawa Aleje Jerozolimskie-Czachówek Górny	future principal	no	29.4	3.70	Sufficient capacity
WARSZAWA ZACHODNIA - KRAKÓW GŁÓWNY	Czachówek Górny-Warka	future principal	comprehensive	21.2	3.70	Sufficient capacity

Line	Section	RFC cat.	TEN-T	Length (km)	Compound index score	Capacity
KRAKÓW GŁÓWNY - MEDYKA	Krakow Biezanow-Podłęże R 101	principal	core	6.0	3.70	Sufficient capacity
KRAKÓW GŁÓWNY - MEDYKA	Gaj-Podłęże R 101	principal	no	8.9	3.70	Sufficient capacity
KRAKÓW MYDLNIKI - PODŁEŻE	Dłubnia-Podłęże	principal	no	18.3	3.80	Sufficient capacity
KRAKÓW MYDLNIKI - PODŁEŻE	Podłęże-Podłęże R 201	principal	no	2.5	3.80	Sufficient capacity
WARSZAWA GŁÓWNA TOWAROWA - WARSZAWA GDAŃSKA	Warszawa Główna Towarowa-Warszawa Gdańska	future principal	core	9.3	3.85	Sufficient capacity
KRAKÓW GŁÓWNY - MEDYKA	Podłęże R 101-Podłęże	principal	core	2.9	3.90	Sufficient capacity
DĄBROWA GÓRNICZA ZĄBKOWICE - KRAKÓW GŁÓWNY	Sosnowiec Maczki-Jaworzno Szczakowa	principal	no	1.3	4.00	Sufficient capacity
WARSZAWA WSCHODNIA OSOBOWA - DOROHUSK	Dęblin-Pilawa	future diversionary	comprehensive	49.3	4.05	Moderate capacity shortage
KRUSZE - PILAWA	Krusze-Pilawa	future diversionary	no	56.6	4.05	Sufficient capacity
WARSZAWA ZACHODNIA - TERESPOL	Łuków-Terespol	principal	core	90.2	4.25	Sufficient capacity
KRAKÓW GŁÓWNY - MEDYKA	Podłęże-Tarnów	principal	core	59.0	4.25	Sufficient capacity
WARSZAWA WSCHODNIA OSOBOWA - GDAŃSK GŁÓWNY	Warszawa Praga-Legionowo	future diversionary	no	14.2	4.35	Moderate capacity shortage

Table 27: Line sections with the compound index values and current capacity utilisation rate (Poland)

Slovak Republic

Line	Section	RFC cat.	TEN-T	Length (km)	Compound index score	Capacity
Komárno - Bratislava Nové Mesto	Komárno-Dunajská Streda	connecting line	no	53.1	3.5	Moderate capacity shortage
Kysacká spojka	Kysacká spojka	principal	no	1.0	3.55	Sufficient capacity
Komárno - Bratislava Nové Mesto	Dunajská Streda-Bratislava Nové Mesto	connecting line	no	34.5	3.65	Moderate capacity shortage
Komárno - Bratislava Nové Mesto	Dunajská Streda-Bratislava Nové Mesto	connecting line	core	4.4	3.65	Moderate capacity shortage

Line	Section	RFC cat.	TEN-T	Length (km)	Compound index score	Capacity
Čadca - Zwardoň PL	Skalité-Zwardoň (state border)	principal	core	6.7	3.65	Sufficient capacity
Kysak - Muszyna PL	Prešov-Kysak	principal	comprehensive	16.8	3.85	Sufficient capacity
Orlovská spojka	Orlovská spojka	principal	no	0.9	3.85	Sufficient capacity
Čadca - Zwardoň PL	Čadca-Skalité	principal	core	13.5	3.95	Sufficient capacity
Kysak - Muszyna PL	Muszyna (state border)-Plaveč	principal	comprehensive	6.8	3.95	Sufficient capacity
Kysak - Muszyna PL	Plaveč-Prešov	principal	comprehensive	54.7	3.95	Sufficient capacity
Košice - Slovenské Nové Mesto - Satoraljaújhely HU	Košice-Michaľany	diversionary	core	47.9	3.95	Sufficient capacity
Košice - Slovenské Nové Mesto - Satoraljaújhely HU	Slovenské Nové Mesto-Satoraljaújhely (state border)	diversionary	no	1.4	3.95	Sufficient capacity
Košice - Slovenské Nové Mesto - Satoraljaújhely HU	Michaľany-Slovenské Nové Mesto	diversionary	core	13.8	4.05	Sufficient capacity
Komárom HU - Komárno	Komárom (state border)-Komárno	principal	comprehensive	8.7	4.15	Sufficient capacity
Bratislava Rača - Bratislava východ	Bratislava Rača-Bratislava východ	principal	no	1.9	4.15	Sufficient capacity
Košice - Kysak	Košice-Kysak	principal	core	15.6	4.25	Sufficient capacity
Komárno - Nové Zámky	Komárno-Nové Zámky	principal	comprehensive	24.7	4.25	Sufficient capacity
Bratislava východ - Bratislava Predmestie	Bratislava východ-Bratislava Predmestie	principal	no	2.4	4.25	Sufficient capacity
Bratislava východ - Bratislava Predmestie	Bratislava východ-Bratislava Predmestie	principal	core	1.2	4.25	Sufficient capacity
Žilina - Čadca	Krásno nad Kysucou-Čadca	principal	core	10.0	4.35	Sufficient capacity
Hidasnémeti HU - Barca	Hidasnémeti (state border)-Barca	principal	comprehensive	18.2	4.35	Sufficient capacity
Barca - Košice nákl. stanica	Barca-Košice nákl.stanica	principal	no	4.6	4.35	Sufficient capacity
Leopoldov - Galanta	Leopoldov-Galanta	principal	comprehensive	29.7	4.35	Sufficient capacity
Bratislava - Štúrovo	Szob (state border)-Štúrovo	principal	comprehensive	13.8	4.35	Sufficient capacity
Bratislava Predmestie - Bratislava Petržalka	Bratislava Predmestie-Bratislava Petržalka	principal	no	14.2	4.35	Sufficient capacity
Bratislava Petržalka - Rajka HU	Bratislava Petržalka-Rajka (state border)	principal	core	14.7	4.45	Sufficient capacity
Bratislava - Štúrovo	Štúrovo-Nové Zámky	principal	comprehensive	44.2	4.55	Sufficient capacity
Bratislava - Štúrovo	Nové Zámky-Palárikovo	principal	comprehensive	10.0	4.55	Sufficient capacity
Bratislava - Štúrovo	Palárikovo-Galanta	principal	comprehensive	32.3	4.55	Sufficient capacity
Bratislava - Žilina	Púchov-Žilina	principal	core	44.2	4.55	Sufficient capacity
Bratislava - Žilina	Púchov-Trenčianska Teplá	principal	core	26.8	4.55	Sufficient capacity
Bratislava - Žilina	Trenčianska Teplá-Trenčín	principal	core	7.5	4.55	Sufficient capacity

Line	Section	RFC cat.	TEN-T	Length (km)	Compound index score	Capacity
Bratislava - Žilina	Trenčín-Nové Mesto nad Váhom	principal	core	24.7	4.55	Sufficient capacity
Bratislava - Žilina	Leopoldov-Trnava	principal	core	17.5	4.55	Sufficient capacity
Bratislava - Žilina	Trnava-Bratislava Rača	principal	core	38.9	4.55	Sufficient capacity
Žilina - Čadca	Žilina-Krásno nad Kysucou	principal	core	19.3	4.65	Sufficient capacity
Bratislava - Žilina	Nové Mesto nad Váhom-Leopoldov	principal	core	35.5	4.65	Sufficient capacity

Table 28: Line sections with the compound index values and current capacity utilisation rate (Slovak Republic)

Hungary

Line	Section	RFC cat.	TEN-T	Length (km)	Compound index score	Capacity
Balotaszállás elágazás - Harkakötöny elágazás	Balotaszállás elágazás-Harkakötöny elágazás	principal	no	1.7	2.90	Sufficient capacity
Felsőzsolca - Sátoraljaújhely - (Border SK)	Sátoraljaújhely-Slovenské Nové Mesto (state border)	diversionary	no	0.5	2.95	Sufficient capacity
Hatvan A elágazás - Hatvan D elágazás	Hatvan A elágazás-Hatvan D elágazás	principal	no	3.8	2.95	Sufficient capacity
Rajka s.b. - Zalaszentiván	Vasvár-Pácsony	principal	comprehensive	10.1	3.00	Sufficient capacity
Rákos elágazás - Szob - (Border SK)	Angyalföldi elágazás-Rákosrendező elágazás	principal	no	1.0	3.05	Sufficient capacity
Újszászi elágazás - Paládicspuszta elágazás	Újszászi elágazás-Paládicspuszta elágazás	principal	comprehensive	1.1	3.05	Sufficient capacity
Rajka s.b. - Zalaszentiván	Egervár-Vasboldogasszony-Zalaszentiván	principal	comprehensive	7.5	3.10	Sufficient capacity
Kőbánya felső - Felsőzsolca	Kőbánya felső-Rákos	principal	core	3.1	3.15	Sufficient capacity
Rajka s.b. - Zalaszentiván	Szombathely-Vasvár	principal	comprehensive	23.9	3.20	Sufficient capacity
Rákos elágazás - Szob - (Border SK)	Rákosrendező elágazás-Rákospalota-Újpest	principal	comprehensive	2.3	3.25	Sufficient capacity
Rajka s.b. - Zalaszentiván	Hegyeshalom-Porpác	principal	comprehensive	94.4	3.30	Sufficient capacity
Hatvan B elágazás - Hatvan C elágazás	Hatvan B elágazás-Hatvan C elágazás	principal	no	1.1	3.35	Sufficient capacity
Szolnok A elágazás - Szolnok-Rendező	Szolnok A elágazás-Szolnok-Rendező	principal	no	5.2	3.35	Sufficient capacity
Szolnok B elágazás - Szolnok-Rendező	Szolnok B elágazás-Szolnok-Rendező	principal	no	3.6	3.35	Sufficient capacity

Line	Section	RFC cat.	TEN-T	Length (km)	Compound index score	Capacity
Szolnok C elágazás - Szolnok-Rendező	Szolnok C elágazás-Szolnok-Rendező	principal	no	2.4	3.35	Sufficient capacity
Nyársapát elágazás - Abony elágazás	Nyársapát elágazás-Abony elágazás	principal	no	1.2	3.35	Sufficient capacity
Rajka s.b. - Zalaszentiván	Porpác-Szombathely	principal	comprehensive	16.7	3.40	Sufficient capacity
Rajka s.b. - Zalaszentiván	Pácsony-Egervár-Vasboldogasszony	principal	comprehensive	8.7	3.40	Sufficient capacity
Szolnok D elágazás - Szolnok-Rendező	Szolnok D elágazás-Szolnok-Rendező	principal	no	3.9	3.45	Sufficient capacity
Ferencváros - Kőbánya felső	Ferencváros-Kőbánya felső	principal	core	4.6	3.50	Sufficient capacity
Sopron - Szombathely	Sopron-Rendező-Harka	principal	comprehensive	3.0	3.55	Sufficient capacity
Sopron - Győr	Sopron-Rendező-Pinnye	principal	comprehensive	17.2	3.55	Sufficient capacity
Ferencváros - Kelebia - (Border SRB)	Kunszentmiklós-Tass-Kiskunhalas	principal	core	73.5	3.55	Sufficient capacity
Ferencváros - Kelebia - (Border SRB)	Kiskunhalas-Kelebia	principal	core	28.9	3.55	Sufficient capacity
Ferencváros - Kelebia - (Border SRB)	Kelebia-Subotica (state border)	principal	core	3.1	3.55	Sufficient capacity
Felsőzsolca - Hidasnémeti - (Border SK)	Felsőzsolca-Felsőzsolca-elág	principal	core	0.9	3.55	Sufficient capacity
Kőbánya felső - Rákos elágazás	Kőbánya felső-Rákos elágazás	principal	no	1.2	3.55	Moderate capacity shortage
Kőbánya felső - Rákos elágazás	Kőbánya felső-Rákos elágazás	principal	comprehensive	1.1	3.55	Moderate capacity shortage
Rákos elágazás - Szob - (Border SK)	Rákos elágazás-Angyalföldi elágazás	principal	no	6.4	3.55	Sufficient capacity
Rákos - Rákos-elágazás	Rákos-Rákos-elágazás	principal	no	1.4	3.55	Moderate capacity shortage
Hatvan - Újszász	Hatvan-Újszász	principal	comprehensive	1.6	3.55	Sufficient capacity
Hatvan - Újszász	Hatvan-Újszász	principal	no	50.4	3.55	Sufficient capacity
Kőbánya felső - Felsőzsolca	Hatvan-Vámosgyörk	principal	core	20.8	3.60	Sufficient capacity
Kőbánya felső - Felsőzsolca	Vámosgyörk-Füzesabony	principal	core	37.7	3.60	Sufficient capacity
Kőbánya felső - Felsőzsolca	Füzesabony-Miskolc-Tiszai	principal	core	57.2	3.60	Sufficient capacity
Kőbánya felső - Felsőzsolca	Miskolc-Tiszai-Felsőzsolca	principal	core	4.6	3.60	Sufficient capacity
Sopron - Győr	Petőháza-Győr	principal	comprehensive	58.1	3.65	Moderate capacity shortage
Kiskunhalas - Kiskunfélegyháza	Kiskunhalas-Kiskunfélegyháza	principal	no	45.7	3.65	Sufficient capacity
Komárom - Border SK	Komárom-Komárno (state border)	principal	comprehensive	2.8	3.65	Sufficient capacity
Ferencváros - Kelebia - (Border SRB)	Soroksár-Kunszentmiklós-Tass	principal	core	44.6	3.70	Sufficient capacity
Sopron - Győr	Fertőszentmiklós-Petőháza	principal	comprehensive	2.2	3.75	Sufficient capacity
Újszász - Újszászi elágazás	Újszász-Újszászi elágazás	principal	comprehensive	13.4	3.75	Sufficient capacity

Line	Section	RFC cat.	TEN-T	Length (km)	Compound index score	Capacity
Rákos elágazás - Szob - (Border SK)	Rákospalota-Újpest-Vác	principal	comprehensive	25.6	3.80	Sufficient capacity
Abony elágazás - Paládicspuszta elágazás	Abony elágazás-Paládicspuszta elágazás	principal	comprehensive	23.5	3.80	Sufficient capacity
Győr - Ferencváros	Kelenföld-Ferencváros	principal	core	5.9	3.90	Moderate capacity shortage
Rákos elágazás - Szob - (Border SK)	Vác-Štúrovo (state border)	principal	comprehensive	30.4	3.60	Sufficient capacity
Rajka s.b. - Zalaszentiván	Rusovce (state border)-Hegyeshalom	principal	core	15.8	3.95	Sufficient capacity
Felsőzsolca - Sátoraljaújhely - (Border SK)	Felsőzsolca-Mezőzombor	diversionary	core	37.5	3.95	Sufficient capacity
Felsőzsolca - Sátoraljaújhely - (Border SK)	Mezőzombor-Mezőzombor kiág	diversionary	core	1.2	3.95	Sufficient capacity
Felsőzsolca - Sátoraljaújhely - (Border SK)	Mezőzombor kiág-Sárospatak	diversionary	no	30.3	3.95	Sufficient capacity
Nyársapát elágazás - Kiskunfélegyháza	Városföld-Kiskunfélegyháza	principal	comprehensive	13.7	4.00	Sufficient capacity
Ferencváros - Kelebia - (Border SRB)	Ferencváros-Soroksári út	principal	core	1.8	4.05	Sufficient capacity
Ferencváros - Kelebia - (Border SRB)	Soroksári út-Soroksár	principal	core	7.1	4.05	Sufficient capacity
Felsőzsolca - Hidasnémeti - (Border SK)	Felsőzsolca-elág-Hidasnémeti	principal	comprehensive	55.8	4.05	Sufficient capacity
Felsőzsolca - Hidasnémeti - (Border SK)	Hidasnémeti-Kechnec (state border)	principal	comprehensive	3.2	4.05	Sufficient capacity
Felsőzsolca - Sátoraljaújhely - (Border SK)	Sárospatak-Sátoraljaújhely	diversionary	no	9.6	4.05	Sufficient capacity
Győr - Ferencváros	Budaörs-Kelenföld	principal	core	5.6	4.10	Sufficient capacity
Sopron - Győr	Pinnye-Fertőszentmiklós	principal	comprehensive	6.9	4.15	Sufficient capacity
Győr - Ferencváros	Tata-Budaörs	principal	core	62.8	4.25	Sufficient capacity
Nyársapát elágazás - Kiskunfélegyháza	Nyársapát elágazás-Városföld	principal	comprehensive	42.4	4.25	Sufficient capacity
Sopron - Szombathely	Harka-Szombathely	principal	comprehensive	57.1	4.35	Sufficient capacity
(Border SLO) - Őriszentpéter - Zalaszentiván	Hodoš (state border)-Őriszentpéter	principal	core	6.1	4.35	Moderate capacity shortage
(Border SLO) - Őriszentpéter - Zalaszentiván	Őriszentpéter-Zalalövő	principal	core	12.6	4.35	Moderate capacity shortage
Győr - Ferencváros	Komárom-Tata	principal	core	20.0	4.35	Sufficient capacity
Kőbánya felső - Felsőzsolca	Rákos-Hatvan	principal	core	58.5	4.40	Sufficient capacity
Győr - Ferencváros	Győr-Komárom	principal	core	37.3	4.45	Sufficient capacity
(Border SLO) - Őriszentpéter - Zalaszentiván	Andráshida elágazás-Zalaszentiván elágazás	principal	core	3.4	4.55	Moderate capacity shortage

Line	Section	RFC cat.	TEN-T	Length (km)	Compound index score	Capacity
(Border SLO) - Őriszentpéter - Zalaszentiván	Zalaszentiván elágazás-Zalaszentiván	principal	core	4.7	4.55	Moderate capacity shortage
(Border SLO) - Őriszentpéter - Zalaszentiván	Zalalövő-Andráshida elágazás	principal	core	20.8	4.65	Moderate capacity shortage

Table 29: Line sections with the compound index values and current capacity utilisation rate (Hungary)

Slovenia

Line	Section	RFC cat.	TEN-T	Length (km)	Compound index score	Capacity
Ljubljana -Novo mesto	Ljubljana-Novo mesto	connecting line	no	76,0	2,40	Moderate capacity shortage
Celje - Velenje	Celje-Velenje	connecting line	no	38,0	2,75	Moderate capacity shortage
Koper - Hodoš	Divača-Koper	principal	core	48,0	3,00	Very serious capacity shortage
Koper - Hodoš	Zidani Most-Ljubljana	principal	core	63,9	3,60	Sufficient capacity
Koper - Hodoš	Zidani Most-Pragersko	principal	core	73,2	3,75	Moderate capacity shortage
Koper - Hodoš	Ljubljana-Divača	principal	core	103,7	4,00	Serious capacity shortage
Koper - Hodoš	Ormož-Hodoš	principal	core	69,2	4,35	Moderate capacity shortage
Koper - Hodoš	Pragersko-Ormož	principal	core	40,3	4,55	Sufficient capacity

Table 30: Line sections with the compound index values and current capacity utilisation rate (Slovenia)

Overall statistics of the Corridor

The sections are categorized by the compound index, as follows:

Compound index value	Section quality
≤ 3.0	very poor
3.01 – 3.50	poor
3.51 – 4.00	fair
4.00 <	acceptable

Table 31: Compound index value ranges translated into comparative section quality

The section quality represents how much the section fulfils the TEN-T and TSI requirements currently. The categorisation is used later to define the relevance and importance of the section on the network and its need for development.

It is highlighted that the compound index is primarily a relative number, allowing to compare the sections to each other and rank them.

The share of RFC Amber sections in terms of the compound index / section quality is as follows:

Section quality compared to TSI requirements	Acceptable > 4.0	Fair 3.51 – 4.00	Poor 3.01 – 3.50	Very poor ≤ 3.0	Total
Poland	269km	317km	354km	300km	1240km
Slovak Republic	474km	189km	53km	-	716km
Hungary	289km	755km	212km	16km	1272km
Slovenia	110km	241km	-	162km	512km
Total	**1142km**	**1501km**	**619km**	**478km**	**3740km**

Table 32: Categorisation of RFC Amber sections by compound index

Majority of the network is therefore far from fulfilling the TEN-T requirements and can be considered barrier of the efficient and competitive railway along the Corridor.

It is assumed, in consideration of current capacity utilisation and future freight transport expectations, that section where infrastructure parameters are characterised with a compound index value under app. 4.0 and run at close to full capacity are the ones where improvement of line parameters are imperative. On other sections with low scores where moderate capacity shortage is indicated the upgrading interventions are not crucial in the short term. As traffic increases in the future, new sections are expected to run at capacity shortage, those sections shall be included in the development programs.

However, to meet TEN-T requirements and make steps towards an interoperable single European rail network and a competitive RFC Amber, on sections where compound index values are relatively low, interventions are needed. Without that, in our opinion, the line cannot be expected to serve RFC Amber international train traffic efficiently. As there are capacity bottlenecks along the Corridor, these lower score sections can be considered bottlenecks in terms of infrastructure parameters hindering efficiency of rail forwarding and level of service. These lines, sections are consequently calling for investments on the infrastructure.

Graphic presentation of the results

A graphic illustration of the outcome of the aggregated parameter features (compound index) is given below in the RFC Amber overview map.

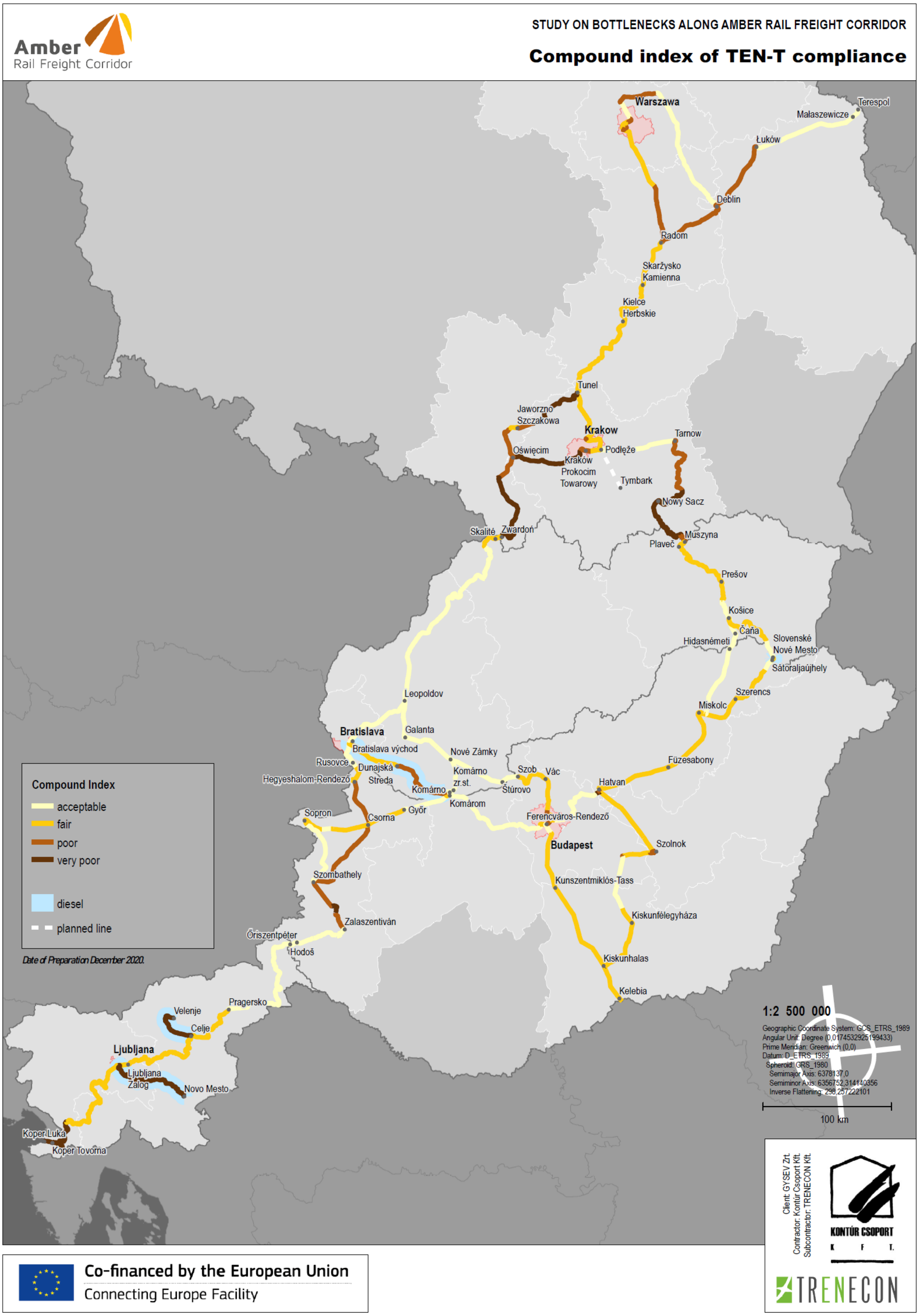


Figure 40. Overall quality of line parameters determined by the compound index values

Other parameters, e.g. TEN-T and RFC role, traffic volume, are both excluded at this point, when ranking the sections by their current state. The network role and traffic are used later in defining and assessing the interventions to eliminate the bottlenecks.

Capacity issues of the lines

It is fundamental to assess the importance of the infrastructure bottlenecks by considering the traffic and the available capacity.

As it is revealed, according to the assessment by IMs/capacity allocation body, capacity shortage is not common on the corridor, only present at a moderate level. Main exception is the case of the port of Koper (Koper-Divača section) where the second track is being built. The other section where capacity shortage is critical is the Łuków-Dęblin section in Poland.

Where currently capacity shortage is present or capacity utilisation is above 50%, supposing that future, expected growth in train traffic will cause capacity issues.

Forecasted capacity bottlenecks based on expected traffic growth are as follows (in order of severity of capacity shortage):

Country	Section	RFC category	Section quality by the compound index	Traffic category	Current capacity use	Capacity bottleneck	Future bottleneck (capacity shortage)
SL	Divača-Koper	principal	very poor	high	Very serious capacity shortage	yes (only 1 track)	Increasing capacity shortage, future capacity bottleneck
PL	Łuków-Dęblin	principal	poor	high	Serious capacity shortage	yes (2 tracks)	Increasing capacity shortage, future capacity bottleneck
SL	Ljubljana-Divača	principal	fair	high	Serious capacity shortage	yes (2 tracks)	Increasing capacity shortage, future capacity bottleneck
PL	Warszawa Gdańska-Warszawa Praga	future principal	poor	high	Moderate capacity shortage	yes (2 tracks)	Increasing capacity shortage, future capacity bottleneck
PL	Sosnowiec Jęzor-Mysłowice Brzezinka	principal	poor	high	Moderate capacity shortage	yes (only 1 track)	Increasing capacity shortage, future capacity bottleneck
PL	Warszawa Gkówna Towarowa-Warszawa Gdańska	future principal	poor	high	Moderate capacity shortage	yes (2 tracks)	Increasing capacity shortage, future capacity bottleneck
PL	Dęblin-Radom	principal	poor	high	Moderate capacity shortage	yes (2 tracks)	Increasing capacity shortage, future capacity bottleneck
PL	Radom-Tunel	principal	fair	high	Moderate capacity shortage	yes (2 tracks)	Increasing capacity shortage, future capacity bottleneck
PL	Dęblin-Pilawa	future diversionary	acceptable	low	Moderate capacity shortage	yes (2 tracks)	Increasing capacity shortage, future capacity bottleneck
PL	Warszawa Praga-Legionowo	future diversionary	acceptable	average	Moderate capacity shortage	yes (2 tracks)	Increasing capacity shortage, future capacity bottleneck
SK	Komárno-Dunajská Streda	connecting line	poor	low	Moderate capacity shortage	yes (only 1 track)	Increasing capacity shortage, future capacity bottleneck
SK	Dunajská Streda-Bratislava Nové Mesto	connecting line	fair	average	Moderate capacity shortage	yes (only 1 track)	Increasing capacity shortage, future capacity bottleneck
HU	Kőbánya felső-Rákos elágazás	principal	fair	high	Moderate capacity shortage	yes (2 tracks)	Increasing capacity shortage, future capacity bottleneck
HU	Rákos-Rákos-elágazás	principal	fair	low	Moderate capacity shortage	yes (2 tracks)	Increasing capacity shortage, future capacity bottleneck
HU	Petőháza-Győr	principal	fair	low	Moderate capacity shortage	yes (only 1 track)	Increasing capacity shortage, future capacity bottleneck
HU	Kelenföld-Ferencváros	principal	fair	high	Moderate capacity shortage	yes (2 tracks)	Increasing capacity shortage, future capacity bottleneck

Country	Section	RFC category	Section quality by the compound index	Traffic category	Current capacity use	Capacity bottleneck	Future bottleneck (capacity shortage)
HU	Hodoš (state border)-Őriszentpéter	principal	acceptable	average	Moderate capacity shortage	yes (only 1 track)	Increasing capacity shortage, future capacity bottleneck
HU	Őriszentpéter-Zalalövő	principal	acceptable	average	Moderate capacity shortage	yes (only 1 track)	Increasing capacity shortage, future capacity bottleneck
HU	Andráshida elágazás-Zalaszentiván elágazás	principal	acceptable	low	Moderate capacity shortage	yes (only 1 track)	Increasing capacity shortage, future capacity bottleneck
HU	Zalaszentiván elágazás-Zalaszentiván	principal	acceptable	average	Moderate capacity shortage	yes (only 1 track)	Increasing capacity shortage, future capacity bottleneck
HU	Zalalövő-Andráshida elágazás	principal	acceptable	average	Moderate capacity shortage	yes (only 1 track)	Increasing capacity shortage, future capacity bottleneck
SL	Ljubljana-Novo mesto	connecting line	very poor	low	Moderate capacity shortage	yes (only 1 track)	Increasing capacity shortage, future capacity bottleneck
SL	Celje-Velenje	connecting line	very poor	low	Moderate capacity shortage	yes (only 1 track)	Increasing capacity shortage, future capacity bottleneck
SL	Zidani Most-Pragersko	principal	fair	high	Moderate capacity shortage	yes (2 tracks)	Increasing capacity shortage, future capacity bottleneck
SL	Ormož-Hodoš	principal	acceptable	average	Moderate capacity shortage	yes (only 1 track)	Increasing capacity shortage, future capacity bottleneck
PL	Wilkowice Bystra-Zwardoń	principal	very poor	low	Sufficient capacity	no	Increasing capacity shortage, future capacity bottleneck
PL	Tarnów-Stróże	principal	poor	low	Sufficient capacity	no	Increasing capacity shortage, future capacity bottleneck
PL	Warka-Radom	future principal	poor	average	Sufficient capacity	no	Increasing capacity shortage, future capacity bottleneck
PL	Oświęcim OWC-Czechowice-Dziedzice	principal	poor	high	Sufficient capacity	no	Increasing capacity shortage, future capacity bottleneck
PL	Łuków-Terespol	principal	acceptable	high	Sufficient capacity	no	Increasing capacity shortage, future capacity bottleneck
HU	Sopron-Rendező-Harka	principal	fair	low	Sufficient capacity	no	Increasing capacity shortage, future capacity bottleneck
HU	Sopron-Rendező-Pinnye	principal	fair	low	Sufficient capacity	no	Increasing capacity shortage, future capacity bottleneck
HU	Fertőszentmiklós-Petőháza	principal	fair	low	Sufficient capacity	no	Increasing capacity shortage, future capacity bottleneck

Country	Section	RFC category	Section quality by the compound index	Traffic category	Current capacity use	Capacity bottleneck	Future bottleneck (capacity shortage)
HU	Budaörs-Kelenföld	principal	acceptable	high	Sufficient capacity	no	Increasing capacity shortage, future capacity bottleneck
HU	Pinnye-Fertőszentmiklós	principal	acceptable	low	Sufficient capacity	no	Increasing capacity shortage, future capacity bottleneck
SL	Zidani Most-Ljubljana	principal	fair	high	Sufficient capacity	no	Increasing capacity shortage, future capacity bottleneck
SL	Pragersko-Ormož	principal	acceptable	average	Sufficient capacity	no	Increasing capacity shortage, future capacity bottleneck

Table 33.: Current and future capacity bottlenecks

7.3.2 Bottlenecks along the lines

The following tables list the infrastructure and capacity bottlenecks on the network, grouped by member states:

Poland

From-to	Length (km)	Section quality by the compound index	Infrastructure deficiency / bottleneck	Capacity bottleneck currently / future	Time frame to comply TSI/TEN-T Guidelines	TEN-T compliance	Bottleneck type
Dęblin-Pilawa	49.3	acceptable	No ERTMS	yes / yes	2050	Main parameters already fulfilled but no ERTMS	infrastructure & capacity
Radom-Tunel	165.6	fair	Very high gradient, no ERTMS	yes / yes	2050	Main parameters already fulfilled but high gradient cannot be eliminated	infrastructure & capacity
Warszawa Praga-Legionowo	14.2	acceptable	Only minor compared to main TEN-T requirements	yes / yes	2030	Main parameters already fulfilled but no ERTMS	infrastructure & capacity
Warszawa Gkówna Towarowa-Warszawa Gdańska	11.9	poor	Axle load low, line speed low, very high gradient, no ERTMS	yes / yes	no obligation (non-TENT-T)	Does not comply with TSI, limitations due to high gradient cannot be eliminated	infrastructure & capacity
Warszawa Gdańska-Warszawa Praga	4.3	poor	Axle load low, line speed low, very high gradient, no ERTMS	yes / yes	2030	Does not comply with TSI, limitations due to high gradient cannot be eliminated	infrastructure & capacity
Łuków-Dęblin	61.2	poor	High gradient, no ERTMS, significant restrictions	yes / yes	no obligation (non-TENT-T)	Main parameters already fulfilled but high gradient cannot be eliminated	infrastructure & capacity
Dęblin-Radom	53.9	poor	High gradient, no ERTMS	yes / yes	no obligation (non-TENT-T)	Main parameters already fulfilled but high gradient cannot be eliminated	infrastructure & capacity
Dęblin-Radom	2.0	poor	High gradient, no ERTMS	yes / yes	2050	Main parameters already fulfilled but high gradient cannot be eliminated	infrastructure & capacity
Sosnowiec Jęzor-Mysłowice Brzezinka	7.2	poor	Axle load low, line speed low, no ERTMS	yes / yes	no obligation (non-TENT-T)	Does not comply with TSI	infrastructure & capacity
Łuków-Terespol	90.2	acceptable	Only minor compared to main TEN-T requirements	no / expected	2030	Main parameters already fulfilled but no ERTMS	infrastructure & future capacity

From-to	Length (km)	Section quality by the compound index	Infrastructure deficiency / bottleneck	Capacity bottleneck currently / future	Time frame to comply TSI/TEN-T Guidelines	TEN-T compliance	Bottleneck type
Warka-Radom	46.2	poor	Line speed low, high gradient, no ERTMS	no / expected	2050	Does not comply with TSI, limitations due to high gradient cannot be eliminated	infrastructure & future capacity
Oświęcim OWC-Czechowice-Dziedzice	20.8	poor	Axle load low, line speed low, no ERTMS	no / expected	2050	Does not comply with TSI	infrastructure & future capacity
Tarnów-Stróże	56.8	poor	Axle load low, line speed low, very high gradient, no ERTMS	no / expected	no obligation (non-TENT-T)	Does not comply with TSI, limitations due to high gradient cannot be eliminated	infrastructure & future capacity
Wilkowice Bystra-Zwardoń	46.7	very poor	Axle load low, line speed low, very high gradient, no ERTMS, significant restrictions	no / expected	2030	Does not comply with TSI, limitations due to high gradient cannot be eliminated	infrastructure & future capacity
Warszawa Aleje Jerozolimskie-Czachówek Górny	29.4	fair	High gradient, no ERTMS	no / not expected	no obligation (non-TENT-T)	Main parameters already fulfilled but high gradient cannot be eliminated	infrastructure
Czachówek Górny-Warka	21.2	fair	High gradient, no ERTMS	no / not expected	2050	Main parameters already fulfilled but high gradient cannot be eliminated	infrastructure
Tunel-Raciborowice	42.5	fair	High gradient, no ERTMS	no / not expected	2030	Main parameters already fulfilled but high gradient cannot be eliminated	infrastructure
Legionowo-Krusze	31.6	poor	Axle load low, significant restrictions	no / not expected	no obligation (non-TENT-T)	Does not comply with TSI and significant restrictions	infrastructure
Krusze-Pilawa	56.6	acceptable	No ERTMS	no / not expected	no obligation (non-TENT-T)	Main parameters already fulfilled but no ERTMS	infrastructure
Tunel-Bukowno	52.3	very poor	Axle load low, very high gradient, no ERTMS, significant restrictions	no / not expected	no obligation (non-TENT-T)	Does not comply with TSI, limitations due to high gradient cannot be eliminated	infrastructure
Krakow Biezanow-Podłęże R 101	6.0	fair	No ERTMS, significant restrictions	no / not expected	2030	Main parameters already fulfilled but significant restrictions	infrastructure

From-to	Length (km)	Section quality by the compound index	Infrastructure deficiency / bottleneck	Capacity bottleneck currently / future	Time frame to comply TSI/TEN-T Guidelines	TEN-T compliance	Bottleneck type
Gaj-Podłęże R 101	8.9	fair	High gradient, no ERTMS	no / not expected	no obligation (non-TENT-T)	Main parameters already fulfilled but high gradient cannot be eliminated	infrastructure
Podłęże R 101-Podłęże	2.9	fair	No ERTMS	no / not expected	2030	Main parameters already fulfilled but no ERTMS	infrastructure
Podłęże-Tarnów	59.0	acceptable	No ERTMS	no / not expected	2030	Main parameters already fulfilled but no ERTMS	infrastructure
Kraków Prokocim-Gaj	4.1	poor	Axle load low, line speed low, high gradient, no ERTMS	no / not expected	no obligation (non-TENT-T)	Does not comply with TSI, limitations due to high gradient cannot be eliminated	infrastructure
Oświęcim OWC1-Oświęcim OWC	1.1	poor	Axle load low, line speed low, no ERTMS	no / not expected	2050	Does not comply with TSI	infrastructure
Kraków Bonarka-Oświęcim	59.3	very poor	Axle load low, very high gradient, no ERTMS, significant restrictions	no / not expected	no obligation (non-TENT-T)	Does not comply with TSI, limitations due to high gradient cannot be eliminated	infrastructure
Oświęcim-Oświęcim OWC	2.0	poor	Axle load low, line speed very low, no ERTMS	no / not expected	2050	Does not comply with TSI	infrastructure
Dłubnia-Podłęże	18.3	fair	No ERTMS	no / not expected	no obligation (non-TENT-T)	Main parameters already fulfilled but no ERTMS	infrastructure
Podłęże-Podłęże R 201	2.5	fair	No ERTMS	no / not expected	no obligation (non-TENT-T)	Main parameters already fulfilled but no ERTMS	infrastructure
Stróże-Nowy Sącz	30.8	very poor	Axle load low, line speed low, very high gradient, no ERTMS, significant restrictions	no / not expected	no obligation (non-TENT-T)	Does not comply with TSI, limitations due to high gradient cannot be eliminated	infrastructure
Nowy Sącz-Muszyna	50.6	very poor	Axle load low, line speed low, high gradient, no ERTMS	no / not expected	2050	Does not comply with TSI, limitations due to high gradient cannot be eliminated	infrastructure
Muszyna-Muszyna (G.P.)	7.5	poor	Axle load low, line speed low, high gradient, no ERTMS	no / not expected	2050	Does not comply with TSI, limitations due to high gradient cannot be eliminated	infrastructure

From-to	Length (km)	Section quality by the compound index	Infrastructure deficiency / bottleneck	Capacity bottleneck currently / future	Time frame to comply TSI/TEN-T Guidelines	TEN-T compliance	Bottleneck type
Kraków Prokocim-Kraków Bieżanów	1.2	poor	Axle load low, line speed low, no ERTMS	no / not expected	2030	Does not comply with TSI	infrastructure
Tymbark-Nowy Sącz	39.5	very poor	Train length very low, axle load very low, line speed very low, very high gradient, no ERTMS, significant restrictions	no traffic / not expected	no obligation (non-TENT-T)	Does not comply with TSI, limitations due to high gradient cannot be eliminated	infrastructure
Sosnowiec Maczki-Jaworzno Szczakowa	1.3	fair	No ERTMS	no / not expected	no obligation (non-TENT-T)	Main parameters already fulfilled but no ERTMS	infrastructure
Jaworzno Szczakowa-Sosnowiec Jęzor	7.3	fair	Axle load low, no ERTMS	no / not expected	2030	Does not comply with TSI	infrastructure
Oświęcim-Oświęcim OWC1	0.6	poor	Axle load low, line speed low, no ERTMS	no / not expected	no obligation (non-TENT-T)	Does not comply with TSI	infrastructure
Oświęcim OWC1-Mysłowice Brzezinka	17.0	poor	Axle load low, no ERTMS, significant restrictions	no / not expected	no obligation (non-TENT-T)	Does not comply with TSI and significant restrictions	infrastructure
Czechowice-Dziedzice-Bielsko-Biała Glowna	11.5	very poor	Axle load low, train length low, high gradient, no ERTMS	no / not expected	2030	Does not comply with TSI, limitations due to high gradient cannot be eliminated	infrastructure
Bielsko-Biała Glowna-Bielsko-Biała Lipnik	1.8	very poor	Axle load low, train length very low, very high gradient, no ERTMS	no / not expected	2030	Does not comply with TSI, limitations due to high gradient cannot be eliminated	infrastructure
Bielsko-Biała Lipnik-Wilkowice Bystra	6.9	very poor	Axle load low, line speed low, very high gradient, no ERTMS	no / not expected	2030	Does not comply with TSI, limitations due to high gradient cannot be eliminated	infrastructure
Zwardoń-Zwardoń (G.P.)	0.4	very poor	Axle load low, line speed low, no ERTMS	no / not expected	2050	Does not comply with TSI	infrastructure
Bukowno-Jaworzno Szczakowa	11.7	poor	Axle load low, no ERTMS, significant restrictions	no / not expected	no obligation (non-TENT-T)	Does not comply with TSI and significant restrictions	infrastructure
Warszawa Główna Towarowa-Warszawa Gdańska	9.3	fair	Line speed low, no ERTMS	no / not expected	2030	Does not comply with TSI	infrastructure

From-to	Length (km)	Section quality by the compound index	Infrastructure deficiency / bottleneck	Capacity bottleneck currently / future	Time frame to comply TSI/TEN-T Guidelines	TEN-T compliance	Bottleneck type
Warszawa Główna Towarowa-Warszawa Aleje Jerozolimskie	2.7	poor	Axle load low, line speed very low, no ERTMS	no / not expected	no obligation (non-TENT-T)	Does not comply with TSI	infrastructure
Kraków Prokocim Towarowy PRD-Kraków Bonarka	4.8	poor	Axle load low, line speed low, very high gradient, no ERTMS	no / not expected	no obligation (non-TENT-T)	Does not comply with TSI, limitations due to high gradient cannot be eliminated	infrastructure
Kraków Prokocim Towarowy PRD-Kraków Bonarka2	3.6	poor	Axle load low, line speed low, very high gradient, no ERTMS	no / not expected	2030	Does not comply with TSI, limitations due to high gradient cannot be eliminated	infrastructure
Raciborowice-Dłubnia	1.0	poor	Axle load low, line speed low, no ERTMS	no / not expected	no obligation (non-TENT-T)	Does not comply with TSI	infrastructure
Podłęże R 201-Podłęże R 101	1.6	fair	Line speed low, no ERTMS	no / not expected	no obligation (non-TENT-T)	Does not comply with TSI	infrastructure
Oświęcim OWC-Oświęcim OWC1	0.5	poor	Axle load low, line speed very low, no ERTMS	no / not expected	no obligation (non-TENT-T)	Does not comply with TSI	infrastructure

Table 34: TEN-T compliance of the sections (Poland)

Slovak Republic

From-to	Length (km)	Section quality by the compound index	Infrastructure deficiency / bottleneck	Capacity bottleneck currently / future	Time frame to comply TSI	TEN-T compliance	Bottleneck type
Komárno-Dunajská Streda	53.1	poor	No electrification, train length very low, no ERTMS	yes / yes	no obligation (non-TENT-T)	Does not comply with TSI	infrastructure & capacity
Dunajská Streda-Bratislava Nové Mesto	34.5	fair	No electrification, axle load low, no ERTMS	yes / yes	no obligation (non-TENT-T)	Does not comply with TSI	infrastructure & capacity
Dunajská Streda-Bratislava Nové Mesto	4.4	fair	No electrification, axle load low, no ERTMS	yes / yes	2030	Does not comply with TSI	infrastructure & capacity
Kysacká spojka	1.0	fair	Line speed very low, very high gradient, no ERTMS	no / not expected	no obligation (non-TENT-T)	Main parameters already fulfilled but line speed is low, no ERTMS, very high gradient	infrastructure
Skalité-Zwardoň (state border)	6.7	fair	Line speed low, very high gradient, no ERTMS	no / not expected	2030	Does not comply with TSI, limitations due to high gradient cannot be eliminated	infrastructure
Prešov-Kysak	16.8	fair	Very high gradient, no ERTMS	no / not expected	2050	Main parameters already fulfilled but high gradient cannot be eliminated	infrastructure
Orlovská spojka	0.9	fair	Train speed very low, no ERTMS	no / not expected	no obligation (non-TENT-T)	Main parameters already fulfilled but line speed is low, no ERTMS	infrastructure
Čadca-Skalité	13.5	fair	Very high gradient, no ERTMS	no / not expected	2030	Main parameters already fulfilled but high gradient cannot be eliminated	infrastructure
Muszyna (state border)-Plaveč	6.8	fair	Line speed low, no ERTMS	no / not expected	2050	Does not comply with TSI	infrastructure
Plaveč-Prešov	54.7	fair	Very high gradient, no ERTMS	no / not expected	2050	Main parameters already fulfilled but high gradient cannot be eliminated	infrastructure
Košice-Michaľany	47.9	fair	Very high gradient, no ERTMS	no / not expected	2030	Main parameters already fulfilled but high gradient cannot be eliminated	infrastructure
Slovenské Nové Mesto-Satoraljaújhely (state border)	1.4	fair	No electrification, train speed very low, no ERTMS	no / not expected	no obligation (non-TENT-T)	Does not comply with TSI	infrastructure

From-to	Length (km)	Section quality by the compound index	Infrastructure deficiency / bottleneck	Capacity bottleneck currently / future	Time frame to comply TSI	TEN-T compliance	Bottleneck type
Michaľany-Slovenské Nové Mesto	13.8	acceptable	High gradient, no ERTMS	no / not expected	2030	Main parameters already fulfilled but high gradient cannot be eliminated	infrastructure
Komárom (state border)-Komárno	8.7	acceptable	No ERTMS	no / not expected	2050	Main parameters already fulfilled but no ERTMS	infrastructure
Bratislava Rača-Bratislava východ	1.9	acceptable	Line speed very low	no / not expected	no obligation (non-TENT-T)	Main parameters already fulfilled but train length and speed is low	infrastructure
Košice-Kysak	15.6	acceptable	No ERTMS	no / not expected	2030	Main parameters already fulfilled but no ERTMS	infrastructure
Komárno-Nové Zámky	24.7	acceptable	No ERTMS	no / not expected	2050	Main parameters already fulfilled but no ERTMS	infrastructure
Bratislava východ-Bratislava Predmestie	2.4	acceptable	Line speed low	no / not expected	no obligation (non-TENT-T)	Main parameters already fulfilled but train length and speed is low	infrastructure
Bratislava východ-Bratislava Predmestie	1.2	acceptable	Line speed low	no / not expected	2030	Main parameters already fulfilled but train length and speed is low	infrastructure
Krásno nad Kysucou-Čadca	10.0	acceptable	Very high gradient	no / not expected	2030	Main parameters already fulfilled but high gradient cannot be eliminated	infrastructure
Hidasnémeti (state border)-Barca	18.2	acceptable	No ERTMS	no / not expected	2050	Main parameters already fulfilled but no ERTMS	infrastructure
Barca-Košice nákl.stanica	4.6	acceptable	No ERTMS	no / not expected	no obligation (non-TENT-T)	Main parameters already fulfilled but no ERTMS	infrastructure
Leopoldov-Galanta	29.7	acceptable	No ERTMS	no / not expected	2050	Main parameters already fulfilled but no ERTMS	infrastructure
Szob (state border)-Štúrovo	13.8	acceptable	No ERTMS	no / not expected	2050	Main parameters already fulfilled but no ERTMS	infrastructure
Bratislava Predmestie-Bratislava Petržalka	14.2	acceptable	Only minor compared to main TEN-Trequirements	no / not expected	no obligation (non-TENT-T)	Main parameters already fulfilled but train length is low	infrastructure
Bratislava Petržalka-Rajka (state border)	14.7	acceptable	Only minor compared to main TEN-Trequirements	no / not expected	2030	Main parameters already fulfilled but train length is low	infrastructure

From-to	Length (km)	Section quality by the compound index	Infrastructure deficiency / bottleneck	Capacity bottleneck currently / future	Time frame to comply TSI	TEN-T compliance	Bottleneck type
Štúrovo-Nové Zámky	44.2	acceptable	Only minor compared to main TEN-Trequirements	no / not expected	2050	Main parameters already fulfilled but train length is low	infrastructure
Nové Zámky-Palárikovo	10.0	acceptable	Only minor compared to main TEN-Trequirements	no / not expected	2050	Main parameters already fulfilled but train length is low	infrastructure
Palárikovo-Galanta	32.3	acceptable	Only minor compared to main TEN-Trequirements	no / not expected	2050	Main parameters already fulfilled but train length is low	infrastructure
Púchov-Žilina	44.2	acceptable	Only minor compared to main TEN-Trequirements	no / not expected	2030	Main parameters already fulfilled but no ERTMS and train length is low	infrastructure
Púchov-Trenčianska Teplá	26.8	acceptable	Only minor compared to main TEN-Trequirements	no / not expected	2030	Main parameters already fulfilled but train length is low	infrastructure
Trenčianska Teplá-Trenčín	7.5	acceptable	Only minor compared to main TEN-Trequirements	no / not expected	2030	Main parameters already fulfilled but train length is low	infrastructure
Trenčín-Nové Mesto nad Váhom	24.7	acceptable	Only minor compared to main TEN-Trequirements	no / not expected	2030	Main parameters already fulfilled but train length is low	infrastructure
Leopoldov-Trnava	17.5	acceptable	Only minor compared to main TEN-Trequirements	no / not expected	2030	Main parameters already fulfilled but train length is low	infrastructure
Trnava-Bratislava Rača	38.9	acceptable	Only minor compared to main TEN-Trequirements	no / not expected	2030	Main parameters already fulfilled but train length is low	infrastructure
Žilina-Krásno nad Kysucou	19.3	acceptable	Only minor compared to main TEN-Trequirements	no / not expected	2030	Main parameters already fulfilled but train length is low	infrastructure
Nové Mesto nad Váhom-Leopoldov	35.5	acceptable	Only minor compared to main TEN-Trequirements	no / not expected	2030	Main parameters already fulfilled but train length is low	infrastructure

Table 35: TEN-T compliance of the sections (Slovak Republic)

Hungary

From-to	Length (km)	Section quality by the compound index	Infrastructure deficiency / bottleneck	Capacity bottleneck currently / future	Time frame to comply TSI	TEN-TEN-T compliance	Bottleneck type
Kőbánya felső-Rákos elágazás	1.2	fair	Axle load low, line speed low	yes / yes	no obligation (non-TENT-T)	Does not comply with TEN-T	infrastructure & capacity
Kőbánya felső-Rákos elágazás	1.1	fair	Axle load low, line speed low	yes / yes	2050	Does not comply with TEN-T	infrastructure & capacity
Rákos-Rákos-elágazás	1.4	fair	Axle load low, line speed low	yes / yes	no obligation (non-TENT-T)	Does not comply with TEN-T	infrastructure & capacity
Petőháza-Győr	58.1	fair	Axle load low, no ERTMS	yes / yes	2050	Does not comply with TEN-T	infrastructure & capacity
Kelenföld-Ferencváros	5.9	fair	Axle load low	yes / yes	2030	Does not comply with TEN-T	infrastructure & capacity
Hodoš (state border)-Őriszentpéter	6.1	acceptable	High gradient	yes / yes	2030	Main parameters already fulfilled but high gradient cannot be eliminated	infrastructure & capacity
Őriszentpéter-Zalalövő	12.6	acceptable	High gradient	yes / yes	2030	Main parameters already fulfilled but high gradient cannot be eliminated	infrastructure & capacity
Andráshida elágazás-Zalaszentiván elágazás	3.4	acceptable	Only minor compared to main TSI requirements	yes / yes	2030	Main parameters already fulfilled but train length is low	infrastructure & capacity
Zalaszentiván elágazás-Zalaszentiván	4.7	acceptable	Only minor compared to main TSI requirements	yes / yes	2030	Main parameters already fulfilled but train length is low	infrastructure & capacity
Zalalövő-Andráshida elágazás	20.8	acceptable	Only minor compared to main TSI requirements	yes / yes	2030	Main parameters already fulfilled but train length is low	infrastructure & capacity
Sopron-Rendező-Harka	3.0	fair	Axle load low, high gradient	no / expected	2050	Does not comply with TEN-T	infrastructure & future capacity
Sopron-Rendező-Pinnye	17.2	fair	Axle load low, no ERTMS	no / expected	2050	Does not comply with TEN-T	infrastructure & future capacity
Fertőszentmiklós-Petőháza	2.2	fair	Axle load low, no ERTMS	no / expected	2050	Does not comply with TEN-T	infrastructure & future capacity

From-to	Length (km)	Section quality by the compound index	Infrastructure deficiency / bottleneck	Capacity bottleneck currently / future	Time frame to comply TSI	TEN-TEN-T compliance	Bottleneck type
Budaörs-Kelenföld	5.6	acceptable	Axle load low	no / expected	2030	Does not comply with TEN-T	infrastructure & future capacity
Pinnye-Fertőszentmiklós	6.9	acceptable	No ERTMS	no / expected	2050	Main parameters already fulfilled but no ERTMS	infrastructure & future capacity
Balotaszállás elágazás-Harkakötöny elágazás	1.7	very poor	Axle load low, train speed very low, no ERTMS	no / not expected	no obligation (non-TENT-T)	Does not comply with TEN-T	infrastructure
Sátoraljaújhely-Slovenské Nové Mesto (state border)	0.5	very poor	No electrification, train length very low, line speed low, no ERTMS	no / not expected	no obligation (non-TENT-T)	Does not comply with TEN-T	infrastructure
Hatvan A elágazás-Hatvan D elágazás	3.8	very poor	Axle load low, train speed very low, no ERTMS, significant restrictions	no / not expected	no obligation (non-TENT-T)	Does not comply with TEN-TTEN-T and significant restrictions	infrastructure
Vasvár-Pácsony	10.1	very poor	Axle load low, very high gradient, no ERTMS	no / not expected	2050	Does not comply with TEN-T, limitations due to high gradient cannot be eliminated	infrastructure
Angyalföldi elágazás-Rákosrendező elágazás	1.0	poor	Axle load low, train speed very low, no ERTMS	no / not expected	no obligation (non-TENT-T)	Does not comply with TEN-T	infrastructure
Újszászi elágazás-Paládicspuszta elágazás	1.1	poor	Axle load low, train speed very low, no ERTMS, significant restrictions	no / not expected	2050	Does not comply with TEN-T and significant restrictions	infrastructure
Egervár-Vasboldogasszony-Zalaszentiván	7.5	poor	Axle load low, no ERTMS	no / not expected	2050	Does not comply with TEN-T	infrastructure
Kőbánya felső-Rákos	3.1	poor	Axle load low, line speed low, no ERTMS	no / not expected	2030	Does not comply with TEN-T	infrastructure
Szombathely-Vasvár	23.9	poor	Axle load low, no ERTMS	no / not expected	2050	Does not comply with TEN-T	infrastructure
Rákosrendező elágazás-Rákospalota-Újpest	2.3	poor	Axle load low, line speed low, no ERTMS	no / not expected	2050	Does not comply with TEN-T	infrastructure
Hegyeshalom-Porpác	94.4	poor	Axle load low, no ERTMS	no / not expected	2050	Does not comply with TEN-T	infrastructure

From-to	Length (km)	Section quality by the compound index	Infrastructure deficiency / bottleneck	Capacity bottleneck currently / future	Time frame to comply TSI	TEN-TEN-T compliance	Bottleneck type
Hatvan B elágazás-Hatvan C elágazás	1.1	poor	Axle load low, train speed very low, no ERTMS	no / not expected	no obligation (non-TENT-T)	Does not comply with TEN-T	infrastructure
Szolnok A elágazás-Szolnok-Rendező	5.2	poor	Axle load low, no ERTMS	no / not expected	no obligation (non-TENT-T)	Does not comply with TEN-T	infrastructure
Szolnok B elágazás-Szolnok-Rendező	3.6	poor	Axle load low, line speed low, no ERTMS	no / not expected	no obligation (non-TENT-T)	Does not comply with TEN-T	infrastructure
Szolnok C elágazás-Szolnok-Rendező	2.4	poor	Axle load low, line speed low, no ERTMS	no / not expected	no obligation (non-TENT-T)	Does not comply with TEN-T	infrastructure
Nyársapát elágazás-Abony elágazás	1.2	poor	Axle load low, train speed very low, no ERTMS	no / not expected	no obligation (non-TENT-T)	Does not comply with TEN-T	infrastructure
Porpác-Szombathely	16.7	poor	Axle load low, no ERTMS	no / not expected	2050	Does not comply with TEN-T	infrastructure
Pácsony-Egervár-Vasboldogasszony	8.7	poor	Axle load low, no ERTMS	no / not expected	2050	Does not comply with TEN-T	infrastructure
Szolnok D elágazás-Szolnok-Rendező	3.9	poor	Axle load low, no ERTMS	no / not expected	no obligation (non-TENT-T)	Does not comply with TEN-T	infrastructure
Ferencváros-Kőbánya felső	4.6	poor	Axle load low, line speed low, significant restrictions	no / not expected	2030	Does not comply with TEN-T and significant restrictions	infrastructure
Kunszentmiklós-Tass-Kiskunhalas	73.5	fair	Axle load low, no ERTMS	no / not expected	2030	Does not comply with TEN-T	infrastructure
Kiskunhalas-Kelebia	28.9	fair	Axle load low, no ERTMS	no / not expected	2030	Does not comply with TEN-T	infrastructure
Kelebia-Subotica (state border)	3.1	fair	Axle load low, no ERTMS	no / not expected	2030	Does not comply with TEN-T	infrastructure
Felsőzsolca-Felsőzsolca-elág	0.9	fair	Axle load low, no ERTMS	no / not expected	2030	Does not comply with TEN-T	infrastructure
Rákos elágazás-Angyalföldi elágazás	6.4	fair	Axle load low, no ERTMS	no / not expected	no obligation (non-TENT-T)	Does not comply with TEN-T	infrastructure
Hatvan-Újszász	1.6	fair	Axle load low, no ERTMS	no / not expected	2050	Does not comply with TEN-T	infrastructure
Hatvan-Újszász	50.4	fair	Axle load low, no ERTMS	no / not expected	no obligation (non-TENT-T)	Does not comply with TEN-T	infrastructure
Hatvan-Vámosgyörk	20.8	fair	Axle load low, no ERTMS, significant restrictions	no / not expected	2030	Does not comply with TEN-T and significant restrictions	infrastructure

From-to	Length (km)	Section quality by the compound index	Infrastructure deficiency / bottleneck	Capacity bottleneck currently / future	Time frame to comply TSI	TEN-TEN-T compliance	Bottleneck type
Vámosgyörk-Füzesabony	37.7	fair	Axle load low, no ERTMS, significant restrictions	no / not expected	2030	Does not comply with TEN-T and significant restrictions	infrastructure
Füzesabony-Miskolc-Tiszai	57.2	fair	Axle load low, no ERTMS, significant restrictions	no / not expected	2030	Does not comply with TEN-T and significant restrictions	infrastructure
Miskolc-Tiszai-Felsőzsolca	4.6	fair	Axle load low, no ERTMS, significant restrictions	no / not expected	2030	Does not comply with TEN-T and significant restrictions	infrastructure
Kiskunhalas-Kiskunfélegyháza	45.7	fair	Axle load low, no ERTMS	no / not expected	no obligation (non-TENT-T)	Does not comply with TEN-T	infrastructure
Komárom-Komárno (state border)	2.8	fair	Axle load low, line speed low	no / not expected	2050	Does not comply with TEN-T	infrastructure
Soroksár-Kunszentmiklós-Tass	44.6	fair	Axle load low, no ERTMS	no / not expected	2030	Does not comply with TEN-T	infrastructure
Újszász-Újszászi elágazás	13.4	fair	Axle load low, no ERTMS	no / not expected	2050	Does not comply with TEN-T	infrastructure
Rákospalota-Újpest-Vác	25.6	fair	Axle load low, no ERTMS	no / not expected	2050	Does not comply with TEN-T	infrastructure
Abony elágazás-Paládicspuszta elágazás	23.5	fair	Axle load low, no ERTMS	no / not expected	2050	Does not comply with TEN-T	infrastructure
Vác-Štúrovo (state border)	30.4	fair	Axle load low, no ERTMS, significant restrictions	no / not expected	2050	Does not comply with TEN-T	infrastructure
Rusovce (state border)-Hegyeshalom	15.8	fair	Axle load low	no / not expected	2030	Does not comply with TEN-T	infrastructure
Felsőzsolca-Mezőzombor	37.5	fair	No ERTMS	no / not expected	2030	Main parameters already fulfilled but no ERTMS	infrastructure
Mezőzombor-Mezőzombor kiág	1.2	fair	No ERTMS	no / not expected	2030	Main parameters already fulfilled but no ERTMS	infrastructure
Mezőzombor kiág-Sárospatak	30.3	fair	No ERTMS	no / not expected	no obligation (non-TENT-T)	Main parameters already fulfilled but no ERTMS	infrastructure
Városföld-Kiskunfélegyháza	13.7	fair	Axle load low, no ERTMS	no / not expected	2050	Does not comply with TEN-T	infrastructure
Ferencváros-Soroksári út	1.8	acceptable	No ERTMS	no / not expected	2030	Main parameters already fulfilled but no ERTMS	infrastructure

From-to	Length (km)	Section quality by the compound index	Infrastructure deficiency / bottleneck	Capacity bottleneck currently / future	Time frame to comply TSI	TEN-TEN-T compliance	Bottleneck type
Soroksári út-Soroksár	7.1	acceptable	No ERTMS	no / not expected	2030	Main parameters already fulfilled but no ERTMS	infrastructure
Felsőzsolca-elág-Hidasnémeti	55.8	acceptable	No ERTMS	no / not expected	2050	Main parameters already fulfilled but no ERTMS	infrastructure
Hidasnémeti-Kechnec (state border)	3.2	acceptable	No ERTMS	no / not expected	2050	Main parameters already fulfilled but no ERTMS	infrastructure
Sárospatak-Sátoraljaújhely	9.6	acceptable	No ERTMS	no / not expected	no obligation (non-TENT-T)	Main parameters already fulfilled but no ERTMS	infrastructure
Tata-Budaörs	62.8	acceptable	Only minor compared to main TSI requirements	no / not expected	2030	Main parameters already fulfilled but no ERTMS	infrastructure
Nyársapát elágazás-Városföld	42.4	acceptable	No ERTMS	no / not expected	2050	Main parameters already fulfilled but no ERTMS	infrastructure
Harka-Szombathely	57.1	acceptable	Only minor compared to main TSI requirements	no / not expected	2050	Main parameters already fulfilled but no ERTMS and train length is low	infrastructure
Komárom-Tata	20.0	acceptable	Only minor compared to main TSI requirements	no / not expected	2030	Main parameters already fulfilled but no ERTMS	infrastructure
Rákos-Hatvan	58.5	acceptable	No ERTMS	no / not expected	2030	Does not comply with TSI	infrastructure
Győr-Komárom	37.3	acceptable	Only minor compared to main TSI requirements	no / not expected	2030	Main parameters already fulfilled but no ERTMS	infrastructure

Table 36: TEN-T compliance of the sections (Hungary)

Slovenia

From-to	Length (km)	Section quality by the compound index	Infrastructure deficiency / bottleneck	Capacity bottleneck currently / future	Time frame to comply TSI	TEN-T compliance	Bottleneck type
Divača-Koper	48.0	very poor	Train length low, line speed low, very high gradient	yes / yes	2030	Does not comply TSI, limitations due to high gradient cannot be eliminated	infrastructure & capacity
Ljubljana-Divača	103.7	fair	High gradient	yes / yes	2030	Main parameters already fulfilled but high gradient cannot be eliminated	infrastructure & capacity

From-to	Length (km)	Section quality by the compound index	Infrastructure deficiency / bottleneck	Capacity bottleneck currently / future	Time frame to comply TSI	TEN-T compliance	Bottleneck type
Ljubljana-Novo mesto	76.0	very poor	No electrification, train length low, axle load low, line speed low, very high gradient	yes / yes	no obligation (non-TENT-T)	Does not comply TSI, limitations due to high gradient cannot be eliminated	infrastructure & capacity
Celje-Velenje	38.0	very poor	No electrification, train length low, line speed low, axle load low, high gradient	yes / yes	no obligation (non-TENT-T)	Does not comply TSI, limitations due to high gradient cannot be eliminated	infrastructure & capacity
Zidani Most-Pragersko	73.2	fair	Train length low	yes / yes	2030	Main parameters already fulfilled but train length is low	infrastructure & capacity
Ormož-Hodoš	69.2	acceptable	High gradient	yes / yes	2030	Main parameters already fulfilled but high gradient cannot be eliminated	infrastructure & capacity
Zidani Most-Ljubljana	63.9	fair	Train length low	no / expected	2030	Main parameters already fulfilled but train length is low	infrastructure & future capacity
Pragersko-Ormož	40.3	acceptable	Only minor compared to main TSI requirements	no / expected	2030	Main parameters already fulfilled but train length is low	infrastructure & future capacity

Table 37: TEN-T compliance of the sections (Slovenia)

7.4 Section relevance

Network role and the volume of (freight) traffic defines the “section relevance” amongst the sections of the Rail Freight Corridor. This indicator shows how the network role (RFC and TEN-T) and traffic volume “demands” the section to be TSI compliant without capacity issues. Grouping of sections is made into four groups: outstanding/high/medium/low.

The network role is based on two main characteristics: role on TEN-T network and role on RFC Amber.

Role on TEN-T network can be:

- TEN-T core sections (fulfilment of TEN-T parameter requirements is an obligation by 2030)
- TEN-T comprehensive sections (fulfilment of TEN-T parameter requirements is an obligation by 2050)
- non-TEN-T sections (no obligation)

Role on RFC network can be:

- principal line sections
- future principal line: they are considered similarly to present principal as their development is a priority to „complete” the Amber Corridor
- other RFC lines/sections (connecting and diversionary)

The defined traffic categorisation is based on the RFC sections’ average. The categorisation is as follows:

- ”high” if traffic volume is higher than 125% of the RFC average,
- “average” if traffic volume is between 125% and 75% of the RFC average,
- “low” if traffic volume is lower than 75% of the RFC average.

Summarised, the categorisation considers the following criteria:

TENT	RFC category	traffic
core	principal	high
comprehensive	future principal	average
no	diversionary	low
	future diversionary	
	connecting line	

Table 38: Criteria for section relevance classification

The section relevance can be, by combining the above listed three characteristics of the line section:

- outstanding
- high
- medium
- low

Categorisation by the parameters are as follows:

if:			then:
TENT=	RFC category=	traffic=	section relevance
core	principal	high	**outstanding**
core	future principal	high	**outstanding**
core	principal	average	**outstanding**
core	future principal	average	**outstanding**
core	principal	low	**high**
core	future principal	low	**high**
core	diversionary	high	**outstanding**
core	future diversionary	high	**outstanding**
core	diversionary	average	**high**
core	future diversionary	average	**high**
core	diversionary	low	**medium**
core	future diversionary	low	**medium**
core	connecting line	average	**medium**
core	connecting line	low	**low**
comprehensive	principal	high	**outstanding**
comprehensive	future principal	high	**outstanding**
comprehensive	principal	average	**high**
comprehensive	future principal	average	**high**
comprehensive	principal	low	**medium**
comprehensive	future principal	low	**medium**
comprehensive	diversionary	average	**medium**
comprehensive	future diversionary	average	**medium**
comprehensive	diversionary	low	**medium**
comprehensive	future diversionary	low	**medium**
comprehensive	connecting line	average	**low**
no	principal	high	**high**
no	future principal	high	**high**
no	principal	average	**medium**
no	future principal	average	**medium**
no	principal	low	**low**
no	future principal	low	**low**
no	diversionary	high	**medium**
no	future diversionary	high	**medium**
no	diversionary	average	**medium**
no	future diversionary	average	**medium**
no	diversionary	low	**low**
no	future diversionary	low	**low**
no	connecting line	average	**medium**
no	connecting line	low	**low**

Table 39: Categorisation of section relevance by the considered parameters

The following tables contain network role, the historic and forecasted traffic volumes and the section relevance, ranked by the relevance category (highest to lowest), by member state.

Poland

From-to	RFC category	TEN-T	Traffic - 2018, all train/year	Traffic - 2018, freight train/year	Traffic - 2018, million grosston/yr	Traffic - 2030, million grosston/yr	Traffic - 2050, cargo ton/year	Traffic - relative to RFC average	Traffic category compared to RFC average	Section relevance
Łuków-Terespol	principal	core	19395	10041	11.7	13.3	16.7	129%	high	outstanding
Radom-Tunel	principal	comprehensive	26877	10025	14.6	16.7	20.9	162%	high	outstanding
Warszawa Gdańska-Warszawa Praga	future principal	core	44788	10272	14.0	16.0	20.1	155%	high	outstanding
Dęblin-Radom	principal	comprehensive	19267	10417	15.6	17.8	22.3	172%	high	outstanding
Krakow Biezanow-Podłęże R 101	principal	core	39219	13375	18.7	21.3	26.8	207%	high	outstanding
Podłęże R 101-Podłęże	principal	core	33470	7705	10.7	12.2	15.3	118%	average	outstanding
Podłęże-Tarnów	principal	core	39549	9610	12.6	14.4	18.1	140%	high	outstanding
Oświęcim OWC1-Oświęcim OWC	principal	comprehensive	25559	22545	29.8	34.0	42.7	329%	high	outstanding
Oświęcim OWC-Czechowice-Dziedzice	principal	comprehensive	25168	22429	29.4	33.5	42.1	325%	high	outstanding
Kraków Prokocim-Kraków Bieżanów	principal	core	11448	6894	8.9	10.1	12.7	98%	average	outstanding
Jaworzno Szczakowa-Sosnowiec Jęzor	principal	core	25991	18058	20.3	23.1	29.0	224%	high	outstanding
Warszawa Główna Towarowa-Warszawa Gdańska	future principal	core	18191	12766	17.4	19.8	24.8	192%	high	outstanding
Kraków Prokocim Towarowy PRD-Kraków Bonarka	principal	core	7360	7191	10.2	11.6	14.6	113%	average	outstanding

From-to	RFC category	TEN-T	Traffic - 2018, all train/year	Traffic - 2018, freight train/year	Traffic - 2018, million grosston/yr	Traffic - 2030, million grosston/yr	Traffic - 2050, cargo ton/year	Traffic - relative to RFC average	Traffic category compared to RFC average	Section relevance
Warka-Radom	future principal	comprehensive	27986	2020	7.0	8.0	10.1	78%	average	high
Tunel-Raciborowice	principal	core	44138	1267	1.5	1.7	2.2	17%	low	high
Warszawa Praga-Legionowo	future diversionary	core	71857	6788	9.5	10.9	13.7	105%	average	high
Warszawa Gkówna Towarowa-Warszawa Gdańska	future principal	no	44788	10272	14.0	16.0	20.1	155%	high	high
Łuków-Dęblin	principal	no	14426	10240	17.9	20.4	25.7	198%	high	high
Dęblin-Radom	principal	no	19267	10417	15.6	17.8	22.3	172%	high	high
Kraków Bonarka-Oświęcim	principal	no	20303	14748	21.6	24.7	31.0	239%	high	high
Stróże-Nowy Sącz	principal	no	12976	4283	12.4	14.1	17.7	136%	high	high
Oświęcim-Oświęcim OWC1	principal	no	33006	25343	36.2	41.2	51.7	400%	high	high
Oświęcim OWC1-Mysłowice Brzezinka	principal	no	34673	26424	38.3	43.6	54.8	423%	high	high
Czechowice-Dziedzice-Bielsko-Biała Glowna	principal	core	29168	1764	1.0	1.1	1.4	11%	low	high
Bielsko-Biała Glowna-Bielsko-Biała Lipnik	principal	core	9447	213	4.2	4.8	6.0	47%	low	high
Bielsko-Biała Lipnik-Wilkowice Bystra	principal	core	9447	213	1.1	1.3	1.6	12%	low	high
Wilkowice Bystra-Zwardoń	principal	core	9447	213	0.2	0.2	0.2	2%	low	high
Sosnowiec Jęzor-Mysłowice Brzezinka	principal	no	16655	16014	23.2	26.5	33.2	256%	high	high
Oświęcim OWC-Oświęcim OWC1	principal	no	13783	12284	17.3	19.7	24.7	191%	high	high

From-to	RFC category	TEN-T	Traffic - 2018, all train/year	Traffic - 2018, freight train/year	Traffic - 2018, million grosston/yr	Traffic - 2030, million grosston/yr	Traffic - 2050, cargo ton/year	Traffic - relative to RFC average	Traffic category compared to RFC average	Section relevance
Dęblin-Pilawa	future diversionary	comprehensive	667	72	0.1	0.1	0.1	1%	low	medium
Czachówek Górny-Warka	future principal	comprehensive	27986	2020	6.4	7.3	9.2	71%	low	medium
Legionowo-Krusze	future diversionary	no	8808	5402	7.9	9.1	11.4	88%	average	medium
Tunel-Bukowno	principal	no	8690	5512	8.9	10.1	12.7	98%	average	medium
Gaj-Podłęże R 101	principal	no	6186	6097	8.5	9.7	12.2	94%	average	medium
Kraków Prokocim-Gaj	principal	no	6186	6097	8.5	9.7	12.2	94%	average	medium
Oświęcim-Oświęcim OWC	principal	comprehensive	6603	5124	6.3	7.2	9.0	70%	low	medium
Dłubnia-Podłęże	principal	no	8886	5970	8.0	9.2	11.5	89%	average	medium
Nowy Sącz-Muszyna	principal	comprehensive	8524	2839	3.4	3.9	4.9	38%	low	medium
Muszyna-Muszyna (G.P.)	principal	comprehensive	2906	2872	3.4	3.9	4.9	38%	low	medium
Zwardoń-Zwardoń (G.P.)	principal	comprehensive	3548	138	0.1	0.1	0.1	1%	low	medium
Kraków Prokocim Towarowy PRD-Kraków Bonarka1	principal	no	7360	7191	10.2	11.6	14.6	113%	average	medium
Podłęże R 201-Podłęże R 101	principal	no	6186	6097	8.5	9.7	12.2	94%	average	medium
Warszawa Aleje Jerozolimskie-Czachówek Górny	future principal	no	27986	2020	6.4	7.3	9.2	71%	low	low

From-to	RFC category	TEN-T	Traffic - 2018, all train/year	Traffic - 2018, freight train/year	Traffic - 2018, million grosston/yr	Traffic - 2030, million grosston/yr	Traffic - 2050, cargo ton/year	Traffic - relative to RFC average	Traffic category compared to RFC average	Section relevance
Krusze-Pilawa	future diversionary	no	3207	2696	4.7	5.3	6.7	52%	low	low
Podłęże-Podłęże R 201	principal	no	4265	2264	2.9	3.3	4.1	32%	low	low
Tarnów-Stróże	principal	no	12976	4283	6.7	7.6	9.6	74%	low	low
Sosnowiec Maczki-Jaworzno Szczakowa	principal	no	10865	4205	5.6	6.3	8.0	62%	low	low
Bukowno-Jaworzno Szczakowa	principal	no	1141	1115	1.9	2.2	2.7	21%	low	low
Warszawa Główna Towarowa-Warszawa Aleje Jerozolimskie	future principal	no	4252	4138	4.5	5.1	6.4	49%	low	low
Raciborowice-Dłubnia	principal	no	1419	640	0.9	1.0	1.2	9%	low	low
Tymbark-Nowy Sącz	future principal	no	0	0	0.0	0.0	0.0	0%	low	low

Table 40: Relevance of the line sections and the input data for categorisation (Poland)

Slovak Republic

From-to	RFC category	TEN-T	Traffic - 2018, all train/year	Traffic - 2018, freight train/year	Traffic - 2018, million grosston/yr	Traffic - 2030, million grosston/yr	Traffic - 2050, cargo ton/year	Traffic - relative to RFC average	Traffic category compared to RFC average	Section relevance
Košice-Michaľany	diversionary	core	58577	20919	16.1	18.0	23.3	174%	high	outstanding
Michaľany-Slovenské Nové Mesto	diversionary	core	58577	20919	16.1	18.0	23.3	174%	high	outstanding
Bratislava východ-Bratislava Predmestie	principal	core	46393	21441	9.3	10.3	13.4	100%	average	outstanding
Krásno nad Kysucou-Čadca	principal	core	38826	13807	23.1	25.7	33.4	249%	high	outstanding

From-to	RFC category	TEN-T	Traffic - 2018, all train/year	Traffic - 2018, freight train/year	Traffic - 2018, million grosston/yr	Traffic - 2030, million grosston/yr	Traffic - 2050, cargo ton/year	Traffic - relative to RFC average	Traffic category compared to RFC average	Section relevance
Szob (state border)-Štúrovo	principal	comprehensive	57651	21366	14.5	16.2	21.0	157%	high	outstanding
Bratislava Petržalka-Rajka (state border)	principal	core	46393	21441	9.3	10.3	13.4	100%	average	outstanding
Štúrovo-Nové Zámky	principal	comprehensive	57651	21366	14.5	16.2	21.0	157%	high	outstanding
Nové Zámky-Palárikovo	principal	comprehensive	57651	21366	14.5	16.2	21.0	157%	high	outstanding
Palárikovo-Galanta	principal	comprehensive	57651	21366	14.5	16.2	21.0	157%	high	outstanding
Púchov-Žilina	principal	core	42876	11493	8.0	8.9	11.5	86%	average	outstanding
Púchov-Trenčianska Teplá	principal	core	77670	16664	9.9	11.1	14.4	107%	average	outstanding
Trenčianska Teplá-Trenčín	principal	core	77670	16664	9.9	11.1	14.4	107%	average	outstanding
Trenčín-Nové Mesto nad Váhom	principal	core	77670	16664	9.9	11.1	14.4	107%	average	outstanding
Leopoldov-Trnava	principal	core	77670	16664	9.9	11.1	14.4	107%	average	outstanding
Trnava-Bratislava Rača	principal	core	77670	16664	9.9	11.1	14.4	107%	average	outstanding
Žilina-Krásno nad Kysucou	principal	core	38826	13807	23.1	25.7	33.4	249%	high	outstanding
Nové Mesto nad Váhom-Leopoldov	principal	core	77670	16664	9.9	11.1	14.4	107%	average	outstanding
Skalité-Zwardoň (state border)	principal	core	6573	110	0.1	0.1	0.1	1%	low	high
Čadca-Skalité	principal	core	6573	110	0.1	0.1	0.1	1%	low	high
Košice-Kysak	principal	core	57115	15271	2.1	2.4	3.1	23%	low	high

From-to	RFC category	TEN-T	Traffic - 2018, all train/year	Traffic - 2018, freight train/year	Traffic - 2018, million grosston/yr	Traffic - 2030, million grosston/yr	Traffic - 2050, cargo ton/year	Traffic - relative to RFC average	Traffic category compared to RFC average	Section relevance
Barca-Košice nákl.stanica	principal	no	52009	19321	25.3	28.2	36.6	273%	high	high
Dunajská Streda-Bratislava Nové Mesto	connecting line	no	24534	5796	7.2	8.0	10.4	77%	average	medium
Dunajská Streda-Bratislava Nové Mesto	connecting line	core	24534	5796	7.2	8.0	10.4	77%	average	medium
Prešov-Kysak	principal	comprehensive	27284	5071	3.8	4.2	5.5	41%	low	medium
Muszyna (state border)-Plaveč	principal	comprehensive	27284	5071	3.8	4.2	5.5	41%	low	medium
Plaveč-Prešov	principal	comprehensive	27284	5071	3.8	4.2	5.5	41%	low	medium
Slovenské Nové Mesto-Satoraljaújhely (state border)	diversionary	no	58577	20919	16.1	18.0	23.3	174%	high	medium
Komárom (state border)-Komárno	principal	comprehensive	17213	6358	4.6	5.1	6.7	50%	low	medium
Komárno-Nové Zámky	principal	comprehensive	17213	6358	4.6	5.1	6.7	50%	low	medium
Bratislava východ-Bratislava Predmestie	principal	no	46393	21441	9.3	10.3	13.4	100%	average	medium
Hidasnémeti (state border)-Barca	principal	comprehensive	7422	4375	4.8	5.3	6.9	52%	low	medium
Leopoldov-Galanta	principal	comprehensive	15366	3511	4.1	4.6	6.0	45%	low	medium

From-to	RFC category	TEN-T	Traffic - 2018, all train/year	Traffic - 2018, freight train/year	Traffic - 2018, million grosston/yr	Traffic - 2030, million grosston/yr	Traffic - 2050, cargo ton/year	Traffic - relative to RFC average	Traffic category compared to RFC average	Section relevance
Bratislava Predmestie-Bratislava Petržalka	principal	no	46393	21441	9.3	10.3	13.4	100%	average	medium
Komárno-Dunajská Streda	connecting line	no	24534	5796	3.3	3.7	4.8	36%	low	low
Kysacká spojka	principal	no	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	low	low
Orlovská spojka	principal	no	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	low	low
Bratislava Rača-Bratislava východ	principal	no	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	low	low

Table 41: Relevance of the line sections and the input data for categorisation (Slovak Republic)

Hungary

From-to	RFC category	TEN-T	Traffic - 2018, all train/year	Traffic - 2018, freight train/year	Traffic - 2018, million grosston/yr	Traffic - 2030, million grosston/yr	Traffic - 2050, cargo ton/year	Traffic - relative to RFC average	Traffic category compared to RFC average	Section relevance
Budaörs-Kelenföld	principal	core	70896	21952	24.5	28.9	38.6	281%	high	outstanding
Kőbánya felső-Rákos elágazás	principal	comprehensive	19546	8138	11.1	13.2	17.6	128%	high	outstanding
Kelenföld-Ferencváros	principal	core	94147	34017	38.1	45.1	60.0	437%	high	outstanding
Hodoš (state border)-Őriszentpéter	principal	core	12039	6923	8.0	9.5	12.6	92%	average	outstanding
Őriszentpéter-Zalalövő	principal	core	13223	6626	8.0	9.5	12.6	92%	average	outstanding
Zalaszentiván elágazás-Zalaszentiván	principal	core	26777	7221	9.2	10.8	14.5	105%	average	outstanding
Zalalövő-Andráshida elágazás	principal	core	13223	6626	8.0	9.5	12.6	92%	average	outstanding

From-to	RFC category	TEN-T	Traffic - 2018, all train/year	Traffic - 2018, freight train/year	Traffic - 2018, million grosston/yr	Traffic - 2030, million grosston/yr	Traffic - 2050, cargo ton/year	Traffic - relative to RFC average	Traffic category compared to RFC average	Section relevance
Rákosrendező elágazás-Rákospalota-Újpest	principal	comprehensive	19546	8138	11.1	13.2	17.6	128%	high	outstanding
Ferencváros-Kőbánya felső	principal	core	20831	11062	16.1	19.1	25.4	185%	high	outstanding
Kiskunhalas-Kelebia	principal	core	12299	3044	6.6	7.8	10.1	76%	average	outstanding
Kelebia-Subotica (state border)	principal	core	5328	2908	8.8	10.4	10.1	100%	average	outstanding
Hatvan-Vámosgyörk	principal	core	31876	7572	11.0	13.0	17.4	126%	high	outstanding
Vámosgyörk-Füzesabony	principal	core	31177	3659	14.6	17.3	17.4	168%	high	outstanding
Füzesabony-Miskolc-Tiszai	principal	core	34587	6180	13.4	15.9	17.4	154%	high	outstanding
Miskolc-Tiszai-Felsőzsolca	principal	core	40887	2976	9.6	11.4	17.4	110%	average	outstanding
Rákospalota-Újpest-Vác	principal	comprehensive	64086	8776	12.6	14.9	19.8	144%	high	outstanding
Abony elágazás-Paládicspuszta elágazás	principal	comprehensive	53553	15349	15.6	18.4	24.6	179%	high	outstanding
Vác-Štúrovo (state border)	principal	comprehensive	39222	8563	12.1	14.3	19.1	139%	high	outstanding
Ferencváros-Soroksári út	principal	core	41342	16481	13.9	16.4	21.9	159%	high	outstanding
Soroksári út-Soroksár	principal	core	33319	10304	10.7	12.6	16.8	122%	average	outstanding
Tata-Budaörs	principal	core	68634	21224	23.5	27.8	37.0	269%	high	outstanding
Komárom-Tata	principal	core	66481	21256	24.0	28.4	37.9	275%	high	outstanding
Rákos-Hatvan	principal	core	39316	4402	8.4	10.0	13.3	96%	average	outstanding

From-to	RFC category	TEN-T	Traffic - 2018, all train/year	Traffic - 2018, freight train/year	Traffic - 2018, million grosston/yr	Traffic - 2030, million grosston/yr	Traffic - 2050, cargo ton/year	Traffic - relative to RFC average	Traffic category compared to RFC average	Section relevance
Győr-Komárom	principal	core	66642	22321	23.6	27.9	37.2	271%	high	outstanding
Kőbánya felső-Rákos elágazás	principal	no	19546	8138	11.1	13.2	17.6	128%	high	high
Andráshida elágazás-Zalaszentiván elágazás	principal	core	5631	158	0.0	0.0	0.1	0%	low	high
Angyalföldi elágazás-Rákosrendező elágazás	principal	no	19546	8138	11.1	13.2	17.6	128%	high	high
Kőbánya felső-Rákos	principal	core	76402	1724	2.0	2.4	3.2	23%	low	high
Kunszentmiklós-Tass-Kiskunhalas	principal	core	12732	4936	6.4	7.6	10.1	74%	low	high
Felsőzsolca-Felsőzsolca-elág	principal	core	17040	3591	5.2	6.2	8.3	60%	low	high
Rákos elágazás-Angyalföldi elágazás	principal	no	19546	8138	11.1	13.2	17.6	128%	high	high
Soroksár-Kunszentmiklós-Tass	principal	core	25430	4914	6.4	7.5	10.1	73%	low	high
Újszász-Újszászi elágazás	principal	comprehensive	62978	10104	7.0	8.3	11.1	81%	average	high
Rusovce (state border)-Hegyeshalom	principal	core	10345	3631	5.9	7.0	9.3	68%	low	high
Sopron-Rendező-Harka	principal	comprehensive	27767	1878	0.9	1.0	1.4	10%	low	medium
Sopron-Rendező-Pinnye	principal	comprehensive	29047	7093	5.2	6.1	8.1	59%	low	medium
Fertőszentmiklós-Petőháza	principal	comprehensive	29047	7093	5.2	6.1	8.1	59%	low	medium

From-to	RFC category	TEN-T	Traffic - 2018, all train/year	Traffic - 2018, freight train/year	Traffic - 2018, million grosston/yr	Traffic - 2030, million grosston/yr	Traffic - 2050, cargo ton/year	Traffic - relative to RFC average	Traffic category compared to RFC average	Section relevance
Pinnye-Fertőszentmiklós	principal	comprehensive	29047	7093	5.2	6.1	8.1	59%	low	medium
Petőháza-Győr	principal	comprehensive	29047	7093	5.2	6.1	8.1	59%	low	medium
Vasvár-Pácsony	principal	comprehensive	13490	3004	3.6	4.3	5.7	41%	low	medium
Újszászi elágazás-Paládicspuszta elágazás	principal	comprehensive	1211	677	0.4	0.5	0.7	5%	low	medium
Egervár-Vasboldogasszony-Zalaszentiván	principal	comprehensive	13490	3004	3.6	4.3	5.7	41%	low	medium
Szombathely-Vasvár	principal	comprehensive	13490	3004	3.6	4.3	5.7	41%	low	medium
Hegyeshalom-Porpác	principal	comprehensive	17985	4955	2.3	2.7	3.6	26%	low	medium
Porpác-Szombathely	principal	comprehensive	32398	3884	1.1	1.3	1.7	13%	low	medium
Pácsony-Egervár-Vasboldogasszony	principal	comprehensive	13490	3004	3.6	4.3	5.7	41%	low	medium
Hatvan-Újszász	principal	comprehensive	15321	3548	2.1	2.5	3.3	24%	low	medium
Komárom-Komárno (state border)	principal	comprehensive	6002	4751	4.0	4.7	6.3	45%	low	medium
Felsőzsolca-Mezőzombor	diversionary	core	14182	1637	4.9	5.8	7.7	56%	low	medium

From-to	RFC category	TEN-T	Traffic - 2018, all train/year	Traffic - 2018, freight train/year	Traffic - 2018, million grosston/yr	Traffic - 2030, million grosston/yr	Traffic - 2050, cargo ton/year	Traffic - relative to RFC average	Traffic category compared to RFC average	Section relevance
Mezőzombor-Mezőzombor kiág	diversionary	core	12455	131	0.1	0.1	0.1	1%	low	medium
Városföld-Kiskunfélegyháza	principal	comprehensive	22444	2483	2.4	2.9	3.8	28%	low	medium
Felsőzsolca-elág-Hidasnémeti	principal	comprehensive	17040	3591	5.2	6.2	8.3	60%	low	medium
Hidasnémeti-Kechnec (state border)	principal	comprehensive	5630	3565	6.0	7.1	8.3	68%	low	medium
Nyársapát elágazás-Városföld	principal	comprehensive	20453	3955	2.8	3.3	4.4	32%	low	medium
Harka-Szombathely	principal	comprehensive	13483	1174	0.8	0.9	1.3	9%	low	medium
Rákos-Rákos-elágazás	principal	no	5023	3803	4.1	4.9	6.5	47%	low	low
Balotaszállás elágazás-Harkakötöny elágazás	principal	no	3174	2632	1.1	1.4	1.8	13%	low	low
Sátoraljaújhely-Slovenské Nové Mesto (state border)	diversionary	no	11	6	0.0	0.0	0.0	0%	low	low
Hatvan A elágazás-Hatvan D elágazás	principal	no	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	low	low
Hatvan B elágazás-Hatvan C elágazás	principal	no	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	low	low
Szolnok A elágazás-Szolnok-Rendező	principal	no	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	low	low
Szolnok B elágazás-Szolnok-Rendező	principal	no	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	low	low
Szolnok C elágazás-Szolnok-Rendező	principal	no	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	low	low

From-to	RFC category	TEN-T	Traffic - 2018, all train/year	Traffic - 2018, freight train/year	Traffic - 2018, million grosston/yr	Traffic - 2030, million grosston/yr	Traffic - 2050, cargo ton/year	Traffic - relative to RFC average	Traffic category compared to RFC average	Section relevance
Nyársapát elágazás-Abony elágazás	principal	no	3889	3118	0.7	0.9	1.2	8%	low	low
Szolnok D elágazás-Szolnok-Rendező	principal	no	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	low	low
Hatvan-Újszász	principal	no	15321	3548	2.1	2.5	3.3	24%	low	low
Kiskunhalas-Kiskunfélegyháza	principal	no	9193	1676	1.8	2.1	2.8	20%	low	low
Mezőzombor kiág-Sárospatak	diversionary	no	12455	131	0.1	0.1	0.1	1%	low	low
Sárospatak-Sátoraljaújhely	diversionary	no	3948	16	0.0	0.0	0.0	0%	low	low

Table 42: Relevance of the line sections and the input data for categorisation (Hungary)

Slovenia

From-to	RFC category	TEN-T	Traffic - 2018, all train/year	Traffic - 2018, freight train/year	Traffic - 2018, million grosston/year	Traffic - 2030, million grosston/year	Traffic - 2050, cargo ton/year	Traffic - relative to RFC average	Traffic category compared to RFC average	Section relevance
Divača-Koper	principal	core	36714	23419	23.5	26.6	46.2	258%	high	outstanding
Ljubljana-Divača	principal	core	45173	31780	33.1	37.4	65.0	363%	high	outstanding
Zidani Most-Pragersko	principal	core	37004	15425	15.2	17.1	29.8	166%	high	outstanding
Ormož-Hodoš	principal	core	13645	7339	7.6	8.6	14.9	83%	average	outstanding
Zidani Most-Ljubljana	principal	core	66685	29717	22.2	25.1	43.5	243%	high	outstanding
Pragersko-Ormož	principal	core	19156	8577	8.1	9.1	15.8	89%	average	outstanding
Ljubljana-Novo mesto	connecting line	no	10722	1183	0.3	0.3	0.6	3%	low	low
Celje-Velenje	connecting line	no	6843	829	0.2	0.2	0.3	2%	low	low

Table 43: Relevance of the line sections and the input data for categorisation (Slovenia)

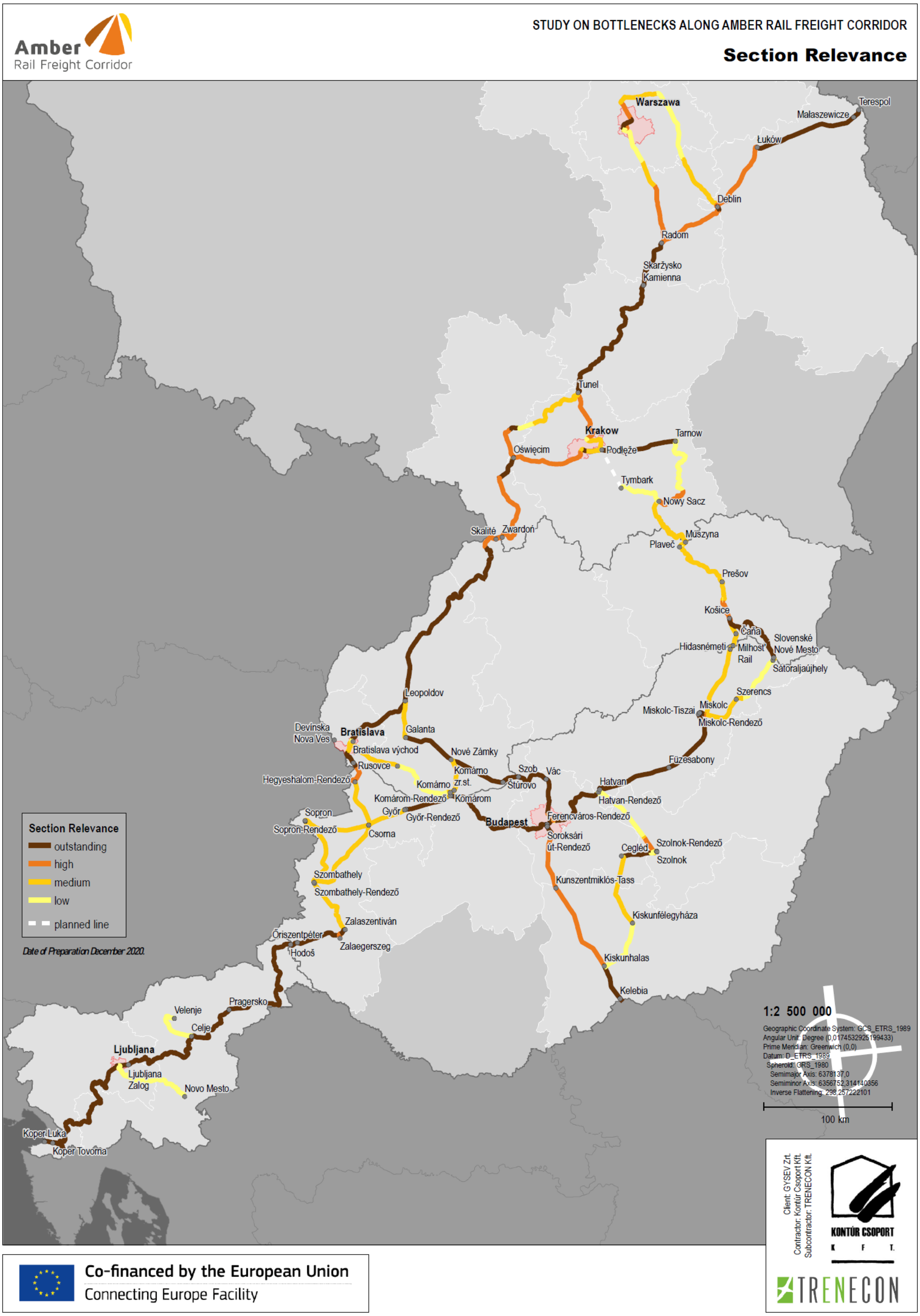


Figure 41: Map of section relevance along RFC Amber

7.5 Identifying issues at major stations and border crossings

7.5.1 Assessment of infrastructure and capacity

Major service points along RFC Amber are the marshalling yards, and the border crossing stations (they are the same at some point).

Marshalling yards are those facilities where there is high capacity is available for train handling (train composition or rearrangement, short term parking or longer term storage etc.). In this aspect these are the main important stations for traffic management purposes – not only as handling the trains but to solve capacity issues on the network, e.g. by short term parking of the trains for prompt traffic management.

Border stations handle the trains at network borders, having significant administrative duties, even inside EU Schengen area.

The following table lists the marshalling yards and border stations along RFC Amber. For TEN-T requirements, maximum train length is an ultimate parameter of the facilities. As data collection allowed, we included the data on the number of freight train tracks (sidings) longer than 740m, only electrified ones, supposing that train management along the Corridor requires the handling or control of electric traction freight trains. Also, for the border crossing stations, the capacity issues are included in the Table 44, as evaluated by the IMs.

Name	Type	No. of electrified ≥740m long tracks	Border crossing function	Capacity assessment	Border average waiting time, minutes
POLAND					
Jaworzno Szczakowa	marshalling yard	4	-	no significant capacity issue	-
Kielce Herbskie	marshalling yard	10	-	no significant capacity issue	-
Kraków Nowa Huta	marshalling yard	28	-	no significant capacity issue	-
Skarżysko-Kamienna	marshalling yard	7	-	capacity problems	-
Tarnów Filia	marshalling yard	10	-	capacity problems	-
Warszawa Praga	marshalling yard	19	-	no significant capacity issue	-
Małaszewicze	marshalling yard	10	-	capacity problems	-
Kraków Prokocim Towarowy	marshalling yard	18	-	no significant capacity issue	
Terespol	border station	0	not handover station	capacity problems	n.a.
Muszyna	border station	0	handover station	sufficient	n.a.
Zwardoń	border station	0	not handover station	sufficient	n.a.
SLOVAK REPUBLIC					
Bratislava Východ	marshalling yard	11	-	no significant capacity issue	-
Žilina Teplička	marshalling yard	6	-	capacity problems (under development)	-
Košice	marshalling yard	9	-	no significant capacity issue	-
Prešov	marshalling yard	0	-	no significant capacity issue	-

Name	Type	No. of electrified ≥740m long tracks	Border crossing function	Capacity assessment	Border average waiting time, minutes
Nové Zámky	marshalling yard	9	-	no significant capacity issue	-
Komárno zr.st.	marshalling yard	7	-	no significant capacity issue	-
Komárno	border station	4	not handover station	sufficient	n.a.
Štúrovo	marshalling yard, border station	19	handover station	capacity problems	265
Skalité	border station	1	handover station	sufficient	n.a.
Plaveč	border station	1	not handover station	sufficient	n.a.
Čaňa	border station	0	not handover station	sufficient	n.a.
Rusovce	border station	3	not handover station	sufficient	n.a.
Slovenské Nové Mesto	border station	2	handover station	sufficient	n.a.
HUNGARY					
Sopron-Rendező	marshalling yard	5	-		-
Győr-Rendező	marshalling yard	6	-	capacity problems	-
Hegyeshalom	marshalling yard	12	-	no significant capacity issue	-
Komárom-Rendező	marshalling yard	2	-	capacity problems	-
Budapest-Ferencváros	marshalling yard	16	-	no significant capacity issue	-
Budapest-Soroksári út	marshalling yard	4	-	no significant capacity issue	-
Hatvan-Rendező	marshalling yard	2	-	no significant capacity issue	-
Miskolc-Rendező	marshalling yard	14	-	no significant capacity issue	-
Szolnok-Rendező	marshalling yard	17	-	no significant capacity issue	-
Szombathely-Rendező	marshalling yard	0	-	capacity problems	-
Rajka	border station	8	handover station	capacity problems	285
Hidasnémeti	border station	4	handover station	sufficient	381
Sátoraljaújhely	border station	0	not handover station	sufficient	30
Kelebia	border station	8	not handover station	sufficient	545
Komárom	border station	0	handover station	capacity problems	199
Őriszentpéter	border station	4	not handover	sufficient	37
Szob	border station	3	not handover	sufficient	8
SLOVENIA					
Celje (SL)	marshalling yard	1	-	no significant capacity issue	-
Ljubljana Zalog (SL)	marshalling yard	1	-	no significant capacity issue	-
Koper Tovorna (SL)	marshalling yard	4	-	capacity problems	-
Hodoš (SL)	border station	1	handover	sufficient	65

Table 44: Marshalling yards and border stations along RFC Amber

As it is included in the table, even the fulfilment of TEN-T requirements for handling freight trains is often limited: availability of long station tracks (parking sidings) is limited at the border stations and also at some marshalling yards, consequently handling of long freight trains, in line with TEN-T requirements and EU goals, faces capacity issues not only on the lines but at the handling points, too.

There are capacity problems at many border-crossing points and the average time for a train to cross the national (mostly EU internal and Schengen zone internal) borders is high, exceeds the generally expected 2 hours/train (and almost always higher than a Western-European standard 0,5 hour/train).

Besides the capacity assessment presented in the table, data on the waiting times at the specific border crossings is limited to Hungary and Slovenia. Detailed data from Hungarian IMs show that the time of border crossing is significantly different location-by-location and also for inbound and outbound traffic (entering or leaving the country). Handover stations, as a consequence of more duties, paperwork and often the loco and driver change, needs much longer time to launch trains, waiting time differs from 3 hours to 6-7 hours per train. Inbound waiting time is always shorter at each location, even half of the outbound time, as the majority of the administration is done outbound, furthermore there is no need to wait for the neighbouring country’s border station to accept the train. Extreme short stay at some locations is not only caused by the fact that it is not a handover station but often by traffic management reasons: when a border station has low free capacity and/or lacks parking tracks, freight trains do not wait at the border but are stopped at a farther station along the line. Where RUs experience longer waits at a non-handover station, usually the neighbouring (handover) station has capacity shortage to receive the train for handling (even administrative or infrastructural reasons).

Not surprisingly the highest average waiting time is registered in Kelebia at the Serbian border (where trains enter the Schengen area) where outbound waiting time is only ~20 minutes (handover station is Subotica) but inbound 13-14 hours.

Besides, Hodoš, although being a handover station and power supply changing point, handles the trains relative rapidly. One reason for that is that the overhead contact line system allows two level station voltage. Electric system permits the transformation of 3 kV DC to 25kV AC voltage and vice versa in all main tracks. It enables simpler and therefore quicker operational train procedures.

The data for that station shows that there can be significant difference in train handling and waiting times depending on the RUs and their transport organization. Even the average time is 60-70 minutes per train, that is valid for RUs that are regular clients at the border crossing of Hodoš, while ad-hoc applicants (i.e. smaller RUs, not having regular traffic here) can experience a waiting and handling time of 90-100 minutes. However, trusted trains, on the basis of mutually agreed contract of co-operating RUs, need only 20-30 minutes to hand over the trains and do the administration. Supposedly the deviations are present at other borders, too, as administration of trains needs similar processes from RUs independently from location (except special locations where trains cross the external border of the European Union Schengen agreement area: Koper, Terespol, Kelebia).

Administratively they are the ‘end points’ of RFC Amber, Koper at the Adriatic Sea and Małaszewice and Terespol at the Belarus border can be declared stations of bottleneck not only on RFC Amber but other RFCs in the area, both having important role in the trade between Europe and the Far East (Koper for sea navigation, Terespol at the new silk way). Their train handling capacity and operational efficiency is essential to improve train traffic along RFC Amber.

From the information on the operational and administrative issues from IMs and RUs (see later in chapter 8), the transfer time at the border crossings is considering that majority of the border crossings are inside the EU Schengen area (where there is no customs control required).

Causes for time consuming train handling at the borders and (as a consequence) capacity shortage at those stations are very complex: it is a mix of infrastructure deficiency at the border stations (e.g. appropriate station track shortage) and also some infrastructure and capacity bottlenecks on the hinterland network, causing delays at the handover stations compared to the reserved path, administrative issues such as necessary safety checks and paperwork, communication and often traffic management problems can result in low efficiency of border processes and high waiting times.

Considering Task Force reports of some of the border crossings, mainly available on RFC Orient/East-Med, the major problems that cause or increase the unnecessary waiting time are waiting for locomotive change or loco driver (and the buffer wagon but that is no longer mandatory in Hungary). Unnecessary waiting for the receiving RU (for loco and/or driver change) is usually caused indirectly by the delayed arrival at the border compared to the booked PaP (or inadequate sharing of information with the RUs). Therefore, the improved punctuality on the national networks can result in lower waiting times and more calculable crossing at the national borders. Other supportive process is the more comprehensive use of hybrid locomotives and the spreading of the trusted train agreement between the RUs.

Another issue is that the line infrastructure parameters often differ significantly on the two sides of the borders. The following table summarizes the main line characteristics at the connecting lines of the border station pairs. Major differences are e.g.:

- different traction (current system) at Sátoraljaújhely-Slovenské Nové Mesto, Őriszentpéter-Hodoš, Hidasnémeti-Čaňa(-Košice),
- axle load is usually different slightly, significant difference is at Hidasnémeti-Čaňa, Sátoraljaújhely-Slovenské Nové Mesto, Rajka-Rusovce,
- significantly different maximum train length: extreme difference at Zwardoń-Skalité

This suggest that border station capacities often need increasing but connection line parameters should also be developed to allow flawless traffic flow.

The previously mentioned direction change of trains is problematic at some locations and, besides of border crossings and marshalling, shunting yards, there are further junctions, stations along the RFC Amber where there is also capacity problems; e.g. in Pragersko and Ljubljana in Slovenia, Szombathely in Hungary.

Border station	State	RFC line category	Electrification	No. of tracks	Axle load	Train length	ERTMS	Capacity problem	Direction change	Average waiting time	Traffic category – thousand trains/yr.	Ratio of freight traffic – %	Handover
Terespol	PL	principal	3 kV DC	2	D3	≥ 740 m	GSM-R	yes	no		< 20	75 - 100	no
Muszyna	PL	principal	3 kV DC	1	C3	600 - 739 m	no	no	no		< 20	26 - 50	yes
Plaveč	SK	principal	3 kV DC	1	D4	600 - 739 m	no	no	no		20 – 40	0-25	no
Zwardoń	PL	principal	3 kV DC	1	C3	< 400 m	no	no	no		< 20	0-25	no
Skalité	SK	principal	3 kV DC	1	D4	600 - 739 m	GSM-R & ETCS L2	no	no		20 – 40	0-25	yes
Komárom	HU	principal	25 kV AC	2	D3	≥ 740 m	GSM-R & ETCS L1	yes	yes	199 min.	60 – 80	26 - 50	yes
Komárno zr.st.	SK	principal/connecting	25 kV AC/diesel	1	D4	600 - 739 m/< 400 m	no	no	yes		20 – 40	26 - 50	no
Szob	HU	principal	25 kV AC	2	C3	≥ 740 m	no	no	no	8 min.	20 – 40	0-25/26 - 50	no
Štúrovo	SK	principal	25 kV AC	2	D4	600 - 739 m	GSM-R	yes	no	265 min.	40 – 60	26 - 50	yes
Hidasnémeti	HU	principal	25 kV AC	1	C2	≥ 740 m	no	no	no	381 min.	< 20	0-25/51 - 75	yes
Čaňa št. hrh.	SK	principal	25 kV AC/3 kV DC	1	D4	600 - 739 m	no	no	no		40 – 60	51 - 75	no
Sátoraljaújhely	HU	diversionary	25 kV AC/diesel	1	C2	600 - 739 m	no	no	no		< 20	0-25	no
Slovenské Nové Mesto	SK	diversionary	diesel/3 kV DC	2	D4	600 - 739 m	no	no	no		40 – 60	26 - 50	yes

Border station	State	RFC line category	Electrification	No. of tracks	Axle load	Train length	ERTMS	Capacity problem	Direction change	Average waiting time	Traffic category – thousand trains/yr.	Ratio of freight traffic – %	Handover
Rajka	HU	principal	25 kV AC	1	C2	600 - 739 m	GSM-R & ETCS L1	yes	no	285 min.	< 20	26 - 50	yes
Rusovce	SK	principal	25 kV AC	1	D4	600 - 739 m	no	no	no		40 – 60	26 - 50	no
Őriszentpéter	HU	principal	25 kV AC	1	D4	600 - 739 m	GSM-R & ETCS L2	no	no	37 min.	< 20	51 - 75	no
Hodoš	SL	principal	25 kV AC/3 kV DC	1	D4	600 - 739 m	GSM-R & ETCS L1	no	no	70 min.	< 20	51 - 75	yes
Kelebia	HU	principal	25 kV AC	1	C3	600 - 739 m	no	no	no	545 min.	< 20	0-25	no
Koper	SL	principal	3 kV DC	1	D3	400 - 599 m	GSM-R & ETCS L1	yes	no		20 – 40	51 - 75	yes

Table 45: Border crossing stations' and connecting lines main parameters

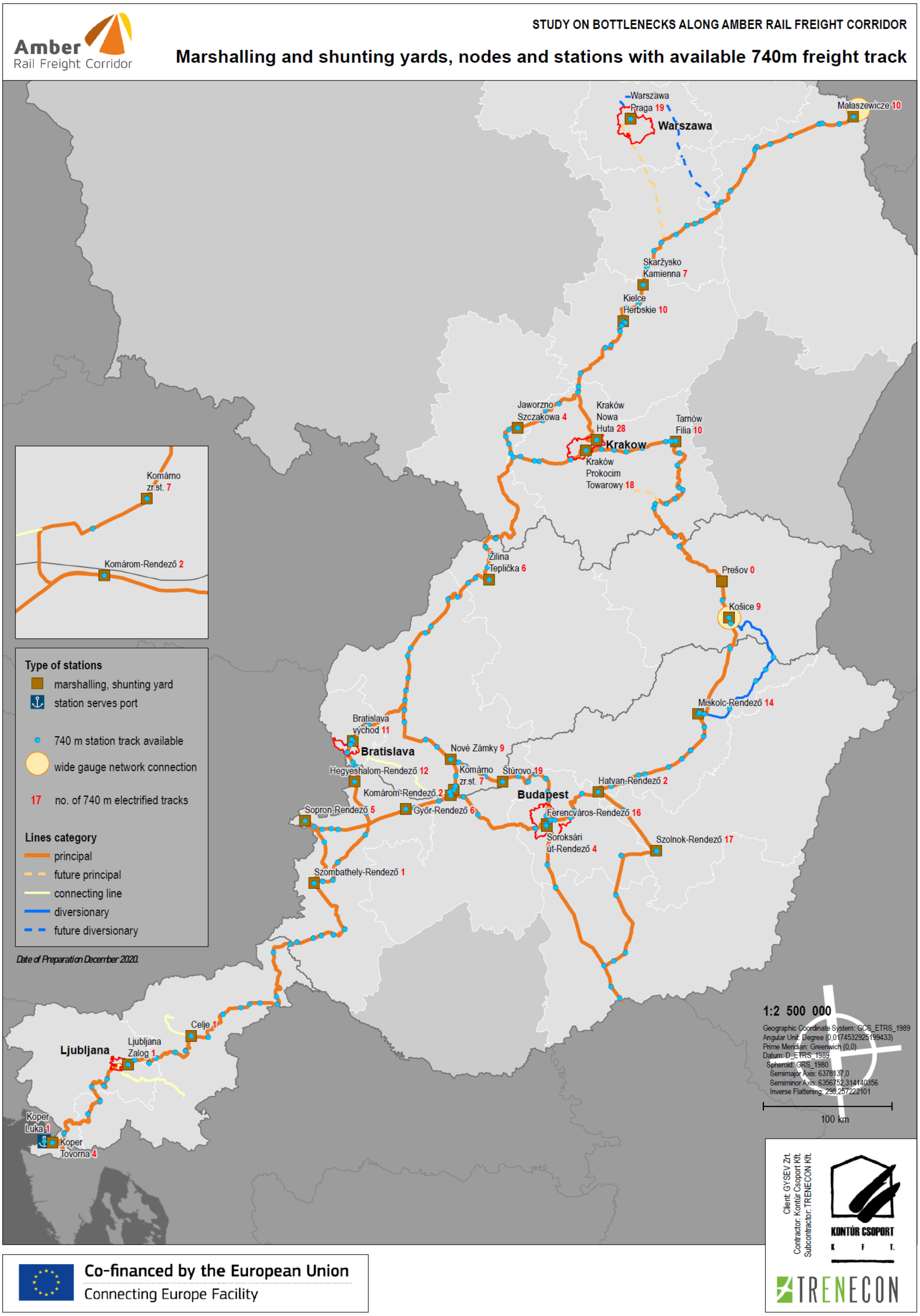


Figure 42: Main infrastructure parameters of marshalling, shunting yards and other stations along RFC Amber

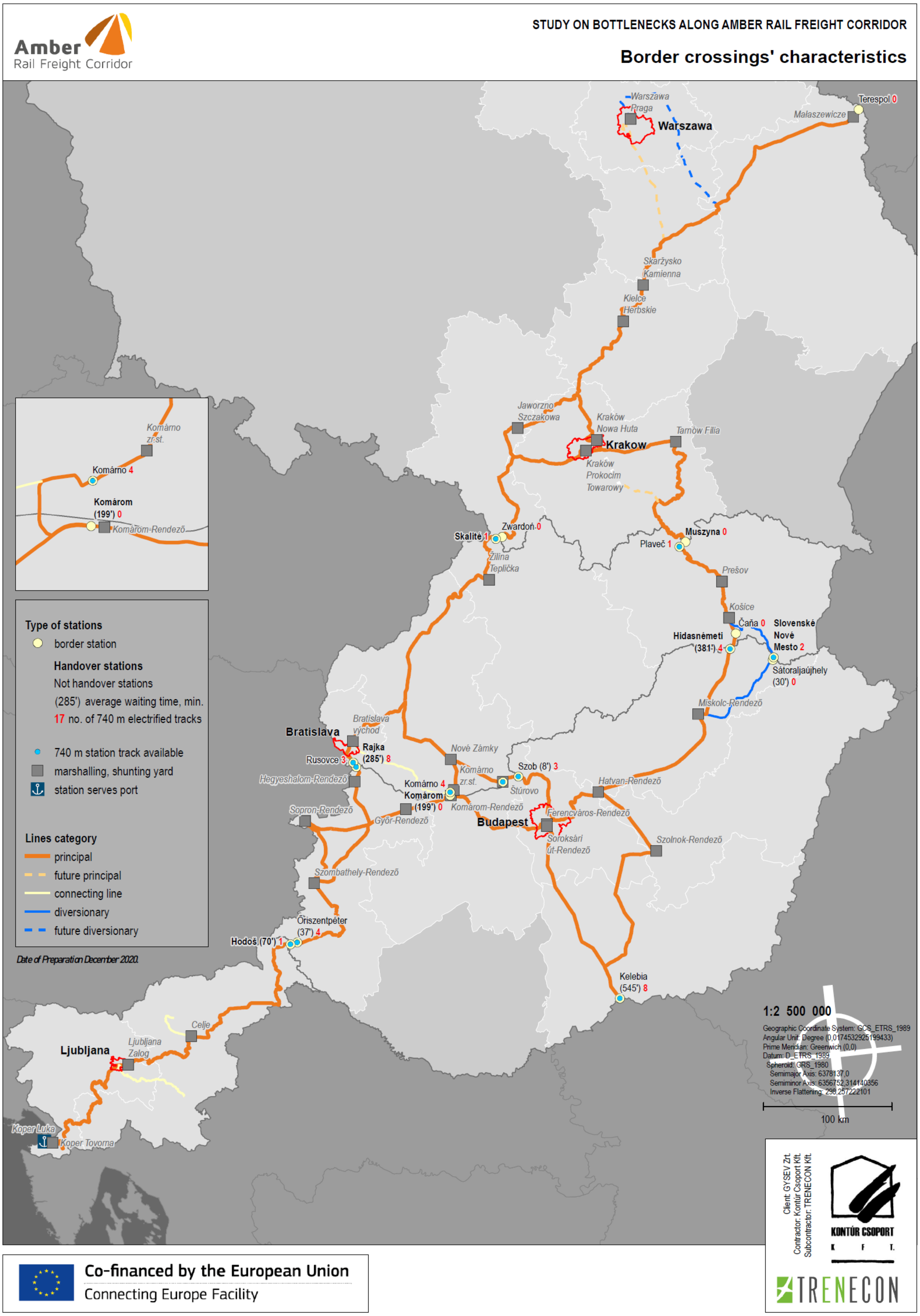


Figure 43. Main infrastructure and service parameters of border crossings along RFC Amber

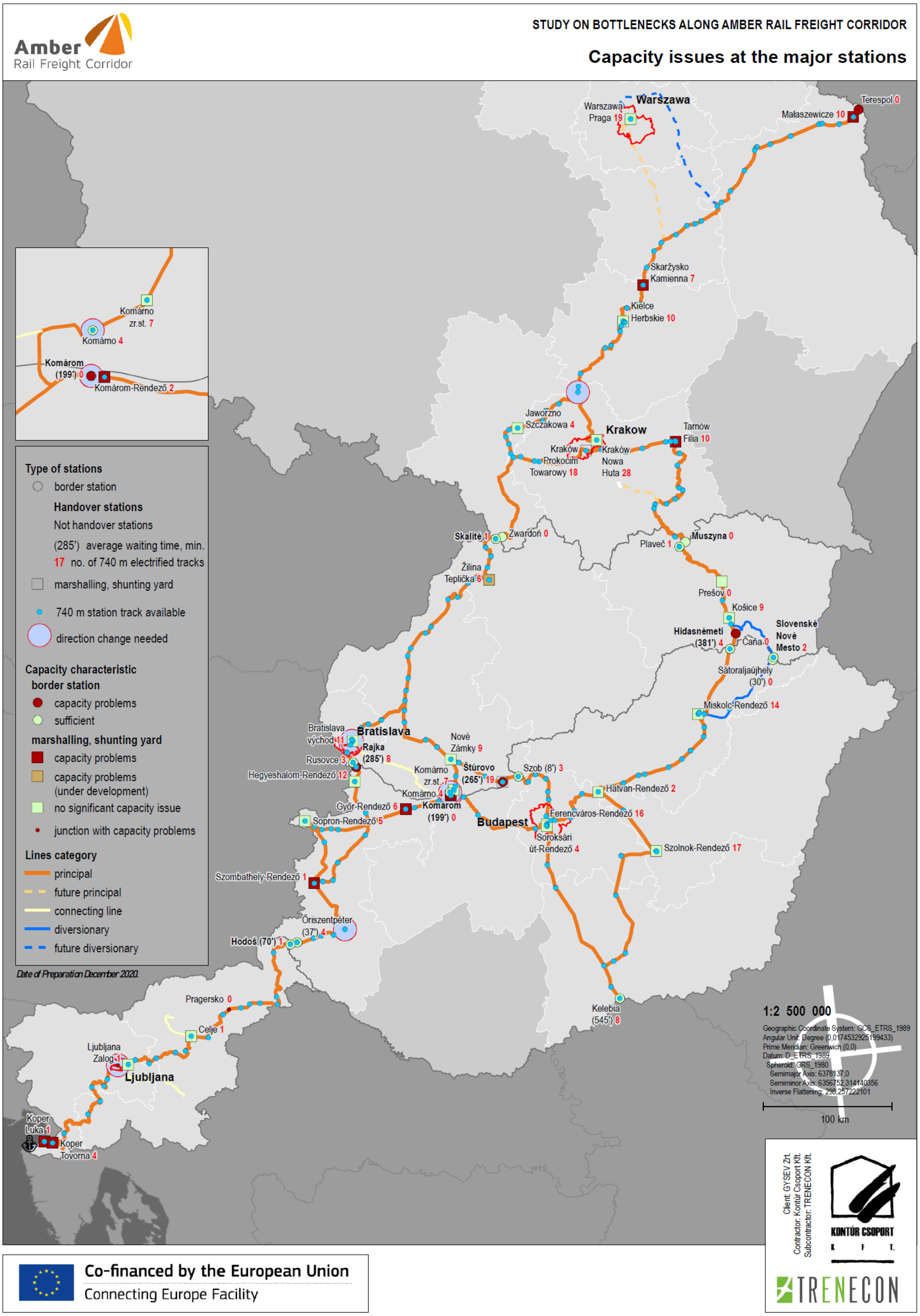


Figure 44. Capacity problems, bottlenecks at the major service points, marshalling, shunting yards and border crossing stations

7.5.2 Freight train tracks at stations influencing the line capacities

Not only the above listed major facilities but other smaller stations are also very important to ensure capacity on the network, where the availability of >740m long station freight train tracks are available. By nature, one long track is usually not enough or not appropriate for efficient traffic management as it is common that the longest one is the through track at the stations.

It is a problem, however, if investments on the corridor lines decrease the number and availability of long tracks at the stations focusing mainly on passenger trains' requirements. This is a frequent complaint from the RUs and from capacity allocation bodies as this capacity shortage can increase freight train transfer time and decrease reliability significantly.

As the following map shows, western branch of RFC Amber in the Slovak Republic (from Skalité to Rusovce, Komárno, Štúrovo) has long-track stations relative densely while the eastern branch (Plaveč to Čaňa and Slovenské Nové Mesto) the availability of such capacities is much lower. In Hungary, on the Budapest-Miskolc, Budapest-Szob lines towards Slovak Republic the density is high while the other sections of the Corridor are worse, i.e. the western branch of the RFC between Slovak Republic and Slovenia (Rajka-Szombathely-Őriszentpéter). According to the available information, density in Slovenia allows better traffic management along the Hodoš-Koper line. In Poland, majority of the network has such stations within 20 km average distance, there are, however, lines where the distance is significantly higher. Density is the lowest on the Tunel-Kraków and Zwardoń-Oświęcim lines (and on the lines to Warszawa supposedly due to data shortage).

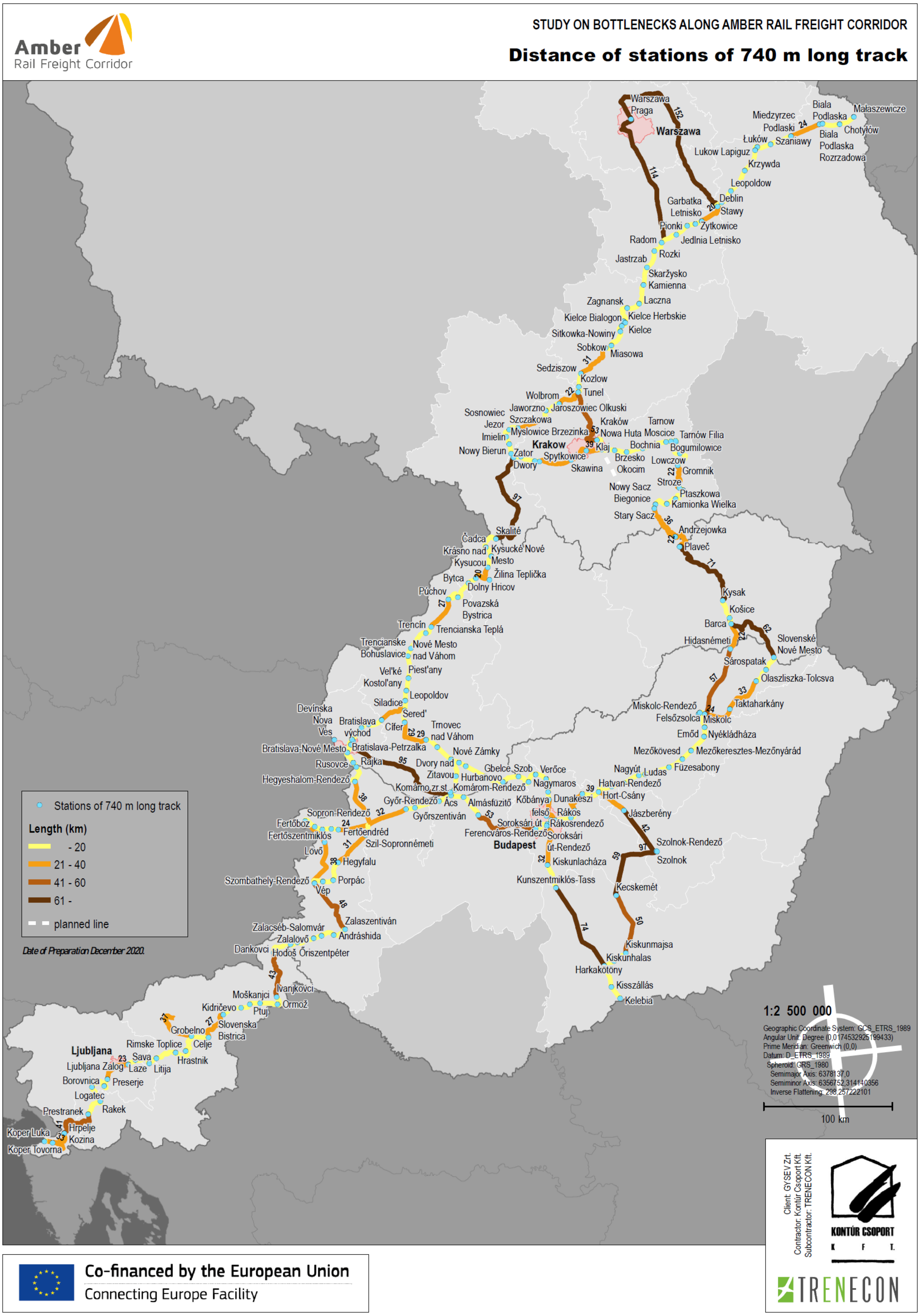


Figure 45: Distance of line sections between stations having long freight train tracks along RFC Amber

8 Operational, technical, and administrative bottlenecks

8.1 The approach of analysis

Today, the competitiveness and efficiency of international rail freight services on RFC Amber are reduced – in addition to infrastructure quality, capacity – by operational inefficiencies and administrative issues that need to be addressed. The quality and reliability of the service can and have to be improved.

The establishment of the Single European Rail Area requires major efforts to achieve technical interoperability and to ensure continuity of international traffic flows across national borders. In addition, standardisation of systems and equipment in a broader sense is crucial to achieve efficient operation and to reduce costs. Specific EU legislation, such as the Technical Pillar of the 4th Railway Package, aims at boosting competitiveness of the sector promoting interoperability. RNE initiatives, IT platforms contribute to collaboration of stakeholders and harmonised exchange of information to achieve EU objectives in sustainable freight transport.

The basic approach for operational technical and administrative bottlenecks applied in the Study is reflecting the approved bottleneck concept as worded in Regulation 1316/2013 of the EU *„… a physical, technical or functional barrier which leads to a system break affecting the continuity of long-distance or cross-border flows and which can be surmounted by creating new infrastructure, or substantially upgrading existing infrastructure, that could bring significant improvements which will solve the bottleneck constraints*”.

Administrative and/or operational deficiencies, characteristics causing inadequate capacity supply or inefficient use of the infrastructure *“affecting the continuity of long-distance or cross-border flows*” are considered bottlenecks subject to assessment under the present study. Lack of capacity is assessed compared to traffic demand and issues resulting in low efficiency either on the side of IMs (causing higher operational costs) or users, RUs (causing higher transport costs) are subject to assessment in the Study. By nature, they can be described and assessed in a qualitative manner. To compare or prioritise problems of operational, administrative nature on RFC Amber the multi-criteria assessment method and a scoring approach were applied.

In identifying and assessing operational bottlenecks to be improved on RFC Amber we mostly rely on the feedback from infrastructure managers, AB and RAG members. The main obstacle of appraising operational bottlenecks regarding RFC Amber is the limited experience in RFC Amber functioning. RFC Amber has been operational only since end of January 2019, therefore it was not reasonable to expect stakeholders to give a well substantiated account of operational problems. Therefore, the conclusions about the operation of overlapping or competing RFCs like RFC 5,6,7 and issues discussed in general by the sector (targeted by RNE at EU level) were also considered. In addition, the Issues Logbook, the Transport Market Study, Action Programme of the overlapping RFC OEM, and Summary Report of cross border activities on RFC OEM Corridor were also consulted to support conclusions on operational barriers affecting RFC Amber performance.

For the sake of readability and coherent wording the general term "**operational bottlenecks**" will be used in this document covering all operational, technical and administrative issues impacting functionality of RFC Amber. This way they are clearly separated from infrastructure bottlenecks and constitute a single group when talking about generalities applicable to all kinds of problems interfering with freight service on RFC Amber different from that of infrastructure nature.

8.2 The process of analysis

Beside the identified infrastructure bottlenecks, the available RFC Amber documents also deal with other non-infrastructure type bottlenecks. For example, the TMS deals with all aspects of railway competitiveness compared to road freight transportation and CID describe rules of capacity, traffic management processes. Also, the Contractor, relying on desk research and mostly based on experience of sector stakeholders with freight transport on other RFCs, has compiled a list of bottlenecks potentially affecting seamless operation of RFC Amber.

The ad-hoc bottleneck Working Group presented the operational bottlenecks identified by the Contractor to the Management Board members. They came to a common understanding of the issues to be assessed in the course of the study implementation and agreed to give their views and opinion on the importance, relevance of each in writing.

The Consultant compiled a questionnaire on the assumed operational and administrative bottlenecks as agreed including assumed potential measure for improvement and requested stakeholders (IMs/AB, RAG/TAG) to share their views and opinion on each issue identified and on potential measures for improvement. The IMs/AB (SŽ-I, MÁV, GYSEV, VPE, ŽSR, PKP,) ranked the importance and relevance of assumed O&A issues in their competence. In the operational bottleneck matrix, the Infrastructure Managers, the Allocation Body made comments, judged impact of the issues on RFC Amber based on their experience, daily routine and shared their ideas on improving bottlenecks and in some cases claimed RU competence.

The Consultant processed and summarised the input, identified missing data and revised the questionnaire. Since appraisal of a number of operational and administrative issues fall under the competence of the railway undertakings the RAG/TAG was interviewed and the setup, the focus and highlights of the questionnaire were slightly changed to get meaningful feedback and to ensure consistency for the processing and analysing exercise.

Evaluation of assumed bottlenecks by the stakeholders, their comments or recommendations were processed, consolidated, and analysed to give a well-founded account of RFC Amber operational bottlenecks and potential improvement measures. The outcome of the iterative assessment process of identifying relevance of issues the causes and impacts was a coherent and prioritised list of operational bottlenecks affecting functionality of RFC Amber.

8.3 Identified operational bottlenecks on RFC Amber

Operational bottlenecks are the issues relating to procedural and organisational or legal, regulatory aspects affecting the demand driven functioning of freight transport service along the corridor.

It has been pointed out that the most important, relevant factors that fundamentally influence the transport modal choice and competitiveness of rail freight services on RFCs in general and RFC Amber in particular, according to shippers and railway undertakings alike, is the quality of service: reliability, flexibility and punctuality in addition to the price of transport service[25]. Besides railway infrastructure, international rail freight service quality is also subject to operational conditions, such as cooperation of stakeholders, availability of information, administrative processes at borders, applicability of IT tools. With seamless operational processes, high level of co-operation and alignment of national administrative rules (i.e. implementing a single European railway area) the competitiveness of RFC Amber can be ensured. However, several "operational bottlenecks" need to be eliminated for RFC Amber to perform. Today, for example, coordination, in cross-border capacity offer, traffic management and planning of infrastructure works, timely exchange of reliable information are the key issues that call for improvement.

According to IMs responses, the efficient and competitive freight traffic on RFC Amber seems to be hindered mostly in Slovenia by traffic management problems while poor communication at borders between actors (IMs, RUs and TCCs) should be tackled in every country. Administrative bottlenecks are issues with similar rating in each partner country but are not considered first priority by IMs.

The issues identified have been grouped in four main categories in the awareness of operational processes, main concerns of IMs/RNE and RUs affecting competitiveness of international rail freight.

CAPACITY MANAGEMENT AND PATH REQUEST

This group of issues covers those in the capacity planning and path allocation phase, the procedures adopted and operability of tools for requesting and allocating capacity.

COMMUNICATION

Efficient communication between stakeholders supported by IT tools is a cornerstone of competitive international rail freight. Related issues are discussed separately as they horizontally affect the operability of the corridor from capacity allocation through traffic management to handover.

TRAFFIC MANAGEMENT

Main traffic management issues that impact international train forwarding, coordination responsibilities to ensure continuity and efficiency of freight forwarding in line with market requirements belong to this category.

ADMINISTRATIVE ISSUES

This group mainly includes issues related to national rules or standards with implications on dwelling, process time at borders. They also related to European legislation or bilateral agreements. Among others, safety, authorisation requirements, border control procedures are discussed and assessed with the purpose to encourage stakeholders, boost rail freight and multimodal transport in the future.

[25] *source: SERAC WG on RFCs (3-4 July 2019) - Workshop on "The quality of rail services – a spotlight on punctuality" (agenda item 4). Input for discussion by DG MOVE ('non-paper')*

1. CAPACITY MANAGEMENT
1A - Path allocation procedure via C-OSS is inadequate
1B - PaP parameters and RC fail to meet market requirements
1C - Limited applicability of the PCS and reliability of data
2. COMMUNICATION
2A - Communication difficulties at handover points, borders
2B – Poorly functioning interfaces between national IT tools and the RNE tools
2C – Inadequate coordination and sharing information on capacity restrictions, disturbances
2D - Insufficient language skills of staff
3. TRAFFIC MANAGEMENT
3A - Ineffective arrangements, processes at border crossings
3B – Low reliability of RFC trains impacts competitiveness
3C - Competitive re-routing, contingency measures for traffic disturbances/TCRs are not available
3D – RFC traffic management staff is not properly prepared
4. ADMINISTRATIVE ISSUES
4A - Cross-border interoperability difficulties due to lack of harmonisation of national rules
4B - Not transparent, calculable procedures and charging in case of multimodal transport
4C - Long technological times of forwarding outside the EU

Table 46: Operational and administrative bottlenecks identified and classified

8.3.1 Capacity management

1A - Path allocation procedure via C-OSS is inadequate

Theoretically, C-OSS operates as the single entry point for RUs to place path request and allocate capacity. Ad-hoc path requests are also being met independently by C-OSS that collaborates and communicates with national OSSs. C-OSS has the responsibility to harmonise the paths allocated in the national systems at the border crossing points to ensure safe running of international trains.

Ongoing improvement of the C-OSS service in the capacity management process is considered important, use of advanced IT tools could improve the satisfaction of path request, allocation of capacity. Added values of C-OSS, such as customer information at an early stage, transparency, reliability and consistency of processes based on harmonized corridor priority rules can be ensured if staff is dedicated, knowledgeable, has required competence and openness to exchange ideas, experience. Infrastructure Managers of the four member states claim that the exchange of experience with other corridors, extension of cooperation between Infrastructure Managers and allocation bodies of the RFCs could contribute to more efficient procedures. The Hungarian AB (VPE) thinks the current practice of capacity allocation leaves nothing to be desired, similarly PKP claims that ad-hoc path allocation is very flexible on the Polish network. The main difficulty is the lack and quality of actual capacity on the corridor in Slovenia, which is of infrastructure nature.

As of today, RUs cannot form a responsible judgment on the RFC Amber capacity allocation procedures, operability of C-OSS or competence of customer service. C-OSS of other RFCs and the allocation of capacities work up to the expectations, staff are competent, processes are transparent and flexible, problem solving is customer oriented. However, some RU (GYSEV Cargo) share the idea that today C-OSS is not a true one-stop-shop, its services fail to cover all steps ranging from capacity request through path modifications to invoicing. With some future upgrade, it is safe to assume that C-OSS of RFC Amber will largely support expansion of RFC traffic as coordinated capacity allocation would ease administrative burden, simplify international path request.

Theoretically, there could be some conflict in capacity allocation on the overlapping RFC sections, which could result in low available capacity for RFC Amber. However, working cooperation between RFCs C-OSS in PaP capacity allocation ensures that such conflicts are rare and can be overcome readily not causing any trouble to RUs. No direct experience on RFC Amber supports the conclusion, though.

It is a general problem in PaP requests that RFCs require RUs to make their path reservation unreasonably soon (general issue due to EU regulation). On the other hand, national IMs are not interested in dedicating capacity for RFC trains (especially at other trains' expense) and the availability of reserved capacity suited to RFC 'ad-hoc' path request is limited, differs from country to country. IMs fail to provide information on future track closure which also compromises efficient RFC transport. So, the process and rules for PaP requests or demand for reserve capacity including deadlines for requests need to be reconsidered in a way that it fits more to the normal operation of RUs.

1B - PaP parameters and RC fail to meet market requirements

The PaP parameters cannot be tailored to the actual needs of RUs because it is not possible to foresee the future demand at such an early stage of planning. Therefore, RFC PaPs are not selling well. Although IMs are trying to develop products with shorter response time (Ad hoc request) for the RFC; e.g. SŽ-I in Slovenia offers so-called flex and extra flex PaPs, capacity windows. As RFC Amber has not been operational for long it is only assumed that reserve capacity is not readily available for RFC trains as of today.

In general, it can be concluded that the PaP catalogue fails to observe the actual needs due to poor or lack of timely communication between the IM/AB and the railway undertakings so, besides the prevalent capacity shortage reasons, their wishes usually cannot be adequately considered in compiling the catalogue. As a result, the booking ratio of the pre-arranged paths is fairly low, railway undertakings rather apply for reserved capacity which is not always readily available for RFC trains because of conflicts with national timetables or other RFCs on overlapping sections due to limited network capacity. The amount and destinations offered in the RFC PaPs i.e. the number of paths to the most frequented destinations should be expanded if we want to improve RFC train service. It is feared (GYSEV Cargo) that the tendency towards introduction of integrated periodic timetables in passenger traffic with increased train frequency would adversely impact freight traffic on RFC Amber, freight paths of sufficient quality would not be available. The availability of freight paths at any time of the day is also important for the attractiveness and competitiveness of the intermodal terminals located along the corridor.

In addition to availability of capacity and flexibility of path allocation, train path speed of RFC trains today is not competitive. The current average speed of train paths along many sections of RFC Amber is sometimes only 20-30 km/h which is unacceptably low. GYSEV-Cargo claims that the speed standard of lines and of train paths on RFC Amber should be in a similar range as on main railway routes in Western Europe. On the one hand the departure times are often too late for the RUs, while on the other hand the foreseen commercial speed of the PaPs and ad-hoc paths make the transport times of RFC paths uncompetitive compared to non-RFC paths or other RFC (i.e. RFC5).

There is hardly any experience of RUs with regard to the availability of reserve capacity for ad-hoc RFC trains on the Amber Corridor. However, it is a general practice that IMs maintain reserve capacity for RFC trains at a minimum level to be on the safe side in managing traffic on the national network. This approach can interfere with efficient and competitive freight transport of RFC trains.

1C - Limited applicability of the PCS and reliability of data

IMs widely use the PCS which is a user-friendly IT tool mostly with current data. Nevertheless, the interface with national systems has not been fully compatible, integration has been underway at VPE and SZ-I. Currently, the Slovenian IT system has more functions enables e.g. path cancellation which means an extra burden of double upload of information. IMs are confident that the RNE tool will soon be fully functional, compatible with the national systems and so, the handling of RFC train paths will be simple and efficient.

The operability and functioning of the RFC are supported by PCS a web-based communication system sharing information between RUs and IMs/Abs, developed by RNE to foster a single European railway network, cargo transport on RFCs. PCS is in fact, a very useful tool, however it's applicability largely depends on the availability of current data which are to be provided by IMs in the first place. Uploading and updating information in the system is simple, however in lack of interface with national systems it is a double effort by the IMs. As a result, data input and upgrade are often neglected which is a general phenomenon affecting reliability of information and therefore overall applicability of the system in optimising path coordination. Consequently, RUs can be discouraged to use PCS in path request, planning and monitoring RFC train runs as e.g. the path offers are not reliable and the request process cannot be adequately harmonised through IMs to build long-distance connections. So, it is designed to avoid double data input to transmit any change in international dossiers data to national systems, however in lack of duly functioning interface with national systems it would not deliver.

Overall conclusions on the issues related to capacity management and path request

C-OSS service currently not prepared to offer a single point of service through coordination of IMs/AB, the lack of operable interface with national systems requires double entry of path request data resulting in cumbersome workflow and increased chances for error. Also, it is not efficiently supported by up-to-data data in PCS while the availability of paths corresponding with demand, particularly on sections overlapping with other RFCs, is limited which is partly due to infrastructure capacity shortage. So, path allocation process does not correspond with the demand, does not fit in the business process of RUs. Demand driven capacity allocation is also made difficult by the limited availability of station tracks for freight (the number of parking tracks are insufficient or located far apart to handle freight traffic). The priority of passenger train traffic also generates TT conflicts, the path requests by railway undertakings for RFC trains cannot be duly considered.

The capacity management concerns can be mitigated with infrastructure capacity enhancement, however interoperable national interfaces to enhance applicability of PCS and competence of C-OSS service can considerably improve capacity allocation for freight transport on RFC Amber.

8.3.2 Communication

2A - Communication difficulties at handover points, borders

The lack of a common language is a general problem for border crossings, but opinions differ on this. According to the position of MÁV, the European Union Directive 59/2007 EC and its amendment, Directive 882/2016 EC deals in detail with the language skills of train drivers in border crossing traffic. Directive 59/2007 EC requires drivers to have a level of B1 knowledge of the language of the country in which they drive. Directive 882/2016 EC provides the possibility to exempt drivers from level B1 language skill provided that, in order to avoid any negative impact on the safety of the rail system, appropriate provisions are put in place as a precondition for the exemption to ensure that the drivers can communicate with the Infrastructure Manager's staff equally in case of routine situation, restricted mode and safety critical emergencies.

The traffic staff of the border stations use a different bilingual communication system with each other, in which all users see the same pre-defined, parameterizable type sentences in their own language. Communication between the traffic staff of the changeover station and the drivers can also take place with pre-defined, parameterizable type sentences, which have been developed taking into account the relevant EU regulations. If type phrases are used, in addition to guaranteeing safe rail transport, it is possible to exempt drivers from level B1 language proficiency. Given the procedures developed under the EC Directives referred to, the training of border staff in English is unlikely to improve the efficiency of communication, given that English is not the mother tongue of all IM and RU staff along the corridor.

On the other hand, SZ-I thinks that probably English should be the common language. VPE claims that communication between RUs and IMs is satisfactory, mostly the poor communication between RUs result in operational inefficiencies, unnecessary waiting time at borders.

Current communication methods and platforms used by IMs and RUs are available to provide high level of service, even in the case of disturbance. The Train Information System (TIS) provides a single platform for all information from the different IMs on a train run from departure to final destination and it can ensure adequate train monitoring from start to end across borders. The new incident management tool in TIS is designed to help communication, overcome language barriers with pre-defined messages, automatic translation of messages which is very important in case of disturbance but currently its applicability, interoperability is not always ensured. Although, the RNE tools can ease communication in traffic management of international trains, IMs have no direct experience with regard to train runs on RFC Amber. The general conclusion of IMs is the overall level of data quality and train linking in TIS is average, train monitoring cannot be served appropriately. On the other hand, the RUs normally do not apply TIS, the trains at the IMs cannot be tracked down as train number. (Introduction of commercial path ID in TAF TSI could be the solution.)

IMs think that any common language spoken at each border crossing would not necessitate higher level of English knowledge to eliminate language related problems.

Communication quality at the national and IM network operative borders between actors (IMs, RUs and TCCs) is considered to be of great importance and relevance in seamless international freight transport. In standard procedure (normal traffic situations, reserved path) the communication is generally adequate however, the efficiency of sharing information is often very poor in the event of disturbances, changes in path parameters (e.g. in the case of delay, need for re-routing). The current communication methods and platforms between IMs and RUs therefore appropriate to provide high level of service only in normal operation. Change of train number at borders, accuracy of information upon handover of trains by cooperating RUs often cause difficulties. The RNE tool, Train Information System (TIS) could be a useful platform to keep track of trains, however due to the overall level of data quality and coherence in TIS, train monitoring cannot be served appropriately. It is assumed that communication with neighbouring IMs and cooperating RUs, sharing of information on running trains can be improved by communicating via pre-defined and translated messages, planned introduction of TIS2020.

2B – Poorly functioning interfaces between national IT tools and the RNE tools

Timely and accurate data, consistent numbering of international trains needs to be improved because today information on e.g. the delays and arrival sequence of trains is often not readily available. RUs are not motivated, and uniform procedures are not in place to communicate well-identifiable information on any single RFC train.

Consolidated train numbering, common train number in case of international trains with better coordination could reduce waiting time considerably too.

Inaccuracy of data or difficulties in tracking trains are not ubiquitous on the entire stretch of RFC Amber; PKP claims that data provided by RUs are correct. At the same time, SZ-I and GYSEV share the opinion that deployment of TAF-TSI (telematic applications for freight), uniform processes, implementation of more reliable TAF TSI messages for all data communication between RUs-IMs support freight services, reliable punctuality and be necessary to successfully operate the corridor.

Low reliability of TAF TSI messages regarding time of arrival, delay, difficulties in train/cargo tracking, in real time communication about train composition is a general problem in the case of the RFC trains for the railway undertakings. It is partly attributed to the poorly functioning TAF-TSI compliant interfaces between national IT tools and the RNE tool. The incident management tool in TIS would considerably improve communication between traffic control centres, but the legacy systems are not always integrated to receive and process data from TIS. In lack of direct relevant RFC Amber experience, the general problem of the application of RNE tools with national systems is considered applicable here.

2C – Inadequate coordination and sharing information on capacity restrictions, disturbances

TCRs at the RFC level are coordinated by a working group (PKP is the coordinator). Information, data on track possessions, restrictions are mostly available on the website however, it requires IMs to ensure the timely exchange information on TCRs, maintenance works to enable stakeholders duly managing delays. Co-ordination of scheduling maintenance works on a particular line or border section is currently not achieved. Also, harmonization of timetabling procedure of the IMs is required to ensure competitive running time for RFC trains. To this end certain IMs (IM/IM and IM/RU) already concluded bilateral agreement about data exchange on restriction and the redesign of the international timetabling process (TTR) is underway by RNE, FTE (Forum Train Europe). TTR project also includes support of planning and integrating TCRs into the capacity model and also a specific TCR IT tool is under development creating a single place for all information for planning and coordinating the TCRs. Some IMs claim (SZ-I:) that the duration of the TCRs are affecting RFC transport very much, and as RFC doesn't have influence on operations in traffic management, introduction of compensation for non-fulfilment of agreed obligations should be introduced for all contracting parties.

According to VPE TCRs, disturbances does not constitute a problem for RFC trains in Hungary. RUs interests are claimed to be considered in Hungary and there is an ongoing coordination with other IMs about upcoming interventions, although track possessions are difficult to foresee due to the uncertainties in financing which is often not under the control of the IMs. Railway developments are mostly major projects financed from EU funds (e.g. CEF) and funding decisions including implementation timeframe requirements cannot be surely foreseen.

Exchange of information on temporary capacity restrictions and in situations of disturbance, information on contingency measures are deemed to be satisfactory by railway undertakings, RAG. However, if such restrictions or track possessions are not known in due course, traffic management difficulties can result in lengthy parking of RFC trains, blocking the capacity with dwelling trains.

Regular coordination and cooperation of neighbouring IMs when programming the works, TCR planning and involvement of RUs for coordination, consideration of freight forwarding destinations differs from country to country. RUs expect that the RNE TTR initiative would contribute to higher level of harmonisation between IMs and timely information of RUs which eventually ensure more efficient planning by RUs.

2D - Insufficient language skills of staff

The very heterogenous rating of the language problem by the IMs show that it has various relevance and importance in the international rail freight transport of the member states.

The language skills of the IM/AB or RU staff along RFC Amber are currently adequate for the management of RFC trains without major difficulties according to PKP. Opinions of IMs in fact, differ: the Slovakian IM thinks that English language courses should be held for the staff. SZ-I admits the language barriers have to be tackled for seamless operation of RFC Amber. MÁV and GYSEV claim that it is not the English language as opposed to the efforts in training but any common language at the particular border has to be mastered by the staff.

The communication is compromised at various degrees at different borders. No particular information is available in this regard for the RFC Amber borders, however the Summary Report 2016-2018 by the 12 Task Forces on OEM RFC7 give some hint on the language barriers at a few relevant border crossings claiming that there is no harmonised solution for every border crossing, tailor-made solutions are required.

Railway undertakings consider language difficulties a general problem; they usually do not have staff that is fluent in English or can speak the local language. Therefore, communication with traffic management, the staff of the other IM/RU is cumbersome and time consuming often leading to unnecessary waiting time, lengthy process times of handover between RUs. However, this problem has been recently addressed by a language programme under RNE umbrella which is expected to mitigate language difficulties between stakeholders by providing a translation tool and pre-defined messages. It has two focus areas: IM-IM communication at national level and IM-RU operational communication.

Overall conclusions on communication efficiency

Sharing of information on trains crossing the borders between RUs and IMs should be improved. To this end a common language is to be used because currently lack of language competencies increase procedures at handover of international trains. On the other hand, the national IT systems are not interconnected with RNE TIS therefore information are not readily provided, most of the RUs fail to apply TIS. Introduction reliable TAF TSI messages is a key to provide information in a uniform manner e.g. on track restrictions, situations of disturbance which will contribute to the enhancement of RFC traffic. Also, the costs of path on diversionary routes should not exceed that of the path originally allocated. Poor coordination of TCRs has been an issue which is being addressed by RNE with a web-based TCR tool and TTR while a language programme is underway to improve communication.

8.3.3 Traffic management

3A - Ineffective arrangements, processes at border crossings

IMs agree that long dwelling time at border stations is very important and has an adverse impact on RFC traffic. They claim that waiting of trains is either part of the process or unjustified and can be shortened by better coordination, collaboration of national stakeholders. Waiting time is mostly due to technical inspection requirements of rolling stock (e.g. double wagon check at border) and lack of cooperation between railway undertakings at handover points. MÁV and VPE equally claim that better technical conditions of wagons could ease the inspection which falls under the responsibility of the RUs. It would be important and also feasible to shorten procedures and accelerate the handover if the trusted train concept was adopted. It would significantly reduce technological processes and would considerably reduce dwelling time at borders.

According to SZ-I specific operational rules are applied upon the request of the RUs due to commercial reasons. ŽSR does not have such rules that would prolong border dwelling times. Respondents unanimously claim that long dwelling times at border is an issue of key importance and relevance adversely impacting RFC transport.

It was also pointed out that in many cases in lack of parking capacity at border stations the locomotives from different RUs parked on the same track were blocking each other.

In addition, different administrative problems due to specific national rules also arise which are discussed separately (issue 4A).

Time consuming, unpredictable procedure of locomotive and driver change (necessary process) or unnecessary waiting time for starting any necessary process because of the lack of human resources are the issues RUs have to face at borders. In most cases it is a direct consequence of insufficient coordination or organisation of processes. They experience cooperation difficulty with IMs and partner RUs at handover points which is not specific to RFC Amber at all, rather a general problem in international rail freight transport.

There is not a fully interoperable IT platform available which could speed up handover of trains at the borders. Adoption of homogenous, automatic processes across RFC Amber to shorten dwelling times could be a competitive edge too.

3B – Low reliability of RFC trains impacts competitiveness

Punctuality is a key in customer satisfaction with traffic management which is in the focus of all IMs. Predictability of the time of arrival is a basic requirement of customers both in the case of on-time and delayed trains. VPE claims that even the punctuality at origin is usually not ensured because the "train ready" message arrives late in many times. In addition, there are many ad-hoc freight trains, which does not have an exact timetable, so the scheduled arrival time and delays cannot be determined as corridor trains do not have priority over other freight trains (in case of disturbance passenger trains always enjoy preferential treatment). A consequence is that there is no flexibility in dispatching RFC trains.

Delays, in addition to the lack of priority of international freight trains, are usually due to inefficient communication between RUs, unpredictable dwelling time at cross-border or poor labour management (e.g. rest time of driver, line knowledge, etc.). Low average speed usually does not cause any significant delay.

To enhance predictability the train path allocated to freight trains which comply with their scheduled time in the working timetable shall not be modified, as far as possible. IT development, designed to facilitate train tracking, TT calculation and to ensure effective traffic simulation could contribute to predictability, but more importantly priority of corridor trains over other freight trains is desirable.

The issue of the expected time of arrival is a general concern of RUs and European rail freight sector (RNE). The level of punctuality of RCF trains are not superior to any international freight train in national networks. There is no preferential treatment of RFC trains over other freight trains in normal traffic situations to meet punctuality requirements of RFC trains. Introduction of RFC train priority would generate higher demand for RFC Amber.

The current average speed of train paths along many sections of RFC Amber is unacceptably low partly due to traffic management but most more importantly to infrastructure bottlenecks. The average speed of train paths has influences both on the ability to meet customer expectations, but also impact on the productivity of assets such as locomotives, wagons and train drivers which is a major concern of RUs (GYSEV-Cargo).

In case of disturbance (in operative transport management) priority rules are not applicable to favour international freight trains which does not encourage the use of RFC Amber.

3C - Competitive re-routing, contingency measures for traffic disturbances/TCRs are not available [26]

Traffic disturbance often heavily impacts international rail freight service particularly at sections managing high passenger traffic at node, or in regions where infrastructure capacity is limited. Seamless re-routing of international freight trains to run by the schedule without major delays is a major challenge. It often takes extra resources of RUs too.

Currently, planning of track possessions are not harmonized by the IMs along RFC Amber although communication regarding traffic is usually good. In the case of some countries (SZ-I) bilateral coordination and harmonisation rules are in place. PKP perceives an improved coordination of closures along RFC Amber.

It is considered a very relevant issue by all IMs. The IMs are well aware of the upgrading requirements, priorities. The major problem for the RUs is the lack of calculability which does not rest with the IM only. In addition to the lack of coordination about planned works, advanced planning of investment projects is not possible (availability of funding sources, conditions) therefore the time and duration of track possessions cannot be calculated.

It is expected that the implementation of the TTR project will help to make planning of TCRs more transparent and coordinated on RFC Amber.

In lack of RFC Amber experience of RUs on a general account of the issue can be given. It is not widely accepted approach to observe RUs needs in the planning of temporary capacity restrictions. Lack of such co-ordination with RUs or information on maintenance works, TCRs often causes delays in freight transport undermining the reliability of RUs. Such inconveniences, extra costs and time could be avoided if multi-annual investment plans were transparent, capacity restrictions were planned in advance in collaboration under harmonised rules, and if contingency measures, routing scenarios in case of disturbances are developed for the corridor. Coordination and introduction of harmonised contingency measures in coherence with RNE contingency management handbook recommendations has been underway to ensure capacity for RFC trains in case of disturbance. Even exemption from operational rules in case of re-routing, especially to other IM-operated network could have been an option to consider in setting up uniform measures. The still not harmonized operational rules are a big obstacle when trains must be rerouted via another country. Corridor train performance management - including reporting, monitoring of KPIs – although organisational framework is set (WG established) and IT support, common database (TIS-OBI) is provided, today do not produce fully fledged benefits. RNE OBI is in place to generate reports on performance, KPIs, while the national train performance management systems are being aligned recently. TIS OBI uses train performance data from the national system, which are provided automatically, however they are not fully compatible with OBI. The main issue with monitoring train performance, usability of KPIs rests with the reliability of data input by the IMs staff. Today, the data are not appropriate for the analysis of underlying reasons of delays in international freight

[26] The International Contingency Management Plan of RFC Amber has been recently issued

transport because, despite RNE guidelines on train performance management (how to improve train punctuality), there is a virtual lack of uniform data input, common and agreed interpretation of the causes of delays which does not support consistent processing of data, KPIs, therefore does not allow for adoption of efficient measures for improvement.

This operational issue has strong interdependence with the communication issue 2C "*Inadequate coordination and sharing information on capacity restrictions, disturbances*".

3D – RFC traffic management staff is not properly prepared

Staff competence is a precondition of the expansion of freight traffic on RFC Amber. Improvement of specific staff competence with trainings about RNE/RFC tools, improvement of education to harmonize requirements is a must.

At present, RUs do not have direct experience with regard to RFC Amber traffic management either with regard to the national IM staff nor with the relevant RFC WG. In the case of other RFCs in operation for a few years by now the general perception is that the staff have the necessary competence to manage traffic related processes of international/RFC trains and can apply operational rules and procedures to ensure seamless transport chain. Their daily work is efficiently supported by RNE tools, they use IT platforms with great competence to the benefit of RFC transport services. In the train performance management efforts, the common IT tool, data warehouse (TIS OBI) is a major asset, however reporting capabilities not fully utilised today by RFC Amber to improve overall corridor performance, service quality criteria.

Overall conclusions on RFC Amber traffic management

Lack of efficient arrangements, collaboration between RUs and poor coordination result in lengthy train handling, long wating times at border crossings heavily impacting competitive freight service and efficiency of resources. International trains often block tracks, occupy infrastructure capacity unnecessarily. Availability of information in TIS for tracking trains, a common IT platform for communication would be important for predictability, more efficient management of resources. Problems related to processes at different border stations vary as players resources, preparedness or infrastructure conditions are different. Bilateral agreements between RUs on trusted train handover could shorten dwelling time. As priority of RFC trains is not ensured, reliability is poor due to delays and lack of real time information in TIS. Ad-hoc bilateral coordination of traffic disturbances results in inadequate rerouting, running of RFC trains. Agreed contingency measures, competitive rerouting scenarios according to the RNE ICM handbook should be defined. Efficient management, co-ordination of TCRs and demand driven contingency measures requires common train performance monitoring, use of a single data source for KPIs, improvement of commercial conditions.

8.3.4 Administrative issues

4A - Cross-border interoperability difficulties due to lack of harmonisation of national rules

Railway undertakings are virtually lacking experience on the handover, running of trains on RFC Amber, therefore the issues of administrative nature generally applicable to international freight forwarding are discussed. It is assumed that they are applicable to RFC trains on the Amber Corridor too. The main problem is mostly the lack of harmonisation of national requirements related to safety (braking rules, different braking performance requirements, tail-light), train composition (e.g. buffer wagon), vehicle authorisation, or cabin crew, drivers licence compliance. The different rules required by national authorities at some countries are now being reconsidered which will make safety, operational rules at borders more flexible.

The Issues Logbook identifies and assesses the need for harmonisation of national rules for other RFCs. Although, they are not assessed for RFC Amber since the corridor has not been operational when the Logbook was compiled but still, they are considered relevant for RFC Amber too.

The different provisions of national rules on safety certification and vehicle authorisation, etc. make the handover of international trains at borders very time consuming. Inspection of rolling stock is often conducted on both sides to comply with national rules. Currently, different regulations on tail signs/plates, train composition, such as buffer wagons, or braking rules apply at borders which require double wagon checks. In fact, compliance with the provisions of the directive on railway safety (DIRECTIVE (EU) 2016/798) would very much ease the process and national authorities should assent to that. PKP believes that a single authorisation process is not needed, and according to most IMs the current safety regulations are to be uniformly adapted by national authorities, digitalisation, or standardised IT solutions, access to standardised sharing of information between clients and IMs would contribute to a more reasonable handover process at borders. SZ-I claims that implementation, full roll-out of ETCS and GSM-R – which is beyond the scope of the operational bottleneck study – would be the solution of most problems, however RUs are not ready to use such interoperability tools because of the considerable costs involved. Smaller RUs do not have the human capacity, resources to readily implement actions necessary for compliance at borders or to meet licencing requirements.

The IMs at the handover station currently issue a new number for the RFC trains and as it is considered a new train, all train preparation procedures, the full technical wagon check and brake test have to be performed again regardless of any actual change. Uniformly applied train numbering and harmonisation of wagon list in the case of RFC trains would also contribute to a more expedient handling and tracking of international trains.

4B - Not transparent, calculable procedures and charging in case of multimodal transport

Multimodal transport requires transloading which is organised in correspondence with complex legal-administrative requirements. It implies involvement of national authorities making the entire process complicated and inefficient. In addition, calculation of total transport cost for customers is very difficult which may discourage them to use RFC services.

The CIS system developed by RNE still does not meet expectations due to significant differences in the ways of calculating fees in Europe. Individual countries have their own system: e.g. PLK has the SKRJ system enabling the collection of fees for train timetable structures and the SEPE (SEPE II) system enabling for settlement of payments for access to the railway infrastructure. However, they calculate only basic price for minimum access package without considering service facilities.

In addition, the national IT tools are usually not equipped with English user interface therefore they are not user-friendly, transparent for international stakeholders.

Introduction of interoperable access charge collection system and IT solutions to make administrative processes more fluent and efficient could enhance the competitiveness of intermodal freight transport on the RFC. Achieving the goal of complex calculation of transport costs including last mile by an IT tool (potentially CIS) should be feasible since all RFC Amber countries are EU members.

Railway undertakings face complex legal-administrative requirements of organizing transloading. In addition, it is claimed that calculation of total transport cost is very complicated, cumbersome and often unclear which discourage customers. Transparency of the entire transloading process and total cost estimates is a must to expand multimodal transport on RFC Amber. RUs consider the complex calculation of total transport costs to be the major problem.

4C - Long technological times of forwarding outside the EU

The three gateways of RFC Amber (Terespol, Koper and Kelebia) are the entry point to the territory of the EU therefore cargo handling processes include customs procedure. Vehicle and staff authorisation and licensing requirements are high for rail transports to or from outside EU especially compared to road transport. Administrative procedures of customs are particularly complex in the case of freight arriving at Koper. Time demand due to slow and complex customs and border control procedures at Schengen borders is hard to estimate and often cause delays.

Due to time-consuming customs procedure and different train/staff authorisation requirements, lack of harmonisation the process time at Schengen borders is lengthy, often erratic and unpredictable. Language issues to operate trains outside the EU also arise, RUs often have not got the capacity to efficiently handle the situation.

Note that the Convention concerning International Carriage by Rail (OTIF - Intergovernmental Organisation for International Carriage by Rail) enables application of simplified transit procedures in the case of member states committed to facilitate border checks of vehicles, staff (like Serbia, the Ukraine) which reduces cost of waiting and influences reliability.

<u>Overall conclusions on administrative issues</u>

Various national rules are in effect interfering with interoperability (braking, buffer wagon, loco staff, vehicle and staff authorization/license etc). In lack of coherent regulation, the mandatory compliance with national rules, authorisation requirements increase process time at handover points, and make overall waiting time unpredictable or impose unreasonable obligations upon RUs/IMs. As a consequence, clients are not able to calculate either transport time or transport cost, especially when multimodal transport requires transloading which impacts competitiveness of RFC Amber.

8.4 Ranking of operational issues – causes and impacts

Underlying causes of the individual problems and their contribution were revealed and analysed through discussions with competent stakeholders (including RFC Amber representatives) and desktop research.

Identified operational and administrative bottlenecks have been assigned to three different categories based on the assumed degree of impact on the efficient functioning of RFC Amber in consideration of the findings of the sector statement, the RNE initiatives targeting common issues on other RFCs.

The three categories of impact (priority category of O&A issue) are **low; medium; high** and the issues are ranked according to the qualitative assessment presented in the previous section. Findings of the analysis i.e. causes and impacts as well as prioritisation of the issues are summarised in the table below.

Bottleneck	main causes	impact	Ranking: impact category
1. CAPACITY MANAGEMENT			
1A - Path allocation procedure via C-OSS is inadequate	- Conflicts with national timetables and capacity management on overlapping RFC sections - Reduced availability and quality of RFC C-OSS service - RFC requests have no preference over domestic freight in TT (path offer) - the deadline for placing PaP requests, RC demand are too early for RUs	- Complex, time consuming path allocation procedure requiring extra human capacity from RUs and IMs (C-OSS) alike - not a true C-OSS since does not cover all steps - redundancy of RFC and national path reservation processes - capacity allocation is inadequate	medium
1B - PaP parameters and RC fail to meet market requirements	- Limited number of paths, inadequate reserve capacity for ad-hoc RFC trains, long transport time - Low flexibility in terms of origin/destinations and scheduling - early planning requirement - Lack of timely communication between stakeholders, insufficient information on capacity needs,	- RFC cannot offer competitive service for RUs - not competitive path parameters (long transport time RFC path capacity, availability of RC does not correspond with RU requirements - TT conflicts - capacity management KPIs for Amber are not improving volume of requests, requested capacity decreasing while volume of offered capacity increases	high
1C - Limited applicability of the PCS and reliability of data	- Capacity allocation process, workflow is not transparent for all stakeholders - data are not regularly updated, not used by RUs - Not fully compatible with national systems – inefficiency due to double upload	- harmonisation, handling of path requests needs extra efforts (IMs – double data input) - workflow is not always transparent; in reality, PCS currently does not provide a single workflow - RUs can be discouraged to use PCS: resource intensive process of path request for RUs causing time loss and low customer satisfaction	low
2. COMMUNICATION			
2A - Communication difficulties at handover points, borders	- inefficient sharing of information in the event of disturbances (delay, rerouting) - not standardised communication procedures - change of train number - incoherent data in TIS therefore it is not used by RUs - language barrier/no English speaking (common language) staff available 24/7	- increase procedures at handover of international trains: unnecessary waiting time at borders, - faulty communication of delays and arrival sequence of trains, - operational inefficiencies, inadequate train monitoring	high

Bottleneck	main causes	impact	Ranking: impact category
2B – Poorly functioning interfaces between national IT tools and the RNE tools	- resource requirement of development is relatively high, - national databases have greater scope of data requirement, - train data are often not current and accurate - national IT systems, interfaces are not TAF-TSI compliant - CIP does not cover all services provided by national IMs	- most RUs fail to apply TIS - increased waiting time at borders (handover points) difficulties in cargo tracking– lower reliability and customer satisfaction, - inefficient resource allocation (time, financial means, rolling stock and staff) in traffic management	medium
2C – Inadequate coordination and sharing information on capacity restrictions, disturbances	- lack of coordination of planned and ad-hoc works, - uncertainties in financing, - lack of uniform messaging in the case of disturbance - only bilateral agreements on data exchange, - failure to update information on maintenance, re-routing, etc. (CIP) - failure to involve RUs/RFC in programming works - TCRs are longer than planned	- uncertainties in scheduling works, length of possessions - non-fulfilment of agreed obligations (in path allocation) - need for managing delays, rerouting difficulties increase cost, transport time (resource allocation difficulties, inefficiency), - difficulties in train/cargo tracking - reduced punctuality, reliability of RFC trains	high
2D - Insufficient language skills of staff	- lack of common language at border (less of a problem for PKP/MÁV) affecting communication mainly between RUs or RU-IM - availability of an effective translation tool	- time loss/delays in traffic management/administrative procedure; (unnecessary waiting time, lengthy process times) - additional human resource requirement	medium
3. TRAFFIC MANAGEMENT			
3A - Ineffective arrangements, processes at border crossings	- technical inspection requirements of rolling stock, poor technical condition of wagons); - cooperation problems between RUs at handover points (no trusted), - lack of human resources, blocking of tracks by dwelling trains, lack of parking track capacity - the need to change driver/locomotives, inefficient arrangements, waiting for driver - low punctuality of trains, unpredictable procedure of change	- lengthy train handling at handover points - time consuming / unpredictable procedure of locomotive and driver change; - reduced reliability of train running, delays low average planned PaP speed – not competitive RFC service, - increased cost to secure human resources (interfering with operational efficiency of RUs) - reduced efficiency for both IMs and RUs – i.e. locos blocking through tracks	high

Bottleneck	main causes	impact	Ranking: impact category
3B – Low reliability of RFC trains impacts competitiveness	- no flexibility in dispatching RFC trains - RUs' difficulties in labour management, limited communication, lack of reliable info on ETA (limited use of TIS in performance monitoring for improvement of commercial conditions). - lack of priority of international freight trains; (many ad-hoc freight trains in addition to passenger transport on national networks, in nodes)	- punctuality targets are not met - delays, low average speed and lack of punctuality (ETA) - low reliability and competitiveness of RFC service, disadvantage against road transport - reduced customer satisfaction - lower efficiency of infrastructure operation and use of RU resources (rolling stock, staff)	medium
3C – Competitive re-routing, contingency measures for traffic disturbances/TCRs are not available	- lack of – or only bilateral – coordination between IMs TCR planning is not transparent - passenger trains have higher priority in the event of traffic disturbance - difficulties in advance planning of the TCRs; - Contingency Management rerouting scenarios were not published for Amber - consolidated data for train performance management (monitoring) are not available	- delays, low average speed, - inefficient operation, extra costs and resource requirement - poor competitiveness - lack of available capacity for RFC trains - undermining reliability of RUs business - causes of delays are not understood to enable the right response, introduction of effective measure	high*
3D – RFC traffic management staff is not properly prepared	- lack of RFC experience in performance management, short history of RFC Amber - familiarity with new IT tools, processes (TIS OBI) - language skills need improvement - TAF TSI messages not fully introduced yet	- inefficient management of RFC traffic - capacities of TIS not fully utilised - extra human resource requirement on the part of IMs/C-OSS	low
4. ADMINISTRATIVE ISSUES			
4A - Cross-border interoperability difficulties due to lack of harmonisation of national rules	- various often unjustified national rules (safety certificate, authorisation of vehicles, driver certification, language requirements, cabin crew, tail sign) - shortage of human resources for separate, different process for each country - train composition requirements/restrictions (e.g. buffer wagon) - technical inspection of rolling stocks - ETCS and GSM-R implementation is slow	- long and unpredictable dwelling time at borders – RFC train reliability suffers, - unreasonable obligations upon RUs: additional RU resource needs (costly procedures which leads to mistakes) - inefficient use of infrastructure/rolling stock	high
4B - Not transparent, calculable procedures and charging in case of multimodal transport	- Complex legal-administrative requirements of transloading - CIS system cannot be readily applied for calculating cost - total cost including last mile is not available	- Complex, difficult calculation of total transport cost for customers - administrative burden on RUs (cost and staff) - not calculable transport time discourage customers	medium

Bottleneck	main causes	impact	Ranking: impact category
4C - Long technological times of forwarding outside the EU	- slow and complex, often erratic customs and border control procedures - RUs often do not have staff with the necessary language skills - Vehicle and staff authorisation/license requirements are high compared to road transport	- transport time is difficult to calculate, frequent delays, - extra burden, resource requirement (cost, competence) on RUs, shippers	medium

* International Contingency Management Plan was adopted by RFC Amber in June, 2020, so the ranking of the issue could soon improve

Table 47: Causes and impacts of O&A bottlenecks

8.5 The most critical operational bottlenecks

In capacity management the process of definition and allocation of freight train paths on RFC Amber is facing a general underlying issue of passenger traffic priority. It. is most crucial at urban nodes where passenger traffic is growing and the frequency of passenger train services will likely increase in the future, i.e. in connection with introduction of integrated system timetables. This can make it more difficult in the future to define a PaP capacity offer meeting the actual needs of the railway undertakings. Therefore, the needs of freight transport should always be taken into account at an early stage when developing timetable-concepts for passenger traffic (this would allow a more realistic assessment of the feasibility of regional integrated system timetable concepts for passenger traffic according to GYSEV Cargo). International freight traffic cannot be limited to night-time; therefore, it is important that availability of high-quality freight train paths is ensured 24/7 even along the entire RFC Amber, including urban nodes and sections with dense passenger traffic. In addition, the speed standard of train paths on RFC Amber are not always competitive; especially for certain intermodal business it is important to shorten travel times by providing train paths with substantially higher average speed than today. The timeframe of the allocation process sets unrealistic deadlines for railway undertakings. Availability of reserved capacity is not flexible enough; RFC trains should have preferential treatment as it cannot fully meet demand.

In terms of **communication** the main problem is the lack of coordination of upgrading works, TCRs between IMs which often implies late departure, unplanned stops and parking of RFC trains resulting in unpredictable transit time. Current lack of consistent numbering of international trains, low reliability of data in TIS in handover of RFC trains interferes with efficient sharing of information between IMs, RUs, C-OSS. Therefore, early introduction of operable interfaces with national IT systems is a must. C-OSS at present is not a true one-stop-shop for RFC Amber, it should be expanded to cover all client processes.

It has been revealed that waiting time at borders due to lengthy process time in lack of trusted train handover, insufficient coordination and application of different national rules heavily impact **traffic management**. Also, punctuality of RFC trains, the expected time of arrival can only be ensured if they enjoyed preferential treatment over other freight trains, if contingency measures were in place and higher level of coordination of TCRs was conducted to ensure competitive train path. Since infrastructure capacity is not readily available at sections, border crossings, the reliability of RFC trains can be enhanced by better traffic management adopting principles that favour the interests of international freight transport. Train performance management processes have not been fully established yet to readily support the achievement of competitive commercial conditions.

At borders, in the process of handover of trains the **administrative issues** are of key importance as compliance with national rules, the lengthy procedural, technological times requires additional capacities, impact punctuality and eventually increase cost of freight transport. Alignment of national safety rules, vehicle authorisation, train composition requirements supported with common IT platform (TAF-TSI compliance) would reduce dwelling time and administrative burden, unreasonable obligations on both RUs and IMs. More transparent and harmonised procedures – strong collaboration of stakeholders – would encourage multimodal transport and support freight transport to and from third countries.

9 Interventions for improvement

9.1 Interdependencies

When thinking about possible interventions for improvement one has to be aware that infrastructure, capacity problems and operational, administrative issues often interrelate. For example, improvement of operational efficiency can solve infrastructure capacity problems without any major infrastructure investment. Similarly, alignment of national rules or adaption of a common IT platform with interoperable national interfaces can make traffic management processes more efficient and reliable and can eliminate human capacity enhancement at IMs/RUs, or spare track development to reduce waiting times at the border crossing stations.

Interdependences of bottlenecks have been addressed in the previous chapters however, they have more relevance in designing and evaluating possible interventions. In fact, the methodology of evaluation of interventions, prioritisation of sections considers interdependencies. In identifying the types of relevant infrastructure interventions and prioritising sections other interventions foreseen on the connecting lines or at nodes, marshalling yards, terminals need to be considered. A new triangle track would render construction of station track developments unnecessary (e.g. Zalaszentiván, Komárno/Komárom, Bratislava), the installation of new interlocking system can increase capacity, so it is to be shown in the prioritisation of sections calling for improvement.

The evaluation methodology, ranking process of interventions to improve operational and administrative issues have not ignored the aspect of interdependence either. When evaluating potential impacts of a measure on RFC functioning higher scores were given to measures that improve several issues or offer a more cost-effective, or feasible option over the other. Harmonisation of national rules or use of common IT platforms necessarily ease communication (less need for language skills, standard messaging) and improve efficiency of traffic management (shorter dwelling time, less train parking capacity required).

The final ranking and prioritisation of measures are based on a scoring matrix of feasibility and impact with the latter including interdependence, the collateral improvement potential on other issues i.e. joint impact on efficient rail freight operations along the corridor.

9.2 Proposed measures to improve line and node bottlenecks

9.2.1 Methodology and steps of evaluation of proposed measures on lines

The Bottleneck Study aims to address main bottlenecks hindering competitiveness and seamless traffic flow. The main objective of the elimination of these bottlenecks is to establish infrastructure and operational conditions for competitive international rail freight transport (RFC service) and capacity supply on RFC Amber in correspondence with traffic demand. These objectives are also serving EU climate change targets.

Major steps to achieve this:

a) Prioritizing, ranking the lines according to their TEN-T infrastructure compliance (compound index) and section relevance
b) Setting target conditions and corresponding types of interventions to reach the targets and consequently eliminate the bottleneck(s)
c) Definition of measures by line sections and nodes to support Amber RFC developments, assessment of feasibility and time frame.

Activities within the steps therefore:

Identifying/ranking the sections by intervention priority

The previously introduced compound index scores are interpreted in consideration of current capacity utilisation, function of the line section thus they theoretically show where upgrading interventions, improvement of line parameters is crucial to ensure operability of RFC Amber. This information can support IMs, decision makers when appraising importance, relevance, or priority of the envisaged projects on the corridor. Projects planned by the member states (IMs) are also needs to be considered and their graphic presentation allows collating with sections where infrastructure bottlenecks are identified.

The intervention priority is based on the compound index value (compliance of current technical conditions with TEN-T Guideline requirements), the section relevance (highlighting the most important ones) and modified by capacity utilisation where it is reasonable.

Investment priority groups are:

1. improvement imperative
2. intervention proposed
3. desired for optimal RFC performance

The following table shows how priority grouping is planned, based on section relevance and compound index:

Section relevance: / Compound index:	outstanding	high	medium	low
≤ 3.0 very poor	1	1	1	2
3.01 – 3.50 poor	1	1	2	3
3.51 – 4.00 fair	1	2	3	3
4.00 < good	2	3	3	3

Table 48: Matrix for prioritisation of sections considering compound index and section relevance

Priority groups of sections are composed considering RFC impact at member state level to support national decision making and allocation of sources.

Capacity utilisation is also considered with high importance: all sections get priority (moved to higher priority group) in case capacity shortage is present or expected.

Setting target conditions

The desired conditions for rail freight forwarding (RFC performance) are the core TEN-T parameters, specified previously, the modern signalling system and ETCS. Additionally, target is the appropriate free capacity on the line to serve the forecasted traffic demand. Besides, “Level of Service” targets can also be set, e.g. preferred maximal waiting times at border crossings.

Differentiation is possible based on the network role (e.g. TEN-T core/comprehensive vs. non-TEN-T) and the traffic categories defined for TEN-T requirements.

The targets can have impact on implementation time horizon, too.

Proposed interventions on sections

Measures will have two main types: infrastructural (development type) and operational, administrative (management type) interventions. The management type of interventions are mentioned here, where relevant, but detailed in the next chapter, about operational and administrative bottlenecks.

Later the interventions can be transformed to projects by the IMs, based on funding conditions, other RFC/network aspects etc. To do so, further analysis for derived projects must be done in feasibility studies, impact studies, in line with national/network development strategies and sector priorities.

Types of measures or intervention categories are set as follows:

- New line/new section construction
- Upgrade to TEN-T requirements, by distinguishing where:
    - Full reconstruction/upgrade is needed
    - Only partial upgrade is needed
- Capacity enhancement
    - of line sections
    - of sections being part of an urban node
    - of important service point such as marshalling and shunting yards and border crossings

New line construction is proposed only at locations where it is decided previously and included in the RFC Amber as future line; namely it is the Tymbark – Podłęże section in Poland. However, it is possible at some locations that the capacity increasing intervention by building a 2nd track along a section is physically results in a new line on new alignment (due to external conditions mainly, i.e. terrain, built-in area limitations) as it is the case in Slovenia with the Divača – Koper "second track" construction project.

The upgrade to TEN-T requirements has two main sub-categories, full reconstruction and partial upgrade. First is needed and proposed in case the full reconstruction is expected to meet the required parameters, as it is the case when axle load or line speed raise is needed or the compound index is low-moderate, suggesting that full, complex reconstruction and development is imperative. Partial upgrade is considered on the sections where the axle load, speed currently fulfils TEN-T requirements or compound index is relatively high (section considered good) but further development of e.g. ERTMS system is needed or speed restrictions

Capacity enhancement intervention is not defined in more details as it is a very complex issue, depends on current parameters, traffic circumstances, etc. of the section that needs detailed analysis and planning one by one; it cannot and should not be judged or decided on strategic level. The intervention or later the project can be, for example, building a second track on full length or only partially, upgrade of the signalling system[27], development of some stations along the line, speed increase etc.

[27] It is widely recognised that ERTMS can bring significant capacity benefits. As a continuous communication-based signalling system, ERTMS reduces the headway between trains enabling up to 40% more capacity on currently existing infrastructure.

At several sections, there is no urgent or obvious need for intervention to fulfil the TEN-T required parameters as the infrastructure is already appropriate for efficient freight train transportation (note that capacity enhancement might be needed in the future for flawless traffic flow in case of the capacity bottlenecks).

Feasibility and realisation time frame of proposed interventions
Time frames of the measures (hence the priority) is influenced by the obligations:

- TEN-T 2030 (short term) – core network shall be TEN-T compliant
- TEN-T 2050 (medium-long term) – comprehensive network shall be TEN-T compliant

The TEN-T obligation influences therefore how the priorities and time frame are set. The timing is also based on intervention priority, defining how important is to remove the specific bottleneck on the section.

Feasibility is evaluated in consideration of cost and complexity of the intervention. Consequently, the assessment is influenced by (primarily) the volume of intervention (based on section's length and the type of measure) and the complexity of the investment (e.g. it is in a node or at a border crossing, where the intervention faces much more other aspects and limitations).

9.2.2 Priority list of sections by member state

The sections are prioritized to define the importance of making intervention for bottleneck elimination.

The next map shows the combination of section relevance and capacity shortage. The priorities are presented on the second map below. The detailed classification of the sections is included in the next chapter where investment priority is included to underpin the investments on the section.

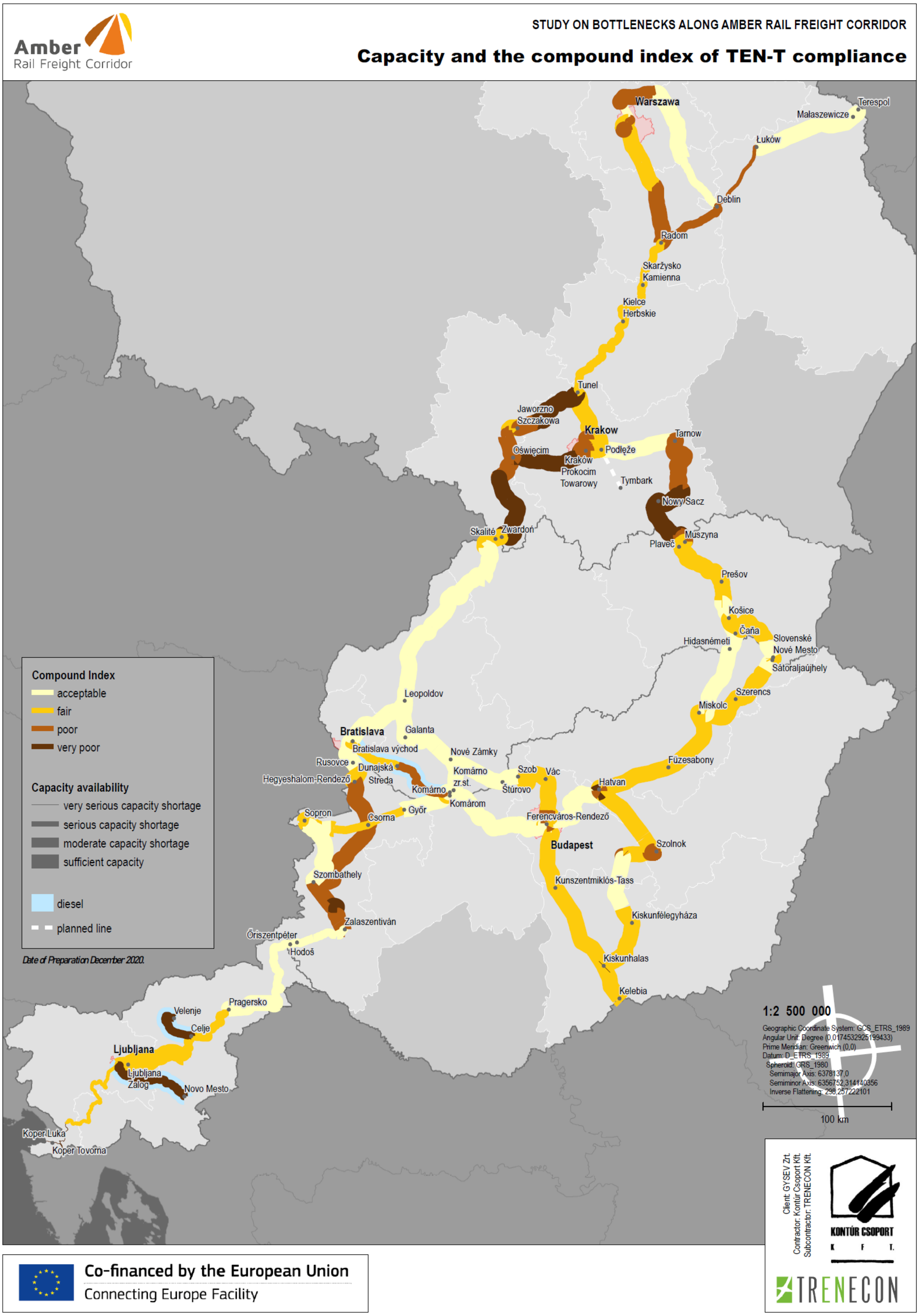


Figure 46: Combination of section relevance and forecasted line capacity bottlenecks along RFC Amber

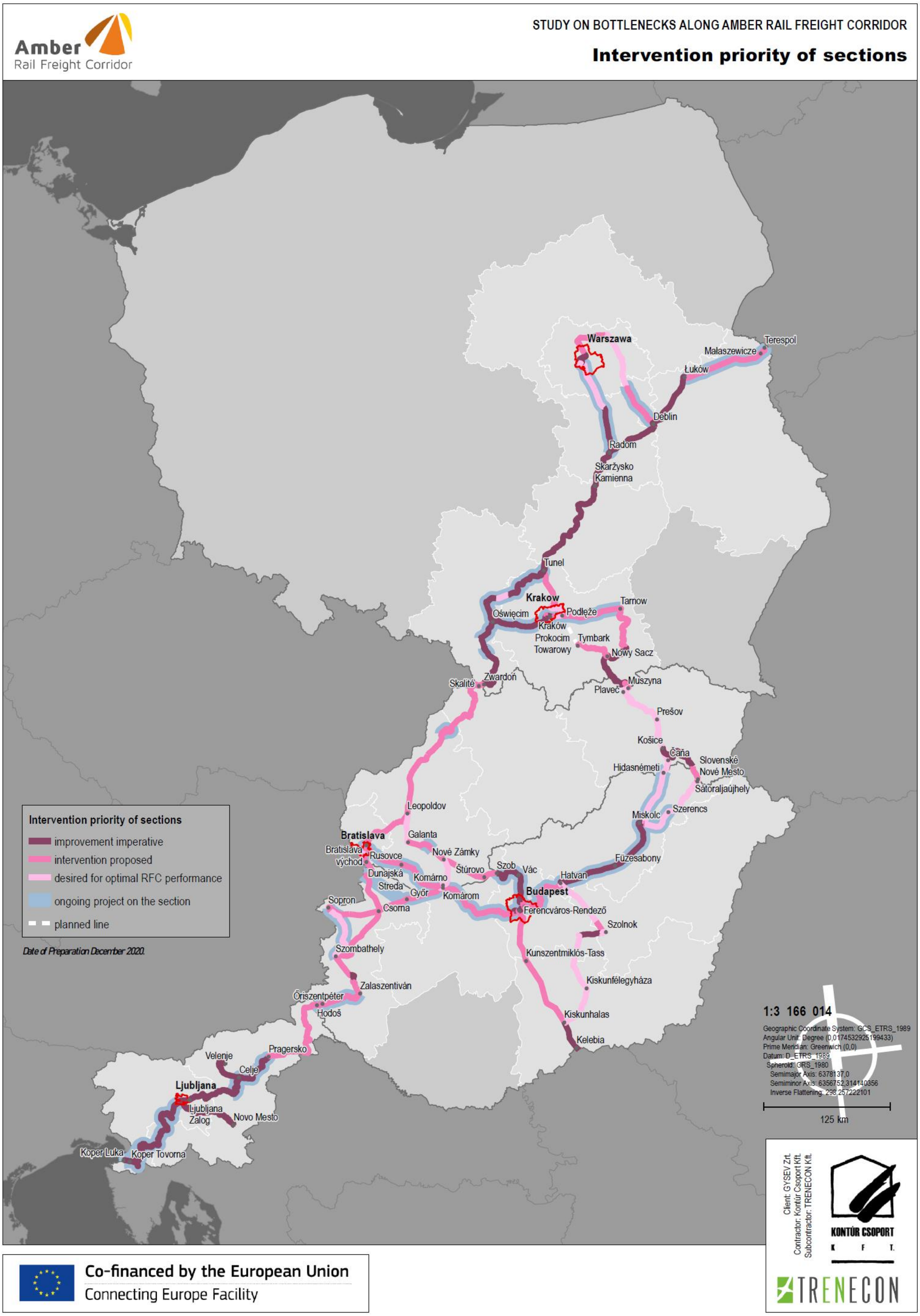


Figure 47: Investment priority (considering capacity issues) of sections along RFC Amber

9.2.3 Projects already proposed by infrastructure managers

IM listed projects are considered as part of implementation of the proposed measures. Therefore, they are not considered in the evaluation of bottlenecks and ranking of the measures. The projects can be assigned to sections and classified as:

- Ongoing and short-term projects: already started or at least decided, financing is ensured
- Medium-long term projects: no financial source allocated or only in early preparatory phase

The projects are also arranged into project types based on the available (often quite limited) information about their technical content and reached infrastructure parameters after completion. The most complex projects according to our understanding are the new line constructions (such as Koper-Divača second track that is practically a new line section) and the upgrades, modernisations, full reconstructions to meet the TEN-T requirements. Some of the latter also include building of second track to increase capacity in large measure, such as Budapest-Kelebia and Győr-Sopron in Hungary.

The smaller projects include only partial reconstruction of the infrastructure, e.g. reconstruction of stations tracks and turnouts, structures or signalling systems, local measures to increase capacity; or installation of ERTMS equipment in itself.

In the long term, the High-Speed Rail network development plans can influence capacity issues along RFC Amber as the strategic plans overlap from Warsaw through Bratislava towards Budapest. The development may result in free capacities on the existing lines (where long distance passenger traffic is moved to the high speed link). However, it is not included in the official project plans of IMs.

The following pages present the table and map of project that were defined by IMs so far. As mentioned above, the categorisation of the project type was done by the Consultant, using similar intervention types as at the bottleneck elimination interventions along RFC Amber (projects that are completed during the preparation of the Bottleneck Study are already excluded):

IM	From	To	RFC line category	Project name	Project type	Project timing
POLAND						
PKP	Muszyna (G.P.)	Muszyna	principal	Works on rail line no. 96 on section Tarnów - Muszyna	upgrade to TEN-T requirements	ongoing
PKP	Muszyna	Nowy Sącz	principal		upgrade to TEN-T requirements	ongoing
PKP	Nowy Sącz	Stróże	principal		upgrade to TEN-T requirements	ongoing
PKP	Stróże	Tarnów	principal		upgrade to TEN-T requirements	medium-long term plan
PKP	Podłęże	Podłęże R 101	principal	N.A., project planned to launch after 2020	upgrade to TEN-T requirements	medium-long term plan
PKP	Raciborowice	Tunel	principal	N.A., project planned to launch after 2020	upgrade to TEN-T requirements	medium-long term plan
PKP	Tunel	Radom	principal	Works on railway line no. 8 on section Skarżysko Kamienna – Kielce – Kozłów	upgrade to TEN-T requirements	short term plan
PKP	Radom	Dęblin	principal	N.A., project planned to launch after 2020	upgrade to TEN-T requirements	medium-long term plan
PKP	Dęblin	Łuków	principal	Work on the railway line C-E 20 on the Skierniewice – Pilawa – Łuków section	upgrade to TEN-T requirements	medium-long term plan
PKP	Podłęże R 101	Podłęże R 201	principal	Works on the E 30 railway line on the Kraków Główny Towarowy – Rudzice section and the addition of the agglomeration line tracks	upgrade to TEN-T requirements	ongoing
PKP	Podłęże R 101	Gaj	principal		upgrade to TEN-T requirements	ongoing
PKP	Gaj	Kraków Prokocim Towarowy	principal		upgrade to TEN-T requirements	ongoing
PKP	Kraków Prokocim Towarowy	Bonarka	principal	Works on the railway line 94 on the Kraków Płaszów – Skawina – Oświęcim section	upgrade to TEN-T requirements	ongoing
PKP	Kraków Bonarka	Oświęcim (OwC)	principal		upgrade to TEN-T requirements	ongoing
PKP	Oświęcim (OwC1)	Mysłowice Brzezinka	principal	Works on lines No. 132, 138, 147, 161, 180, 654, 655, 657, 658, 699 on the Gliwice – Bytom – Chorzów Stary – Mysłowice Brzezinka – Oświęcim and Dorota – Mysłowice Brzezinka sections	upgrade to TEN-T requirements	ongoing
PKP	Mysłowice Brzezinka	Sosnowiec Jęzor	principal		upgrade to TEN-T requirements	ongoing
PKP	Sosnowiec Jęzor	Jaworzno Szczakowa	principal		upgrade to TEN-T requirements	ongoing
PKP	Jaworzno Szczakowa	Bukowno	principal	Works on the railway lines No. 62, 660 on the Tunel – Bukowno – Sosnowiec Płd. section.	upgrade to TEN-T requirements	ongoing
PKP	Bukowno	Tunel	principal		upgrade to TEN-T requirements	ongoing

IM	From	To	RFC line category	Project name	Project type	Project timing
PKP	Radom	Warka	future principal	Modernisation railway line no. 8, section Warszawa Okęcie – Radom (LOsT: A, B, F) Phase II. Works on railway line no. 8, section Warka – Radom (Lots: C, D, E)	upgrade to TEN-T requirements	ongoing
PKP	Warka	Warszawa al. Jerozolimskie	future principal		upgrade to TEN-T requirements	ongoing
PKP	Warszawa al. Jerozolimskie	Warszawa Główna Tow.	future principal	N.A., project planned to launch after 2020	upgrade to TEN-T requirements	medium-long term plan
PKP	Zwardoń (G.P.)	Zwardoń	diversionary	Works on the railway line 139 on the Czechowice Dziedzice – Bielsko Biała - Zwardoń (national border)	upgrade to TEN-T requirements	medium-long term plan
PKP	Zwardoń	Wilkowice Bystra	diversionary		upgrade to TEN-T requirements	medium-long term plan
PKP	Wilkowice Bystra	Bielsko-Biała Lipnik	diversionary		upgrade to TEN-T requirements	ongoing
PKP	Bielsko-Biała Lipnik	Bielsko-Biała	diversionary		upgrade to TEN-T requirements	medium-long term plan
PKP	Bielsko-Biała	Czechowice-Dziedzice	diversionary		upgrade to TEN-T requirements	medium-long term plan
PKP	Czechowice-Dziedzice	Oświęcim	diversionary	Works on the railway line 93 on the Trzebinia – Oświęcim – Czechowice Dziedzice section	upgrade to TEN-T requirements	ongoing
PKP	Oświęcim	Oświęcim (OwC1)	diversionary		upgrade to TEN-T requirements	ongoing
PKP	Oświęcim	Oświęcim (OwC)	diversionary		upgrade to TEN-T requirements	ongoing
PKP	Oświęcim (OwC)	Oświęcim (OwC1)	principal		upgrade to TEN-T requirements	ongoing
PKP	Dęblin	Pilawa	future diversionary	Works on the railway line no. 7 Warszawa Wschodnia Osobowa – Dorohusk on the Warszawa – Otwock – Dęblin – Lublin section	upgrade to TEN-T requirements	ongoing
PKP	Pilawa	Krusze	future diversionary	Works on the railway lines no. 13, 513 on section Krusze / Tłuszcz – Pilawa	upgrade to TEN-T requirements	medium-long term plan
PKP	Krusze	Legionowo Piaski	future diversionary	N.A., project planned to launch after 2020	upgrade to TEN-T requirements	medium-long term plan
PKP	Nowy Sącz	Tymbark	future principal (new line)	Construction of a new railway line Podłęże – Szczyrzyc – Tymbark/Mszana Dolna and modernisation of the existing railway line no. 104 Chabówka – Nowy Sącz – Stage II	upgrade to TEN-T requirements	short term plan

IM	From	To	RFC line category	Project name	Project type	Project timing
PKP	Tymbark	Podłęże	future principal (new line)	Construction of a new railway line Podłęże – Szczyrzyc – Tymbark/Mszana Dolna and modernisation of the existing railway line no. 104 Chabówka – Nowy Sącz – Stage III	building new line	medium-long term plan
PKP	Tarnów	Podłęże	principal	Construction of ERTMS/ETCS on TEN-T core network	ERTMS	ongoing
PKP	Łuków	Terespol	principal		ERTMS	ongoing
PKP	all lines	all lines		Construction of GSM-R network infrastructure	ERTMS	short term plan
SLOVAK REPUBLIC						
ŽSR	Púchov	Považská Teplá	principal	Reconstruction, modernisation of track to 160km/h	upgrade to TEN-T requirements	ongoing
ŽSR	Žilina	Žilina	principal	Modernisation of railway node Žilina	upgrade to TEN-T requirements	short term plan
ŽSR	state border CZ/SK	Čadca	principal	Modernisation of railway corridor State border CZ/SK – Čadca – Krásno nad Kysucou, section state border CZ/SK - Čadca (excl)	upgrade to TEN-T requirements	short term plan
ŽSR	Čadca	Krásno nad Kysucou	principal	Modernisation of railway corridor State border CZ/SK – Čadca – Krásno nad Kysucou, section Čadca - Krásno nad Kysucou (excl)	upgrade to TEN-T requirements	short term plan
ŽSR	Bratislava	Dunajská Streda	principal	Local measures to increase the capacity	other (capacity increase)	ongoing
ŽSR	Dunajská Streda	Komárno	principal	Local measures to increase the capacity	other (capacity increase)	ongoing
HUNGARY						
MÁV	Budapest (Rákos)	Hatvan	principal	Upgrading of Budapest (Rákos) - Hatvan railway line	upgrade to TEN-T requirements	ongoing
MÁV	Soroksár	Kelebia border	principal	Modernization of Budapest - Belgrad railway line, 2nd track construction	upgrade to TEN-T requirements, 2nd track construction	short term plan
MÁV	Ferencváros	Soroksár	principal	Modernization of Ferencváros - Soroksár railway line	upgrade to TEN-T requirements	short term plan
MÁV	Hatvan	Felsőzsolca	principal	Deployment of ETCS L2 system	ERTMS	medium-long term plan
MÁV	Budapest (Kőbánya felső)	Felsőzsolca	principal	Deployment of GSM-R system stage 2	ERTMS	ongoing
MÁV	Felsőzsolca	Hidasnémeti	principal	Deployment of GSM-R system stage 2	ERTMS	ongoing
MÁV	Felsőzsolca	Mezőzombor	principal	Deployment of GSM-R system stage 2	ERTMS	ongoing
MÁV	Rákos	Szob	principal	Deployment of GSM-R system stage 2	ERTMS	ongoing
MÁV	Kelenföld	Hegyeshalom (Border AT)	principal	Deployment of GSM-R system stage 2 (Upgrade of GSM-R system from R1 to R2)	ERTMS	ongoing

IM	From	To	RFC line category	Project name	Project type	Project timing
MÁV	Ferencváros	Kelenföld	principal	Deployment of ETCS L2 system	ERTMS	ongoing
MÁV	Rákos	Kőbánya felső	principal	Solving bottleneck by new tracks and redesigned of stations	upgrade to TEN-T requirements, additional track construction	short term plan
MÁV	Hatvan	Füzesabony	principal	Modernisation of line (upgrade line up to 160 kph)	upgrade to TEN-T requirements	short term plan
MÁV	Almásfüzitő	Komárom	principal	Modernisation of line (upgrade line up to 160 kph)	upgrade to TEN-T requirements	medium-long term plan
MÁV	Kelenföld	Budaörs	principal	Construction of new 3rd and 4th tracks, 120/140kph	additional track construction	medium-long term plan
MÁV	Ferencváros	Kelenföld	principal	Modernisation of the Danube bridges, construction of new 3rd bridge	upgrade to TEN-T requirements, additional track construction	ongoing
MÁV	Ferencváros	Kelenföld	principal	Construction of new 3rd track	additional track construction	short term plan
MÁV	Ferencváros	Ferencváros	principal	Construction of a single track overpass in Ferencváros	new line section	medium-long term plan
MÁV	Soroksári út	Soroksár	principal	Direct link to Danube bridges, construction of new 2nd track	additional track construction	medium-long term plan
MÁV	Hodoš state border	Zalaszentiván	principal	Deployment of ETCS L2 system	ERTMS	ongoing
GYSEV	Rajka s.b.	Hegyeshalom	principal	Upgrade of railway infrastructure	upgrade to TEN-T requirements	short term plan
GYSEV	Hegyeshalom	Csorna	principal	Upgrade of railway infrastructure to 225kN	upgrade to TEN-T requirements	short term plan
GYSEV	Csorna	Porpác	principal	Upgrade of railway infrastructure to 225kN, 120 km/h	upgrade to TEN-T requirements	short term plan
GYSEV	Porpác	Szombathely	principal	Upgrade of railway infrastructure to 225kN, 120 km/h	upgrade to TEN-T requirements	short term plan
GYSEV	Szombathely	Vasvár	principal	Upgrade of railway infrastructure to 225kN, partially 120 km/h	upgrade to TEN-T requirements	short term plan
GYSEV	Vasvár	Pácsony	principal		upgrade to TEN-T requirements	short term plan
GYSEV	Pácsony	Egervár-Vasboldogasszony	principal		upgrade to TEN-T requirements	short term plan
GYSEV	Egervár-Vasboldogasszony	Zalaszentiván	principal		upgrade to TEN-T requirements	short term plan

IM	From	To	RFC line category	Project name	Project type	Project timing
GYSEV	Szombathely	Szombathely	principal	Upgrade of railway and signalling infrastructure at Szombathely rail node	station development	short term plan
GYSEV	Zalaszentiván		principal	Zalaszentiván new triangle track (“delta”)	building new line	short term plan
GYSEV	Sopron station		principal	Capacity increase of Sopron station	station development	short term plan
GYSEV	Sopron	Harka	principal	Construction of the second from Sopron to Harka	upgrade to TEN-T requirements, additional track construction	short term plan
GYSEV	Sopron	Fertőboz	principal	Upgrade of railway infrastructure, construction of the second track (phases 1-2/A-2/B altogether)	upgrade to TEN-T requirements, additional track construction	medium-long term plan
GYSEV	Fertőboz	Csorna	principal		upgrade to TEN-T requirements, additional track construction	medium-long term plan
GYSEV	Csorna	Győr	principal		upgrade to TEN-T requirements, additional track construction	short term plan
GYSEV	Hegyeshalom	Szombathely	principal	Deployment of GSM-R system stage 2	ERTMS	short term plan
GYSEV	Szombathely	Zalaszentivan	principal	Deployment of GSM-R system stage 2	ERTMS	short term plan
GYSEV	Sopron	Győr	principal	Deployment of GSM-R system stage 2	ERTMS	short term plan
GYSEV	Sopron	Szombathely	principal	Deployment of ETCS L2 system	ERTMS	ongoing
SLOVENIA						
SŽ-I	Zidani Most	Pragersko	principal	Modernisation, upgrade of railway infrastructure Higher category (C3 to D4)	upgrade to TEN-T parameters	ongoing
SŽ-I	Ljubljana	Ljubljana	principal	Modernisation, upgrade of railway station Ljubljana Lack of capacity, longer station tracks, signalling and ensure intermodal hub with regional lines and new stops. - Emonika	station development	short term plan
SŽ-I	Zidani Most	Ljubljana	principal	Modernisation, upgrade of railway infrastructure, Signalling, longer station tracks,	upgrade to TEN-T requirements	short term plan
SŽ-I	Divača	Koper	principal	Modernisation, upgrade of railway infrastructure Lack of capacity, longer station tracks / Identification of additional measures for upgrading (increase abilities) of the existing line Divača-Koper Elimination of bottleneck Bivje on the railway section Divača-Koper	upgrade to TEN-T requirements	ongoing

IM	From	To	RFC line category	Project name	Project type	Project timing
SŽ-I	Divača	Koper	principal	Construction of the second track Divača - Koper, An additional track on other route (shorter track) but not parallel, creation of new structure (line, tunnel, bridge, leapfrog) / New line	building new line	ongoing
SŽ-I	Ljubljana	Divača	principal	Modernisation, upgrade of railway infrastructure, more energy for traction, signalling, longer station tracks / The modernisation of the station Brezovica and logatec (also for required 740m track length).	upgrade to TEN-T requirements	ongoing
SŽ-I	Ljubljana	Ljubljana	principal	New section assuring direct connection and increase abilities of train station in Ljubljana (project called Tivoli Arch)	station development	short term plan
SŽ-I	Ljubljana	Ljubljana	principal	Upgrading of station Ljubljana and ensure intermodal hub with regional lines and new stops	station development	medium-long term plan
SŽ-I	Ormož	Hodoš	principal	Creation of new structure (Automatic Block Signalling)	other	short term plan

Table 49. Project proposals of Infrastructure managers

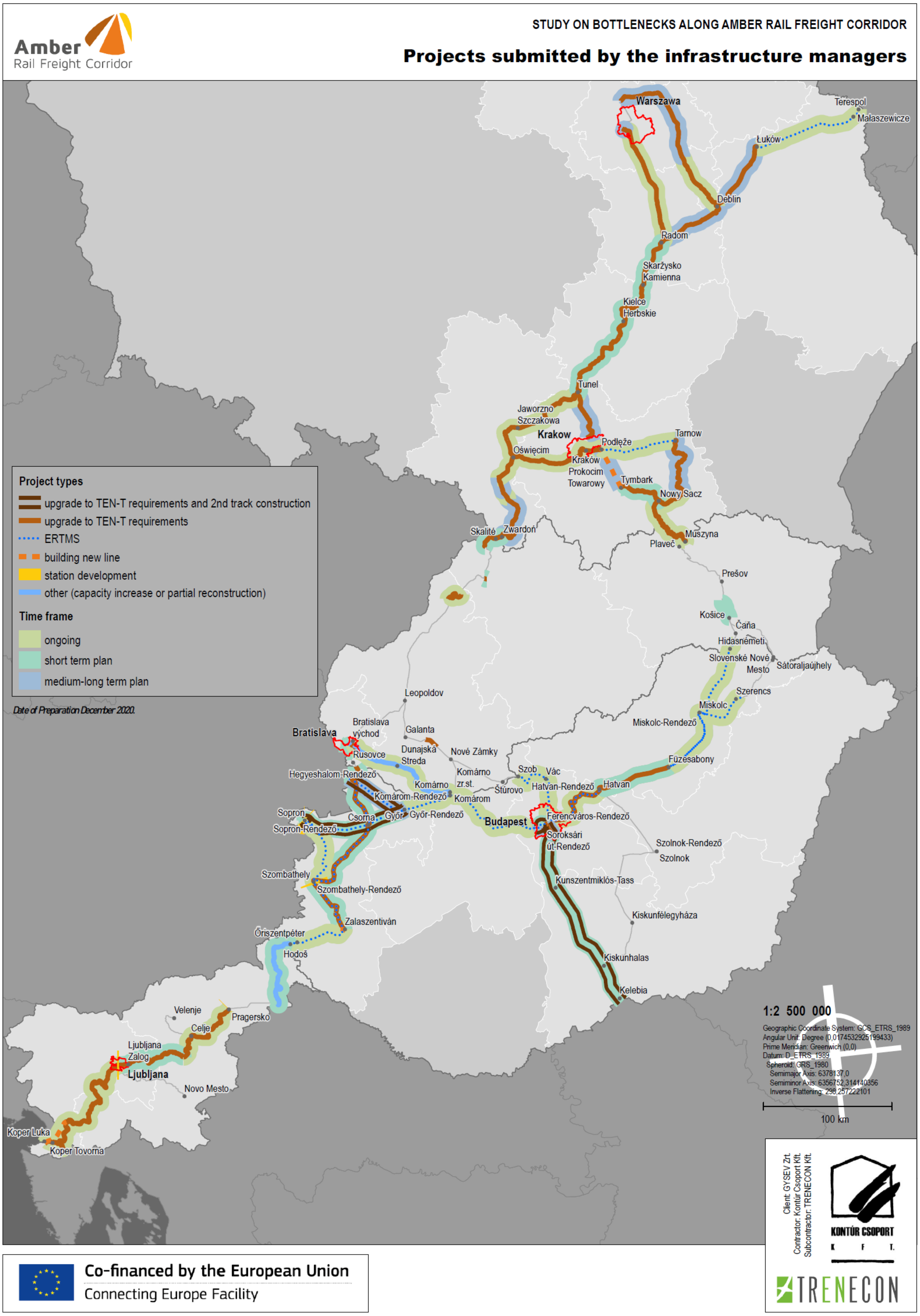


Figure 48: Project plans along RFC Amber

9.2.4 Interventions to remove line infrastructure and capacity bottlenecks

Definition and assessment of interventions

Interventions to eliminate bottlenecks are based on current deficiency (bottleneck type and causes). As presented previously, the interventions are grouped into major categories. They are then assigned manually for each section, based on the infrastructure parameters, the type of bottleneck (infra and/or capacity) and the severity of the problem.

The interventions are categorized to short-medium (by 2030) and long term, on strategic time frame by 2050. The time frame is defined based on intervention priority of the section and the TEN-T obligation. Sections classified to priority group 1 (improvement imperative) and 2 (intervention proposed) or being part of TEN-T core network are included in the short- and medium-term developments. The sections of priority group 3 (desired for optimal RFC performance) and TEN-T comprehensive or non-TEN-T are classified to long term intervention.

The feasibility is evaluated in consideration of cost and time horizon.

The cost categorisation is based on the extent of the intervention, considering the complexity of the measure, the section length etc. Cost categories are planned to be „high" and „moderate".

General considerations for developments

It is supposed and proposed that new lines and developments on the RFC topology (i.e. future principal sections) got development priority.

It can be subject of debate that developments should be focused for all relevant sections along the same line as a scheduled investment programme. It is proposed because the main objective is to remove and develop most crucial bottlenecks, but it is also important to reach homogenous network/lines along the Corridor.

The electrification should be one of the first priorities even if they are required only on connecting and diversionary lines. It is possible and can be considered and assessed that a sole electrification project is started prior to the complex upgrade to fulfil TEN-T requirements.

It is worth considering also that new sections (even relative short triangle tracks) can substitute station developments and/or other line infra developments:

- e.g. new delta tracks at Zalaszentiván, Komárno/Komárom, Bratislava can ease the operation in the neighbouring stations
- e.g. Nowy Sącz – Tymbark upgrade and Tymbark – Podłęże new section can substitute reconstruction of other line sections

Intervention priority of sections by member states

On following pages, the results of priority assessment are listed, country by country. It is highlighted that the list does not suggest ranking of the sections, only grouping them by intervention priority.

Poland

In Poland, several investments are decided that will have impact on the RFC topology. Currently the principal route to Warszawa is the Deblin-Tluszcz-Warszawa line and that route is planned to be „downgraded” to diversionary line when the already operating Warszawa-Radom is developed and will be appropriate to be the „principal” route. (they are currently categorized as „future diversionary” and „future principal”, current role is not obvious though).

Besides, almost the same situation is applicable to the Nowy Sącz-Tymbark-Podłęże planned route. Currently the Nowy Sącz-Tarnów-Podłęże line is the principal route but PKP plans to build the new link between Tymbark-Podłęże and fully upgrade the connecting Nowy Sącz-Tymbark section to create alternative route to the current principal one. (according to CID, the route to Tymbark is „future principal” but through Tarnow it is not defined if it will become diversionary or remain principal). It is proposed that investments are focused on building the new connection through Tymbark to divert traffic from the Nowy Sącz-Tarnów-Podłęże route.

Group of the sections of highest priority (in all tables, * marks those sections that got higher intervention priority because of capacity shortage):

Section	Length (km)	Intervention priority group	Type of intervention	Intervention comment	Intervention time frame	Urban node	Feasibility
Radom-Tunel	165.6	1	Capacity enhancement & partial upgrade (ERTMS/train length/restrictions)	Planned/ongoing project on the section.	Short-medium	-	Moderate cost, complex content.
Warszawa Gdańska-Warszawa Praga	4.3	1	Capacity enhancement & major reconstruction/upgrade to comply TEN-T	Future diversionary line after Warszawa-Warka-Radom line upgrade.	Short-medium	Warszawa	High cost, complex content. Intervention should consider node requirements
Dęblin-Radom	2.0	1	Capacity enhancement & partial upgrade (ERTMS/train length/restrictions)	Planned/ongoing project on the section.	Short-medium	-	Moderate cost, complex content.
Krakow Biezanow-Podłęże R 101	6.0	1	Partial upgrade (ERTMS/train length/restrictions)	Planned/ongoing project on the section.	Short-medium	Krakow	Moderate cost, complex content. Intervention should consider node requirements
Podłęże R 101-Podłęże	2.9	1	Partial upgrade (ERTMS/train length/restrictions)	Planned/ongoing project on the section.	Short-medium	-	Moderate cost, moderate complexity.
Oświęcim OWC1-Oświęcim OWC	1.1	1	Major reconstruction/upgrade to comply TEN-T	Planned/ongoing project on the section.	Short-medium	-	High cost, complex content.

Section	Length (km)	Intervention priority group	Type of intervention	Intervention comment	Intervention time frame	Urban node	Feasibility
Oświęcim OWC-Czechowice-Dziedzice	20.8	1	Capacity enhancement & major reconstruction/upgrade to comply TEN-T	Planned/ongoing project on the section.	Short-medium	-	High cost, complex content.
Kraków Prokocim-Kraków Bieżanów	1.2	1	Major reconstruction/upgrade to comply TEN-T	Planned/ongoing project on the section.	Short-medium	Krakow	High cost, complex content. Intervention should consider node requirements
Jaworzno Szczakowa-Sosnowiec Jęzor	7.3	1	Major reconstruction/upgrade to comply TEN-T	Planned/ongoing project on the section.	Short-medium	-	High cost, complex content.
Warszawa Główna Towarowa-Warszawa Gdańska	9.3	1	Partial upgrade (ERTMS/train length/restrictions)	Future diversionary line after Warszawa-Warka-Radom line upgrade.	Short-medium	Warszawa	Moderate cost, complex content. Intervention should consider node requirements
Kraków Prokocim Towarowy PRD-Kraków Bonarka	3.6	1	Major reconstruction/upgrade to comply TEN-T	Planned/ongoing project on the section.	Short-medium	Krakow	High cost, complex content. Intervention should consider node requirements
Tunel-Bukowno	52.3	1	Major reconstruction/upgrade to comply TEN-T	Planned/ongoing project on the section.	Short-medium	-	High cost, complex content.
Nowy Sącz-Muszyna	50.6	1	Major reconstruction/upgrade to comply TEN-T	Planned/ongoing project on the section.	Short-medium	-	High cost, complex content.
Zwardoń-Zwardoń (G.P.)	0.4	1	Major reconstruction/upgrade to comply TEN-T	Planned/ongoing project on the section.	Short-medium	-	High cost, complex content.
Warka-Radom	46.2	1	Capacity enhancement & major reconstruction/upgrade to comply TEN-T	Future principal line to replace Warszawa-Pilawa-Deblin line. Planned/ongoing project on the section.	Short-medium	-	High cost, complex content.
Warszawa Gkówna Towarowa-Warszawa Gdańska	11.9	1	Capacity enhancement & major reconstruction/upgrade to comply TEN-T	Future diversionary line after Warszawa-Warka-Radom line upgrade. Planned/ongoing project on the section.	Short-medium	Warszawa	High cost, complex content. Intervention should consider node requirements

Section	Length (km)	Intervention priority group	Type of intervention	Intervention comment	Intervention time frame	Urban node	Feasibility
Łuków-Dęblin	61.2	1	Capacity enhancement & partial upgrade (ERTMS/train length/restrictions)	Planned/ongoing project on the section.	Short-medium	-	Moderate cost, complex content.
Dęblin-Radom	53.9	1	Capacity enhancement & partial upgrade (ERTMS/train length/restrictions)	Planned/ongoing project on the section.	Short-medium	-	Moderate cost, complex content.
Kraków Bonarka-Oświęcim	59.3	1	Major reconstruction/upgrade to comply TEN-T	Planned/ongoing project on the section.	Short-medium	Krakow	High cost, complex content. Intervention should consider node requirements
Stróże-Nowy Sącz	30.8	1	Major reconstruction/upgrade to comply TEN-T	Novy Sącz-Podłęże line realization will give shorter route. Planned/ongoing project on the section.	Short-medium	-	High cost, complex content.
Oświęcim-Oświęcim OWC1	0.6	1	Major reconstruction/upgrade to comply TEN-T	Planned/ongoing project on the section.	Short-medium	-	High cost, complex content.
Oświęcim OWC1-Mysłowice Brzezinka	17.0	1	Major reconstruction/upgrade to comply TEN-T	Planned/ongoing project on the section.	Short-medium	-	High cost, complex content.
Czechowice-Dziedzice-Bielsko-Biała Glowna	11.5	1	Major reconstruction/upgrade to comply TEN-T	Planned/ongoing project on the section.	Short-medium	-	High cost, complex content.
Bielsko-Biała Glowna-Bielsko-Biała Lipnik	1.8	1	Major reconstruction/upgrade to comply TEN-T	Planned/ongoing project on the section.	Short-medium	-	High cost, complex content.
Bielsko-Biała Lipnik-Wilkowice Bystra	6.9	1	Major reconstruction/upgrade to comply TEN-T	Planned/ongoing project on the section.	Short-medium	-	High cost, complex content.
Wilkowice Bystra-Zwardoń	46.7	1	Capacity enhancement & major reconstruction/upgrade to comply TEN-T	Planned/ongoing project on the section.	Short-medium	-	High cost, complex content.
Sosnowiec Jęzor-Mysłowice Brzezinka	7.2	1	Capacity enhancement & major reconstruction/upgrade to comply TEN-T	Planned/ongoing project on the section.	Short-medium	-	High cost, complex content.

Section	Length (km)	Intervention priority group	Type of intervention	Intervention comment	Intervention time frame	Urban node	Feasibility
Oświęcim OWC-Oświęcim OWC1	0.5	1	Major reconstruction/upgrade to comply TEN-T	Planned/ongoing project on the section.	Short-medium	-	High cost, complex content.
Podłęże-Tymbark**	n.a.	1	Building new line	Future principal line to shorten Nowy Sącz-Tarnów-Podłęże route.	Short-medium	-	High cost, complex content

* sections that got higher intervention priority because of capacity shortage

** building the new line can be prioritised (together with Tymbark-Nowy Sącz upgrade) to bypass the Nowy Sącz-Podłęże-Tarnów current line

Table 50: Interventions on the RFC Amber highest priority sections (Poland)

Group of the sections of medium priority:

Section	Length (km)	Intervention priority group	Type of intervention	Intervention comment	Intervention time frame	Urban node	Feasibility
Łuków-Terespol	90.2	2	Capacity enhancement & partial upgrade (ERTMS/train length/restrictions)	Planned/ongoing project on the section.	Short-medium	-	Moderate cost, complex content.
Podłęże-Tarnów	59.0	2	Partial upgrade (ERTMS/train length/restrictions)	Novy Sącz-Podłęże line realization will give shorter route. Planned/ongoing project on the section.	Short-medium	-	Moderate cost, moderate complexity.
Dęblin-Pilawa	49.3	2*	Capacity enhancement & partial upgrade (ERTMS/train length/restrictions)	Future diversionary line after Warszawa-Warka-Radom line upgrade. Planned/ongoing project on the section to be completed.	Short-medium	-	Moderate cost, complex content.
Kraków Prokocim-Gaj	4.1	2	Major reconstruction/upgrade to comply TEN-T	Planned/ongoing project on the section.	Short-medium	Krakow	High cost, complex content. Intervention should consider node requirements
Oświęcim-Oświęcim OWC	2.0	2	Major reconstruction/upgrade to comply TEN-T	Planned/ongoing project on the section.	Short-medium	-	High cost, complex content.
Muszyna-Muszyna (G.P.)	7.5	2	Major reconstruction/upgrade to comply TEN-T	Planned/ongoing project on the section.	Short-medium	-	High cost, complex content.

Section	Length (km)	Intervention priority group	Type of intervention	Intervention comment	Intervention time frame	Urban node	Feasibility
Kraków Prokocim Towarowy PRD-Kraków Bonarka	4.8	2	Major reconstruction/upgrade to comply TEN-T	Planned/ongoing project on the section.	Short-medium	Kraków	High cost, complex content. Intervention should consider node requirements
Tarnów-Stróże	56.8	2*	Capacity enhancement & major reconstruction/upgrade to comply TEN-T	Novy Sącz-Podłęże line realization will give shorter route. Planned/ongoing project on the section.	Short-medium	-	High cost, complex content.
Tymbark-Nowy Sącz	39.5	2	Major reconstruction/upgrade to comply TEN-T	Future principal line to shorten Novy Sącz-Tarnów-Podłęże route. Planned/ongoing project on the section.	Short-medium	-	High cost, complex content.
Tunel-Raciborowice	42.5	2	Partial upgrade (ERTMS/train length/restrictions)	Planned/ongoing project on the section.	Short-medium	-	Moderate cost, moderate complexity.
Warszawa Praga-Legionowo	14.2	2*	Capacity enhancement & partial upgrade (ERTMS/train length/restrictions)	Future diversionary line after Warszawa-Warka-Radom line upgrade.	Short-medium	Warszawa	Moderate cost, complex content. Intervention should consider node requirements
Legionowo-Krusze**	31.6	2	Major reconstruction/upgrade to comply TEN-T	Future diversionary line after Warszawa-Warka-Radom line upgrade. Planned/ongoing project on the section.	Long	-	High cost, complex content.

* sections that got higher intervention priority because of capacity shortage

** the section, being future diversionary line, can be scheduled in longer term to focus on the Warszawa – Warka – Radom future principal line

Table 51: Interventions on the RFC Amber medium priority sections (Poland)

Group of the sections of lowest priority:

Section	Length (km)	Intervention priority group	Type of intervention	Intervention comment	Intervention time frame	Urban node	Feasibility
Warszawa Aleje Jerozolimskie-Czachówek Górny**	29.4	3	Partial upgrade (ERTMS/train length/restrictions)	Future principal line to replace Warszawa-Pilawa-Deblin line. Planned/ongoing project on the section to be completed.	Short-medium	Warszawa	Moderate cost, complex content. Intervention should consider node requirements

Section	Length (km)	Intervention priority group	Type of intervention	Intervention comment	Intervention time frame	Urban node	Feasibility
Czachówek Górny-Warka**	21.2	3	Partial upgrade (ERTMS/train length/restrictions)	Future principal line to replace Warszawa-Pilawa-Deblin line. Planned/ongoing project on the section.	Short-medium	-	Moderate cost, moderate complexity.
Gaj-Podłęże R 101	8.9	3	Partial upgrade (ERTMS/train length/restrictions)	Planned/ongoing project on the section.	Long	-	Moderate cost, moderate complexity.
Dłubnia-Podłęże	18.3	3	Partial upgrade (ERTMS/train length/restrictions)	Planned/ongoing project on the section.	Long	-	Moderate cost, moderate complexity.
Podłęże R 201-Podłęże R 101	1.6	3	Partial upgrade (ERTMS/train length/restrictions)	Planned/ongoing project on the section.	Long	-	Moderate cost, moderate complexity.
Krusze-Pilawa	56.6	3	Partial upgrade (ERTMS/train length/restrictions)	Future diversionary line after Warszawa-Warka-Radom line upgrade. Planned/ongoing project on the section.	Long	-	Moderate cost, moderate complexity.
Podłęże-Podłęże R 201	2.5	3	Partial upgrade (ERTMS/train length/restrictions)	Planned/ongoing project on the section.	Long	-	Moderate cost, moderate complexity.
Sosnowiec Maczki-Jaworzno Szczakowa	1.3	3	Partial upgrade (ERTMS/train length/restrictions)	Planned/ongoing project on the section.	Long	-	Moderate cost, moderate complexity.
Bukowno-Jaworzno Szczakowa	11.7	3	Major reconstruction/upgrade to comply TEN-T	Planned/ongoing project on the section.	Long	-	High cost, complex content.
Warszawa Główna Towarowa-Warszawa Aleje Jerozolimskie	2.7	3	Major reconstruction/upgrade to comply TEN-T	Future diversionary line after Warszawa-Warka-Radom line upgrade. Planned/ongoing project on the section.	Long	Warszawa	High cost, complex content. Intervention should consider node requirements
Raciborowice-Dłubnia	1.0	3	Major reconstruction/upgrade to comply TEN-T	Planned/ongoing project on the section.	Long	-	High cost, complex content.

** the marked sections, being part of the future principal line, can be scheduled in short-medium term to complete the principal network of RFC Amber

Table 52: Interventions on the RFC Amber lowest priority sections (Poland)

Slovak Republic

On the network of the Slovak Republic, the overall priority is slightly lower than the average on RFC Amber. Cause is that, although the section relevance is high at the most important branches of the corridor (they are TEN-T lines having high traffic), the TEN-T compliance (the compound index) is relative good compared to lines in other countries.

Section of highest priority:

Section	Length (km)	Intervention priority group	Type of intervention	Intervention comment	Intervention time frame	Urban node	Feasibility
Košice-Michaľany	47.9	1	Partial upgrade (ERTMS/train length/restrictions)	Planned/ongoing project on the section.	Short-medium	-	Moderate cost, moderate complexity.

Table 53: Interventions on the RFC Amber highest priority sections (Slovak Republic)

Group of the sections of medium priority:

Section	Length (km)	Intervention priority group	Type of intervention	Intervention comment	Intervention time frame	Urban node	Feasibility
Michaľany-Slovenské Nové Mesto	13.8	2	Partial upgrade (ERTMS/train length/restrictions)		Short-medium	-	Moderate cost, moderate complexity.
Bratislava východ-Bratislava Predmestie	1.2	2	Partial upgrade (ERTMS/train length/restrictions)		Short-medium	Bratislava	Moderate cost, complex content. Intervention should consider node requirements
Krásno nad Kysucou-Čadca	10.0	2	Partial upgrade (ERTMS/train length/restrictions)	Planned/ongoing project on the section.	Short-medium	-	Moderate cost, moderate complexity.
Szob (state border)-Štúrovo	13.8	2	Partial upgrade (ERTMS/train length/restrictions)		Short-medium	-	Moderate cost, complex content. Intervention should consider border crossing capacity increasing
Bratislava Petržalka-Rajka (state border)	14.7	2	Partial upgrade (ERTMS/train length/restrictions)	Planned/ongoing project on the section.	Short-medium	Bratislava	Moderate cost, complex content. Intervention should consider node requirements and also the border crossing capacity increasing.

Section	Length (km)	Intervention priority group	Type of intervention	Intervention comment	Intervention time frame	Urban node	Feasibility
Štúrovo-Nové Zámky	44.2	2	Partial upgrade (ERTMS/train length/restrictions)		Short-medium	-	Moderate cost, moderate complexity.
Nové Zámky-Palárikovo	10.0	2	Partial upgrade (ERTMS/train length/restrictions)		Short-medium	-	Moderate cost, moderate complexity.
Palárikovo-Galanta	32.3	2	Partial upgrade (ERTMS/train length/restrictions)		Short-medium	-	Moderate cost, moderate complexity.
Púchov-Žilina	44.2	2	Partial upgrade (ERTMS/train length/restrictions)	Planned/ongoing project on the section.	Short-medium	-	Moderate cost, moderate complexity.
Púchov-Trenčianska Teplá	26.8	2	Partial upgrade (ERTMS/train length/restrictions)		Short-medium	-	Moderate cost, moderate complexity.
Trenčianska Teplá-Trenčín	7.5	2	Partial upgrade (ERTMS/train length/restrictions)		Short-medium	-	Moderate cost, moderate complexity.
Trenčín-Nové Mesto nad Váhom	24.7	2	Partial upgrade (ERTMS/train length/restrictions)		Short-medium	-	Moderate cost, moderate complexity.
Leopoldov-Trnava	17.5	2	Partial upgrade (ERTMS/train length/restrictions)		Short-medium	-	Moderate cost, moderate complexity.
Trnava-Bratislava Rača	38.9	2	Partial upgrade (ERTMS/train length/restrictions)		Short-medium	-	Moderate cost, moderate complexity.
Žilina-Krásno nad Kysucou	19.3	2	Partial upgrade (ERTMS/train length/restrictions)	Planned/ongoing project on the section.	Short-medium	-	Moderate cost, moderate complexity.
Nové Mesto nad Váhom-Leopoldov	35.5	2	Partial upgrade (ERTMS/train length/restrictions)		Short-medium	-	Moderate cost, moderate complexity.
Dunajská Streda-Bratislava Nové Mesto	38.9	2*	Capacity enhancement & major reconstruction/upgrade to comply TSI	Electrification is needed. Planned/ongoing project on the section.	Short-medium	Bratislava	High cost, complex content. Intervention should consider node requirements

Section	Length (km)	Intervention priority group	Type of intervention	Intervention comment	Intervention time frame	Urban node	Feasibility
Komárno-Dunajská Streda	53.1	2*	Capacity enhancement & major reconstruction/upgrade to comply TEN-T	Electrification is needed. Planned/ongoing project on the section.	Short-medium	-	High cost, complex content.
Skalité-Zwardoň (state border)	6.7	2	Partial upgrade (ERTMS/train length/restrictions)	Planned/ongoing project on the section.	Short-medium	-	Moderate cost, complex content. Intervention should consider border crossing capacity increasing
Čadca-Skalité	13.5	2	Partial upgrade (ERTMS/train length/restrictions)	Planned/ongoing project on the section.	Short-medium	-	Moderate cost, moderate complexity.

* those sections that got higher intervention priority because of capacity shortage

Table 54: Interventions on the RFC Amber medium priority sections (Slovak Republic)

Group of the sections of lowest priority:

Section	Length (km)	Intervention priority group	Type of intervention	Intervention comment	Intervention time frame	Urban node	Feasibility
Prešov-Kysak	16.8	3	Partial upgrade (ERTMS/train length/restrictions)	Planned/ongoing project on the section.	Long	-	Moderate cost, moderate complexity.
Muszyna (state border)-Plaveč	6.8	3	Partial upgrade (ERTMS/train length/restrictions)		Long	-	Moderate cost, complex content. Intervention should consider border crossing capacity increasing
Plaveč-Prešov	54.7	3	Partial upgrade (ERTMS/train length/restrictions)		Long	-	Moderate cost, moderate complexity.
Slovenské Nové Mesto-Satoraljaújhely (state border)	1.4	3	Partial upgrade (ERTMS/train length/restrictions)	Electrification is needed.	Long	-	Moderate cost, complex content. Intervention should consider border crossing capacity increasing
Komárom (state border)-Komárno	8.7	3	Partial upgrade (ERTMS/train length/restrictions)	Planned/ongoing project on the section.	Long	-	Moderate cost, complex content. Intervention should consider border crossing capacity increasing
Komárno-Nové Zámky	24.7	3	Partial upgrade (ERTMS/train length/restrictions)	Planned/ongoing project on the section.	Long	-	Moderate cost, moderate complexity.

Section	Length (km)	Intervention priority group	Type of intervention	Intervention comment	Intervention time frame	Urban node	Feasibility
Bratislava východ-Bratislava Predmestie1	2.4	3	Partial upgrade (ERTMS/train length/restrictions)	0	Long	Bratislava	Moderate cost, complex content. Intervention should consider node requirements
Hidasnémeti (state border)-Barca	18.2	3	Partial upgrade (ERTMS/train length/restrictions)	0	Long	-	Moderate cost, complex content. Intervention should consider border crossing capacity increasing
Leopoldov-Galanta	29.7	3	Partial upgrade (ERTMS/train length/restrictions)	0	Long	-	Moderate cost, moderate complexity.
Bratislava Predmestie-Bratislava Petržalka	14.2	3	Partial upgrade (ERTMS/train length/restrictions)	Planned/ongoing project on the section.	Long	Bratislava	Moderate cost, complex content. Intervention should consider node requirements
Kysacká spojka	1.0	3	Partial upgrade (ERTMS/train length/restrictions)	0	Long	-	Moderate cost, moderate complexity.
Orlovská spojka	0.9	3	Partial upgrade (ERTMS/train length/restrictions)	0	Long	-	Moderate cost, moderate complexity.
Bratislava Rača-Bratislava východ	1.9	3	Partial upgrade (ERTMS/train length/restrictions)	0	Long	Bratislava	Moderate cost, complex content. Intervention should consider node requirements
Košice-Kysak	15.6	3	Partial upgrade (ERTMS/train length/restrictions)	Planned/ongoing project on the section.	Short-medium	-	Moderate cost, moderate complexity.
Barca-Košice nákl.stanica	4.6	3	Partial upgrade (ERTMS/train length/restrictions)	0	Long	-	Moderate cost, moderate complexity.

Table 55: Interventions on the RFC Amber lowest priority sections (Slovak Republic)

Even though it is on diversionary line, it would be important to electrify the short diesel link at the Slovenské Nové Mesto-Sátoraljaújhely border crossing in short term. Similar case is on the Bratislava-Dunajská Streda-Komárno connecting line where the investment would be much costy due to its length (but electrification may not be connected to full upgrade that TEN-T compliance requires).

Hungary

Group of the sections of highest priority:

Section	Length (km)	Intervention priority group	Type of intervention	Intervention comment	Intervention time frame	Urban node	Feasibility
Kőbánya felső-Rákos elágazás	2.3	1	Capacity enhancement & major reconstruction/upgrade to comply TEN-T	Planned/ongoing project on the section.	Short-medium	Budapest	High cost, complex content. Intervention should consider node requirements
Kelenföld-Ferencváros	5.9	1	Capacity enhancement & major reconstruction/upgrade to comply TEN-T	Planned/ongoing project on the section.	Short-medium	Budapest	High cost, complex content. Intervention should consider node requirements
Rákosrendező elágazás-Rákospalota-Újpest	2.3	1	Major reconstruction/upgrade to comply TEN-T	Planned/ongoing project on the section.	Short-medium	Budapest	High cost, complex content. Intervention should consider node requirements
Ferencváros-Kőbánya felső	4.6	1	Major reconstruction/upgrade to comply TEN-T	Planned/ongoing project on the section.	Short-medium	Budapest	High cost, complex content. Intervention should consider node requirements
Kiskunhalas-Kelebia	28.9	1	Major reconstruction/upgrade to comply TEN-T	Planned/ongoing project on the section.	Short-medium	-	High cost, complex content.
Kelebia-Subotica (state border)	3.1	1	Major reconstruction/upgrade to comply TEN-T	Planned/ongoing project on the section.	Short-medium	-	High cost, complex content. Intervention should consider border crossing capacity increasing
Hatvan-Vámosgyörk	20.8	1	Major reconstruction/upgrade to comply TEN-T	Planned/ongoing project on the section.	Short-medium	-	High cost, complex content.
Vámosgyörk-Füzesabony	37.7	1	Major reconstruction/upgrade to comply TEN-T	Planned/ongoing project on the section.	Short-medium	-	High cost, complex content.
Füzesabony-Miskolc-Tiszai	57.2	1	Major reconstruction/upgrade to comply TEN-T	Planned/ongoing project on the section.	Short-medium	-	High cost, complex content.
Miskolc-Tiszai-Felsőzsolca	4.6	1	Major reconstruction/upgrade to comply TEN-T	Planned/ongoing project on the section.	Short-medium	-	High cost, complex content.
Rákospalota-Újpest-Vác	25.6	1	Major reconstruction/upgrade to comply TEN-T	Planned/ongoing project on the section.	Short-medium	-	High cost, complex content. Intervention should consider node requirements

Section	Length (km)	Intervention priority group	Type of intervention	Intervention comment	Intervention time frame	Urban node	Feasibility
Abony elágazás-Paládicspuszta elágazás	23.5	1	Major reconstruction/upgrade to comply TEN-T	0	Short-medium	-	High cost, complex content.
Vác-Štúrovo (state border)	30.4	1	Major reconstruction/upgrade to comply TEN-T	Planned/ongoing project on the section.	Short-medium	-	High cost, complex content. Intervention should consider border crossing capacity increasing
Vasvár-Pácsony	10.1	1	Major reconstruction/upgrade to comply TEN-T	Planned/ongoing project on the section.	Short-medium	-	High cost, complex content
Angyalföldi elágazás-Rákosrendező elágazás	1.0	1	Major reconstruction/upgrade to comply TEN-T	Planned/ongoing project on the section.	Short-medium	Budapest	High cost, complex content. Intervention should consider node requirements
Kőbánya felső-Rákos	3.1	1	Major reconstruction/upgrade to comply TEN-T	Planned/ongoing project on the section.	Short-medium	Budapest	High cost, complex content. Intervention should consider node requirements

Table 56: Interventions on the RFC Amber highest priority sections (Hungary)

Group of the sections of medium priority:

Section	Length (km)	Intervention priority group	Type of intervention	Intervention comment	Intervention time frame	Urban node	Feasibility
Budaörs-Kelenföld	5.6	2	Capacity enhancement & major reconstruction/upgrade to comply TSI	Planned/ongoing project on the section.	Short-medium	Budapest	High cost, complex content. Intervention should consider node requirements
Hodoš (state border)-Őriszentpéter	6.1	2	Capacity enhancement & partial upgrade (ERTMS/train length/restrictions)	Planned/ongoing project on the section.	Short-medium	-	Moderate cost, complex content. Intervention should consider border crossing capacity increasing
Őriszentpéter-Zalalövő	12.6	2	Capacity enhancement & partial upgrade (ERTMS/train length/restrictions)	Planned/ongoing project on the section.	Short-medium	-	Moderate cost, complex content.

Section	Length (km)	Intervention priority group	Type of intervention	Intervention comment	Intervention time frame	Urban node	Feasibility
Zalaszentiván elágazás-Zalaszentiván	4.7	2	Capacity enhancement & partial upgrade (ERTMS/train length/restrictions)	Planned/ongoing project on the section.	Short-medium	-	Moderate cost, complex content.
Zalalövő-Andráshida elágazás	20.8	2	Capacity enhancement & partial upgrade (ERTMS/train length/restrictions)	Planned/ongoing project on the section.	Short-medium	-	Moderate cost, complex content.
Ferencváros-Soroksári út	1.8	2	Partial upgrade (ERTMS/train length/restrictions)	Planned/ongoing project on the section.	Short-medium	Budapest	Moderate cost, complex content. Intervention should consider node requirements
Soroksári út-Soroksár	7.1	2	Partial upgrade (ERTMS/train length/restrictions)	Planned/ongoing project on the section.	Short-medium	Budapest	Moderate cost, complex content. Intervention should consider node requirements
Tata-Budaörs	62.8	2	Partial upgrade (ERTMS/train length/restrictions)	Planned/ongoing project on the section.	Short-medium	-	Moderate cost, moderate complexity.
Komárom-Tata	20.0	2	Partial upgrade (ERTMS/train length/restrictions)	Planned/ongoing project on the section.	Short-medium	-	Moderate cost, moderate complexity.
Rákos-Hatvan	58.5	2	Partial upgrade (ERTMS/train length/restrictions)	Planned/ongoing project on the section.	Short-medium	-	Moderate cost, moderate complexity.
Győr-Komárom	37.3	2	Partial upgrade (ERTMS/train length/restrictions)	Planned/ongoing project on the section.	Short-medium	-	Moderate cost, moderate complexity.
Sopron-Rendező-Harka	3.0	2*	Capacity enhancement & major reconstruction/upgrade to comply TSI	High gradient can be eliminated locally. Planned/ongoing project on the section.	Short-medium	-	High cost, complex content.
Sopron-Rendező-Pinnye	17.2	2*	Capacity enhancement & major reconstruction/upgrade to comply TSI	Planned/ongoing project on the section.	Short-medium	-	High cost, complex content.

Section	Length (km)	Intervention priority group	Type of intervention	Intervention comment	Intervention time frame	Urban node	Feasibility
Fertőszentmiklós-Petőháza	2.2	2*	Capacity enhancement & major reconstruction/upgrade to comply TSI	Planned/ongoing project on the section.	Short-medium	-	High cost, complex content.
Pinnye-Fertőszentmiklós	6.9	2*	Capacity enhancement & partial upgrade (ERTMS/train length/restrictions)	Planned/ongoing project on the section.	Short-medium	-	Moderate cost, complex content.
Petőháza-Győr	58.1	2*	Capacity enhancement & major reconstruction/upgrade to comply TEN-T	Planned/ongoing project on the section.	Short-medium	-	High cost, complex content.
Újszászi elágazás-Paládicspuszta elágazás	1.1	2	Major reconstruction/upgrade to comply TEN-T		Short-medium	-	High cost, complex content.
Egervár-Vasboldogasszony-Zalaszentiván	7.5	2	Major reconstruction/upgrade to comply TEN-T	Planned/ongoing project on the section.	Short-medium	-	High cost, complex content
Szombathely-Vasvár	23.9	2	Major reconstruction/upgrade to comply TEN-T	Planned/ongoing project on the section.	Short-medium	-	High cost, complex content
Hegyeshalom-Porpác	94.4	2	Major reconstruction/upgrade to comply TEN-T	Planned/ongoing project on the section.	Short-medium	-	High cost, complex content
Porpác-Szombathely	16.7	2	Major reconstruction/upgrade to comply TEN-T	Planned/ongoing project on the section.	Short-medium	-	High cost, complex content
Pácsony-Egervár-Vasboldogasszony	8.7	2	Major reconstruction/upgrade to comply TEN-T	Planned/ongoing project on the section.	Short-medium	-	High cost, complex content
Rákos-Rákos-elágazás	1.4	2*	Capacity enhancement & major reconstruction/upgrade to comply TEN-T	Planned/ongoing project on the section.	Short-medium	Budapest	High cost, complex content. Intervention should consider node requirements

Section	Length (km)	Intervention priority group	Type of intervention	Intervention comment	Intervention time frame	Urban node	Feasibility
Balotaszállás elágazás-Harkakötöny elágazás	1.7	2	Major reconstruction/upgrade to comply TEN-T	Planned/ongoing project on the section.	Short-medium	-	High cost, complex content.
Sátoraljaújhely-Slovenské Nové Mesto (state border)	0.5	2	Partial upgrade (ERTMS/train length/restrictions)	Electrification is needed.	Short-medium	-	Moderate cost, complex content. Intervention should consider border crossing capacity increasing
Hatvan A elágazás-Hatvan D elágazás	3.8	2	Major reconstruction/upgrade to comply TEN-T	Planned/ongoing project on the section.	Short-medium	-	High cost, complex content.
Andráshida elágazás-Zalaszentiván elágazás	3.4	2*	Capacity enhancement & partial upgrade (ERTMS/train length/restrictions)	Planned/ongoing project on the section.	Short-medium	-	Moderate cost, complex content.
Kunszentmiklós-Tass-Kiskunhalas	73.5	2	Major reconstruction/upgrade to comply TEN-T	Planned/ongoing project on the section.	Short-medium	-	High cost, complex content.
Felsőzsolca-Felsőzsolca-elág	0.9	2	Major reconstruction/upgrade to comply TEN-T	Planned/ongoing project on the section.	Short-medium	-	High cost, complex content.
Rákos elágazás-Angyalföldi elágazás	6.4	2	Major reconstruction/upgrade to comply TEN-T	Planned/ongoing project on the section.	Short-medium	Budapest	High cost, complex content. Intervention should consider node requirements
Soroksár-Kunszentmiklós-Tass	44.6	2	Major reconstruction/upgrade to comply TEN-T	Planned/ongoing project on the section.	Short-medium	-	High cost, complex content.
Újszász-Újszászi elágazás	13.4	2	Major reconstruction/upgrade to comply TEN-T		Short-medium	-	High cost, complex content.
Rusovce (state border)-Hegyeshalom	15.8	2	Major reconstruction/upgrade to comply TEN-T	Planned/ongoing project on the section.	Short-medium	-	High cost, complex content. Intervention should consider border crossing capacity increasing

* those sections that got higher intervention priority because of capacity shortage

Table 57: Interventions on the RFC Amber medium priority sections (Hungary)

Group of the sections of lowest priority:

Section	Length (km)	Intervention priority group	Type of intervention	Intervention comment	Intervention time frame	Urban node	Feasibility
Hatvan-Újszász	52.0	3	Major reconstruction/upgrade to comply TEN-T		Long	-	High cost, complex content.
Komárom-Komárno (state border)	2.8	3	Major reconstruction/upgrade to comply TEN-T	Planned/ongoing project on the section.	Long	-	High cost, complex content. Intervention should consider border crossing capacity increasing
Felsőzsolca-Mezőzombor	37.5	3	Partial upgrade (ERTMS/train length/restrictions)	Planned/ongoing project on the section.	Short-medium	-	Moderate cost, moderate complexity.
Mezőzombor-Mezőzombor kiág	1.2	3	Partial upgrade (ERTMS/train length/restrictions)	Planned/ongoing project on the section.	Short-medium	-	Moderate cost, moderate complexity.
Városföld-Kiskunfélegyháza	13.7	3	Major reconstruction/upgrade to comply TEN-T		Long	-	High cost, complex content.
Felsőzsolca-elág-Hidasnémeti	55.8	3	Partial upgrade (ERTMS/train length/restrictions)	Planned/ongoing project on the section.	Long	-	Moderate cost, moderate complexity.
Hidasnémeti-Kechnec (state border)	3.2	3	Partial upgrade (ERTMS/train length/restrictions)	Planned/ongoing project on the section.	Long	-	Moderate cost, complex content. Intervention should consider border crossing capacity increasing
Nyársapát elágazás-Városföld	42.4	3	Partial upgrade (ERTMS/train length/restrictions)		Long	-	Moderate cost, moderate complexity.
Harka-Szombathely	57.1	3	Partial upgrade (ERTMS/train length/restrictions)	Planned/ongoing project on the section.	Long	-	Moderate cost, moderate complexity.
Hatvan B elágazás-Hatvan C elágazás	1.1	3	Major reconstruction/upgrade to comply TEN-T	Planned/ongoing project on the section.	Long	-	High cost, complex content.
Szolnok A elágazás-Szolnok-Rendező	5.2	3	Major reconstruction/upgrade to comply TEN-T		Long	-	High cost, complex content.
Szolnok B elágazás-Szolnok-Rendező	3.6	3	Major reconstruction/upgrade to comply TEN-T		Long	-	High cost, complex content.

Section	Length (km)	Intervention priority group	Type of intervention	Intervention comment	Intervention time frame	Urban node	Feasibility
Szolnok C elágazás-Szolnok-Rendező	2.4	3	Major reconstruction/upgrade to comply TEN-T		Long	-	High cost, complex content.
Nyársapát elágazás-Abony elágazás	1.2	3	Major reconstruction/upgrade to comply TEN-T		Long	-	High cost, complex content.
Szolnok D elágazás-Szolnok-Rendező	3.9	3	Major reconstruction/upgrade to comply TEN-T		Long	-	High cost, complex content.
Kiskunhalas-Kiskunfélegyháza	45.7	3	Major reconstruction/upgrade to comply TEN-T	Planned/ongoing project on the section.	Long	-	High cost, complex content.
Mezőzombor kiág-Sárospatak	30.3	3	Partial upgrade (ERTMS/train length/restrictions)		Long	-	Moderate cost, moderate complexity.
Sárospatak-Sátoraljaújhely	9.6	3	Partial upgrade (ERTMS/train length/restrictions)		Long	-	Moderate cost, moderate complexity.

Table 58: Interventions on the RFC Amber lowest priority sections (Hungary)

Even though it is on diversionary line, it would be important to electrify the short diesel link at the Slovenské Nové Mesto-Sátoraljaújhely border crossing in short term.

Slovenia

Group of the sections of highest priority:

Section	Length (km)	Intervention priority group	Type of intervention	Intervention comment	Intervention time frame	Urban node	Feasibility
Divača-Koper	48.0	1	Capacity enhancement & major reconstruction/upgrade to comply TSI	Planned/ongoing project on the section.	Short-medium	-	High cost, complex content.
Ljubljana-Divača	103.7	1	Capacity enhancement & partial upgrade (ERTMS/train length/restrictions)	Planned/ongoing project on the section.	Short-medium	Ljubljana	Moderate cost, complex content. Intervention should consider node requirements
Zidani Most-Pragersko	73.2	1	Capacity enhancement & partial upgrade (ERTMS/train length/restrictions)	Planned/ongoing project on the section.	Short-medium	-	Moderate cost, complex content.
Zidani Most-Ljubljana	63.9	1	Capacity enhancement & partial upgrade (ERTMS/train length/restrictions)	Planned/ongoing project on the section.	Short-medium	Ljubljana	Moderate cost, complex content. Intervention should consider node requirements
Ljubljana-Novo mesto	76.0	1*	Capacity enhancement & major reconstruction/upgrade to comply TEN-T	Electrification is needed. Planned/ongoing project on the section.	Short-medium	Ljubljana	High cost, complex content. Intervention should consider node requirements
Celje-Velenje	38.0	1*	Capacity enhancement & major reconstruction/upgrade to comply TEN-T	Electrification is needed. Planned/ongoing project on the section.	Short-medium	-	High cost, complex content.

* those sections that got higher intervention priority because of capacity shortage

Table 59: Interventions on the RFC Amber highest priority sections (Slovenia)

Group of the sections of medium priority:

Section	Length (km)	Intervention priority group	Type of intervention	Intervention comment	Intervention time frame	Urban node	Feasibility
Ormož-Hodoš	69.2	2	Capacity enhancement & partial upgrade (ERTMS/train length/restrictions)	Planned/ongoing project on the section.	Short-medium	-	Moderate cost, complex content.
Pragersko-Ormož	40.3	2	Capacity enhancement & partial upgrade (ERTMS/train length/restrictions)	Planned/ongoing project on the section.	Short-medium	-	Moderate cost, complex content.

Table 60: Interventions on the RFC Amber medium priority sections (Slovenia)

Even though they are connecting lines, it would be important to electrify the Ljubljana-Novo mesto and the Celje-Velenje lines (but electrification may not be connected to full upgrade that TEN-T compliance requires).

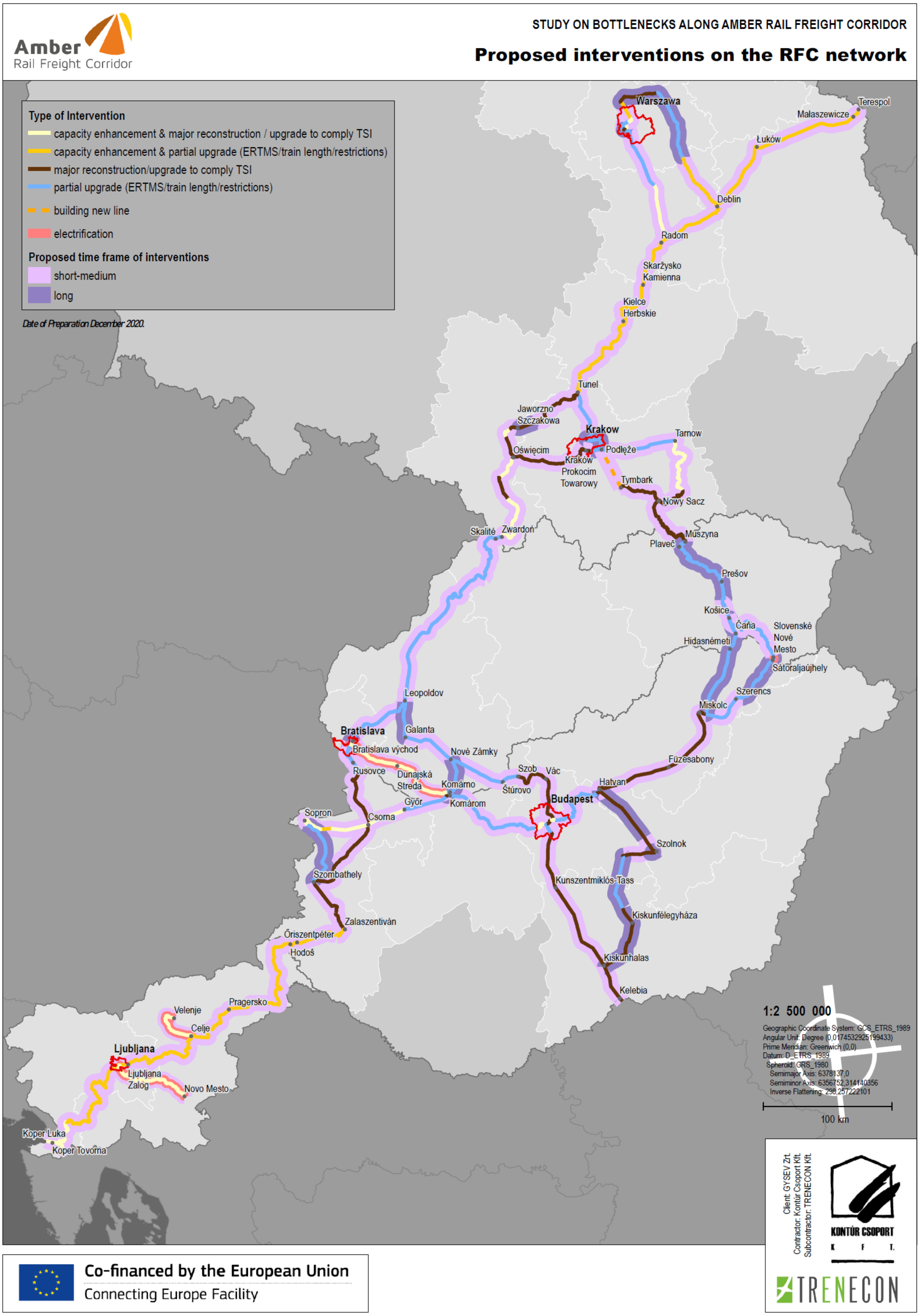


Figure 49: Type and time frame of the proposed RFC Amber line infrastructure interventions

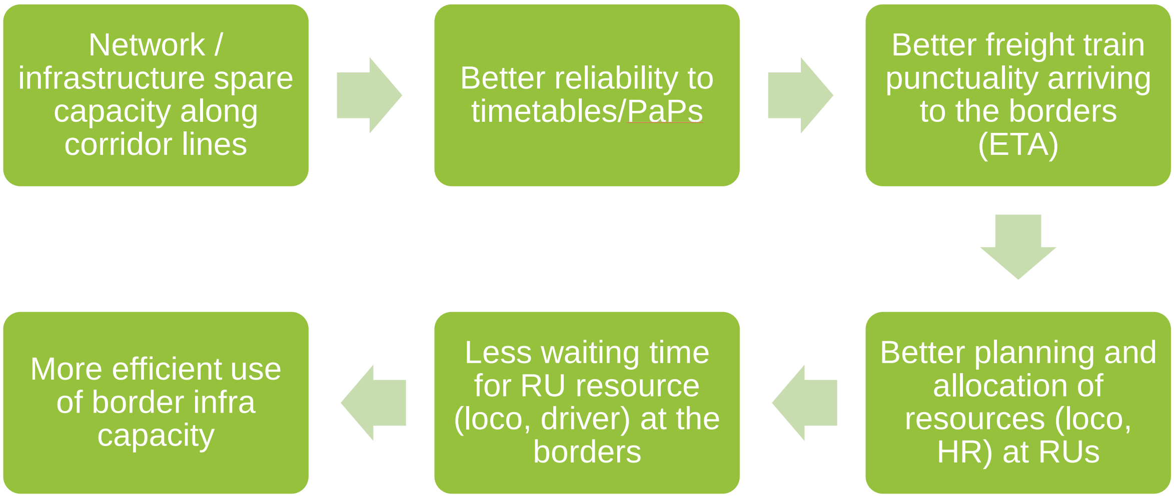
9.2.5 Station and border station developments

To ensure appropriate capacity and higher flexibility of traffic management along the whole network, stations having (>740m long) freight train tracks have important role.

All line capacity increasing and upgrading investments should increase the number of 740m long freight train tracks (currently it is prevalent that such tracks are ceased along the TEN-T corridors if the project development focuses on passenger train capacities and demand). At appropriate density on the network there should be such station, having more than one dedicated freight train tracks.

It is also important that new track connections can substitute station developments or expansions, e.g. new delta tracks at Zalaszentiván, Komárno and Komárom, Bratislava etc. can ease the operation in the neighbouring stations (that are border crossings in the case of Komárno-Komárom).

The waiting or transfer time at the borders or also the processing or train handling times at marshalling yards are result of complex impacts. At these points, interdependence is the highest with other aspects of RFC operation. The operation, capacity and reliability of the overall RFC is in close interaction with border efficiency:



Consequently, border station developments are proposed to be planned and assessed considering the complex impacts on its efficiency and operation. The infrastructure capacity extension might not be the most cost-efficient intervention when it comes to shorten the waiting times at the border crossing stations.

The following table lists the proposed interventions at major service points of RFC Amber, the marshalling, shunting yards, and the border crossings. Due to the overlapping rail freight corridors, interventions and investments should be consulted and agreed with other RFCs. The findings of other RFCs' working groups or analyses, e.g. the RFC border crossing task forces, can be the basis of RFC Amber intervention proposals where available.

High priority interventions at locations where capacity shortage is present and traffic or network importance of the station is high:

Name / location	Country	Station type	No. of electrified >740m tracks	Handover / not handover border station	Average waiting time at border station	Capacity	Proposed intervention
Skalité	SK	border station	1	handover	n.a.	no significant capacity issue	number and length of station tracks should be increased to meet traffic demand
Győr-Rendező	HU	marshalling/shunting yard	6			capacity problems	node, station capacity enhancement, number and length of station tracks should be increased to meet traffic demand
Komárom-Rendező	HU	marshalling/shunting yard	2			capacity problems	node, station capacity enhancement, number and length of station tracks should be increased to meet traffic demand
Koper Luka	SL	station serves port	1			capacity problems	node, station capacity enhancement & number and length of station tracks should be increased, infrastructure upgrade is needed to meet traffic demand
Koper Tovorna	SL	marshalling/shunting yard	4			capacity problems	node, station capacity enhancement, number and length of station tracks should be increased, infrastructure upgrade is needed to meet traffic demand
Terespol	PL	border station	0	not handover	n.a.	capacity problems	node, station capacity enhancement, number and length of station tracks should be increased to meet traffic demand
Žilina Teplička	SK	marshalling/shunting yard	6			capacity problems	node, station capacity enhancement - Žilina node is under development, incl. Teplička
Ferencváros-Rendező	HU	marshalling/shunting yard	16			no significant capacity issue	minor infrastructure interventions could further increase capacity - developments should be in line with Node Study
Małaszewicze	PL	marshalling/shunting yard	10			capacity problems	node, station capacity enhancement
Skarżysko Kamienna	PL	marshalling/shunting yard	7			capacity problems	node, station capacity enhancement

Name / location	Country	Station type	No. of electrified >740m tracks	Handover / not handover border station	Average waiting time at border station	Capacity	Proposed intervention
Tarnów Filia	PL	marshalling/shunting yard	10			capacity problems	node, station capacity enhancement
Rajka	HU	border station	8	handover	285’	capacity problems	node, station capacity enhancement, reduction of waiting time
Štúrovo	SK	marshalling/shunting yard, border station	19	handover	265’	capacity problems	node, station capacity enhancement, reduction of waiting time
Komárom	HU	border station	0	handover	199’	capacity problems	node, station capacity enhancement, number and length of station tracks should be increased to meet traffic demand (harmonised with Komárom-Rendező interventions), reduction of waiting time, intervention to avoid direction change (Győr-Komárno direction)
Komárno*	SK	border station	4	not handover	n.a.	no significant capacity issue	intervention to avoid direction change (Komárom – Dunajská Streda direction)
Ljubljana	SL	junction	0			capacity problems	node, station capacity enhancement, number and length of station tracks should be increased to meet traffic demand, intervention to avoid direction change (Ljubljana-Novo mesto direction) if traffic requires in the future - developments should be in line with Node Study
Pragersko	SL	junction	3			capacity problems	node, station capacity enhancement, infrastructure upgrade to increase available capacity
Zalaszentiván	HU	junction	2			no significant capacity issue	intervention to avoid direction change (Őriszentpéter – Szombathely direction)

** at Komárno, new triangle track has high priority, other interventions mentioned with medium priority, see next table*

Table 61. Interventions of high priority locations (stations, nodes, junctions) along RFC Amber

Medium priority locations, where capacity shortage is present and traffic role is medium:

Name / location	Country	Station type	No. of electrified >740m tracks	Handover / not handover border station	Average waiting time at border station	Capacity	Proposed intervention
Hodoš	SL	border station	1	handover	70’	no significant capacity issue	sufficient capacity, investments concluded, further works can be assessed to increase long station track availability
Ljubljana Zalog	SL	marshalling/shunting yard	1			no significant capacity issue	number and length of station tracks should be increased to meet traffic demand - developments should be in line with Node Study
Muszyna	PL	border station	0	handover	n.a.	no significant capacity issue	number and length of station tracks should be increased to meet traffic demand
Plaveč	SK	border station	1	not handover	n.a.	no significant capacity issue	number and length of station tracks should be increased to meet traffic demand
Prešov	SK	marshalling/shunting yard	0			no significant capacity issue	number and length of station tracks should be increased to meet traffic demand
Zwardoń	PL	border station	0	not handover	n.a.	no significant capacity issue	number and length of station tracks should be increased to meet traffic demand
Čaňa	SK	border station	0	not handover	n.a.	capacity problems	node, station capacity enhancement, number and length of station tracks should be increased to meet traffic demand
Szombathely-Rendező	HU	marshalling/shunting yard	1			capacity problems	node, station capacity enhancement, number and length of station tracks should be increased to meet traffic demand
Košice	SK	marshalling/shunting yard	9			no significant capacity issue	minor infrastructure interventions could further increase capacity
Kraków Nowa Huta	PL	marshalling/shunting yard	28			no significant capacity issue	minor infrastructure interventions could further increase capacity
Kraków Prokocim Towarowy	PL	marshalling/shunting yard	18			no significant capacity issue	minor infrastructure interventions could further increase capacity

Name / location	Country	Station type	No. of electrified >740m tracks	Handover / not handover border station	Average waiting time at border station	Capacity	Proposed intervention
Miskolc-Rendező	HU	marshalling/shunting yard	14			no significant capacity issue	minor infrastructure interventions could further increase capacity
Warszawa Praga	PL	marshalling/shunting yard	19			no significant capacity issue	minor infrastructure interventions could further increase capacity - developments should be in line with Node Study
Szolnok-Rendező	HU	marshalling/shunting yard	17			no significant capacity issue	sufficient capacity currently but upgrade could ease other yards' operation (e.g. yards in the Budapest Node)
Hidasnémeti	HU	border station	4	handover	381'	no significant capacity issue	reduction of waiting time
Hegyeshalom-Rendező	HU	marshalling/shunting yard	12			no significant capacity issue	investment on infrastructure completed in 2019, only minor infrastructure interventions (e.g. traction compliance with Austria)
Jaworzno Szczakowa	PL	marshalling/shunting yard	4			no significant capacity issue	minor infrastructure interventions to further increase capacity
Kielce Herbskie	PL	marshalling/shunting yard	10			no significant capacity issue	minor infrastructure interventions could further increase capacity
Komárno*	SK	border station	4	not handover	n.a.	no significant capacity issue	minor infrastructure interventions could further increase capacity (harmonised with Komárno zr.st. interventions)
Nové Zámky	SK	marshalling/shunting yard	9			no significant capacity issue	minor infrastructure interventions could further increase capacity
Őriszentpéter	HU	border station	4	not handover	37'	no significant capacity issue	node, station capacity enhancement to reduce waiting time
Bratislava Nové Mesto	SK	junction	4			no significant capacity issue	intervention to avoid direction change (Rusovce – Dunajská Streda direction) - developments should be in line with Node Study

* at Komárno, new triangle track has high priority, other interventions mentioned with medium priority, see next table

Table 62. Interventions of medium priority locations (stations, nodes, junctions) along RFC Amber

Low priority locations, where capacity shortage is not present and traffic role is also lower:

Name / location	Country	Station type	No. of electrified >740m tracks	Handover / not handover border station	Average waiting time at border station	Capacity	Proposed intervention
Celje Tovorna	SL	marshalling/shunting yard	2			no significant capacity issue	number and length of station tracks should be increased to meet traffic demand / intervention to avoid direction change, Celje-Velenje direction, is not a priority currently
Sátoraljaújhely	HU	border station	0	not handover	30’	no significant capacity issue	number and length of station tracks should be increased to meet traffic demand
Slovenské Nové Mesto	SK	border station	2	handover	n.a.	no significant capacity issue	number and length of station tracks should be increased to meet traffic demand
Bratislava východ	SK	marshalling/shunting yard	11			no significant capacity issue	minor infrastructure interventions could further increase capacity
Hatvan-Rendező	HU	marshalling/shunting yard	2			no significant capacity issue	minor infrastructure interventions could further increase capacity
Sopron-Rendező	HU	marshalling/shunting yard	5			no significant capacity issue	minor infrastructure interventions could further increase capacity, high gradient should be eliminated on the connecting track of the Sopron-Szombathely line
Soroksári út-Rendező	HU	marshalling/shunting yard	4			no significant capacity issue	minor infrastructure interventions could further increase capacity - developments should be in line with Node Study
Kelebia	HU	border station	8	not handover	545’	no significant capacity issue	reduction of waiting time
Komárno zr.st.	SK	marshalling/shunting yard	7			no significant capacity issue	minor infrastructure interventions could further increase capacity (harmonised with Komárno border station interventions)
Szob	HU	border station	3	not handover	8’	no significant capacity issue	minor infrastructure interventions could further increase capacity
Tunel	PL	junction	0			no significant capacity issue	intervention to avoid direction change (Ljubljana-Novo mesto direction) - developments should be in line with Node Study

Table 63. Interventions of lowest priority locations (stations, nodes, junctions) along RFC Amber

At the border stations, organisational, operational actions also proposed to reduce unnecessary (and probably necessary) waiting time. Better punctuality and determination of the expected time of arrival (ETA), also the lower administrative duties might reduce the overall capacity that is required for operation and higher level of service.

Additionally, border station capacities often need increasing but connection line parameters should also be developed to allow flawless traffic flow and interoperability. As mentioned in the current status assessment, significant differences are present at some locations, e.g. in the axle load at Hidasnémeti-Čaňa, Sátoraljaújhely-Slovenské Nové Mesto, Rajka-Rusovce or in maximum train length at Zwardoń-Skalité

The map below summarizes the proposals:

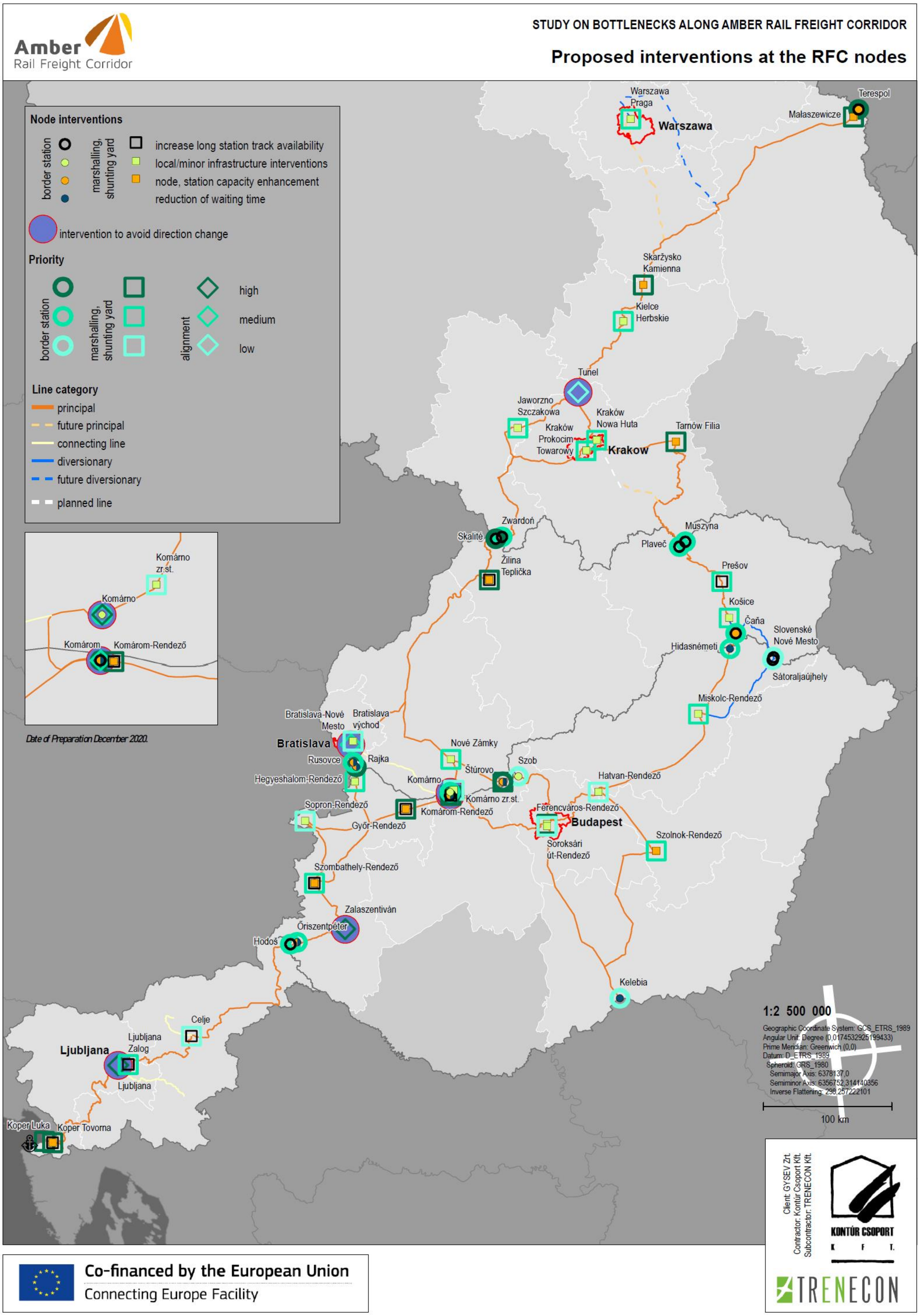


Figure 50: Type and priority of the proposed RFC Amber station infrastructure interventions

9.3 Proposed measures to improve operational & administrative bottlenecks

9.3.1 Methodology - Steps of evaluation of proposed measures

Operational and administrative issues are usually very complex and have been addressed previously by EU legislation, RNE guidelines, initiatives (e.g. Issues Logbook) and by overlapping RFCs' action programmes. Although, there is limited direct experience on RFC Amber operation – resulting in limited feedback from stakeholders, customers – Contractor identified potential issues of operational nature, categorised and assessed the operational and administrative bottlenecks (O&A bottlenecks) and engaged in discussion of potential improvement actions with stakeholders (IMs/AB, RAG) in the course of study implementation.

The approach of finding the solutions or mitigating measures best suited to improve the particular operational or administrative bottlenecks was similar to that for infrastructure (development) measures; the target conditions were set at first, then relevance of issues was assessed, measures were defined finally. Steps were as follows:

1. Setting target conditions for each bottleneck category
2. Definition of potential measures
3. Evaluation of measures based on feasibility and impact
4. Ranking and prioritisation of potential measures

STEP 1: Setting TARGET conditions

Operational/Administrative issues are grouped and the conditions to be achieved are assigned to these groups based on feedback from the most competent stakeholders, however obvious interdependencies (even with infrastructure interventions like infrastructure capacity enhancement, building parking tracks at border stations) of different types of actions contribute to the achievement of the desired conditions (e.g. max. 2 hours waiting time at borders). Target conditions are mostly defined in a descriptive manner, no exact parameters, target values can be set for improving operational efficiency and improved competitiveness of RFC. They are to be interpreted as the main criteria to motivate customer choice of RFC service through increased reliability and efficiency to achieve relative competitiveness over road transport. However, achievement of the desired conditions/processes/collaboration will necessarily improve RFC Amber KPIs, so the success of potential/proposed interventions will be manifested in better indicator values.

STEP 2: Definition of potential measures

Several measures can be proposed – and were mostly discussed by the sector previously – to improve the main bottlenecks identified. Here, we identified four different types of measures in consideration of the main causes of the bottlenecks They are designed to eliminate or avoid the causes of the particular bottleneck situation that have been discussed and impacts assessed during the analysis of bottlenecks (see section above).

Potential measures can be grouped into four main categories since operational and administrative bottlenecks are attributed to different operational processes, poor collaboration, inefficient communication, application of national rules. So, application of RNE guidelines in coherence with RFC endeavours (in compliance with EU legislation), improved collaboration of stakeholders (IMs, RUs), integration of IT systems with common platforms, and harmonisation of national rules form the main categories.

Types of Potential Measures

a) Compliance with RNE guidelines on processes/procedures (TTR to consider RU requirements; demand driven capacity offer (path allocation: PaP, RC)

b) Collaboration, improve communication at handover points: trusted train, co-ordination of TCR planning

c) Ensuring interoperability of national IT tools with those promoted by RNE/consolidation of data in PCS/CIP/TIS/CIS, CCS – they contribute to more efficient capacity and traffic management through standardised, transparent exchange of information.

d) Harmonisation of national rules, processes / Concluding bilateral agreements, improved cooperation (Introduction of TAF TSI)

e) Developed commercial conditions – Performance regime

Measures were identified in consideration of general sector position and RFC efforts, RNE initiatives (projects) but mostly relying on the discussions, feedback from IMs and RAG/TAG and experience of overlapping RFCs.

Main purpose of the measures is to improve communication and collaboration, to support exchange of information (with RUs and between IMs) or to make O&A processes more efficient (higher service level at lower cost and use of human resources) either for RUs or IMs particularly at handover points (border crossings).

STEP 3: Evaluation of measures in consideration of feasibility and impact

When evaluating the potential measures targeting the improvement of the particular bottleneck, the approach of multicriteria analysis has been adopted. Several aspects have been considered either for assessing impact or feasibility.

When assessing impact of a measure in addition to the potential degree of improvement of the particular bottleneck, its assumed impact on any other O&A issue or interdependence with any other measure (joint impact, relation to infrastructure development) were considered. Similarly, in terms of feasibility the assumed magnitude of cost, resources, previous efforts (availability of RNE tools, guidelines), possible implementation timeframe, the number of stakeholders involved, and their interests were taken into account.

Three categories of impact and feasibility alike were set with scoring as follows:

Criteria category/score	1	3	5
impact	low	medium	high
feasibility	unrealistic	complex	feasible

Table 64: Scoring of impact and feasibility of O&A interventions

Each one of the measures get a total score based on the table that indicates its reasonable potential to improve RFC functionality (operational efficiency) and thus its contribution to competitive RFC service.

STEP 4: Ranking and prioritisation of potential measures

Simple and homogenous hierarchy of scoring categories were set up to ensure coherent rating. Three score ranges were identified that assign the three priority groups of interventions as follows:

Ranges for priority group	4-9	10-14	15-20
Intervention priority group	desirable	to be considered	proposed

Table 65: Scoring categories to define O&A intervention priority groups

The measures having the highest scores are assumed to be the most feasible and desirable (low cost, strong stakeholder support, maturity – RNE activity – and the highest impact), therefore they are proposed to be implemented in the first place, while the implementation of those in the second category are to be considered. The last group includes those that have either the lowest contribution to the efficiency and competitiveness of RFC Amber. (see table above), or implementation for any reason is not deemed reasonable.

The highest importance is attributed in the MCA to those potential measure that target an actual bottleneck which is perceived as strongly influencing efficient and competitive RFC functioning by the stakeholders in the questionnaire. This approach ensures that operational or administrative issues impacting RFC Amber functionality the most, earn the attention and are duly addressed in the study.

However, given the qualitative nature of the assessment it is not possible to give an exact priority list of measures or make any accurate distinction on feasibility and impact of measures in different RFC member states. It is also beyond the scope of the study to identify handover points (border crossings) where implementation of the proposed interventions is the most critical as current operational processes should have been assessed individually due to local particularities.

9.3.2 Target conditions

In general, the purpose of potential interventions is to enhance efficiency, efficient use of the infrastructure and to ensure capacity, increase competitiveness of RFC service. A qualitative description of the conditions to be achieved, the foreseen operational conditions that serve the above purpose is given under each group of operational bottlenecks as follows:

- *Capacity management:* Efficient path (PaP/RC) allocation process through competent C-OSS service; PaP parameters will better meet RU (shippers') requirements; interoperable national IT systems and PCS providing reliable data and reasonable path allocation process is in place.
- *Communication:* application of RNE tools/introduction of pre-defined TAF TSI messages, coherent train identification across borders, timely and quality information (in TIS, CIP, CID), particularly on TCRs, in the event of disturbance, TAF TSI implemented, language barriers cleared: coherent: common language is spoken at each border supported by IT platform and pre-defined messages. TIS data are up-to-date ensuring reliable train tracking. Transparent and coordinated planning of TCRs in correspondence with RNE guidelines improves efficiency of service to the benefit of RUs and IMs alike.
- *Traffic management*: Availability of real time, consolidated train information in TIS, priority of RFC trains are ensured enhancing punctuality, reliability of RFC freight service (ETA – less than 30 minutes delay), which not only improves functionality of RFC Amber but also increases efficiency of traffic management by easing operational processes of

rerouting and improving organisation of resources (loco, driver, etc.), coordination of processes at borders, bilateral agreements on trusted handover are in place, so unnecessary waiting time at borders reduces. Bilateral agreements between RUs save time of technical train check at handover points. Availability of infrastructure capacity increases which allows running of more trains, higher path speed, more efficient management.

- *Administrative issues*: National rules are harmonised (consistent safety certification, common train composition requirements, drivers' licence, authorisation), communication between RUs and IMs are on a common platform (TAF TSI compliance, common train number with reliable data in CIS and CIP enabling uniform calculation of costs to encourage multimodal transport. Waiting time drops under 2 hours at each border and congestions (blocking of tracks) ease enhancing traffic management potentials. Agreements, administrative measures at gateway stations to third countries result in simpler, reasonable border procedures to encourage rail freight transport.

9.3.3 Definition of potential measures

The Sector Statement (2016) "Boosting International Rail Freight" address the issues of rail freight competitiveness, operational efficiency and capacity availability and summarised the most important actions to enhance international rail freight. The issues identified in this Study and the measures proposed are in coherence with the provisions in the Sector Statement. They are also extensively discussed and promoted by legislation and sector guidelines too.

Overall measures consisting of several individual actions to mitigate the main causes have been defined for each bottleneck as follows:

Ref. no.	Bottlenecks	Impact	Proposed measure
	1. CAPACITY MANAGEMENT		
1A	Path allocation procedure via C-OSS is inadequate (is to be aligned with market, RU expectations)	medium	Ensure resources and increase role of a competent C-OSS for path allocation and capacity planning
1B	PaP parameters and RC fail to meet market requirements	high	Enhance surveying and consideration of RU demand in PaP parameters and RC to offer competitive RFC capacity
1C	Limited applicability of the PCS and reliability of data	low	Improve applicability of the PCS and reliability of its data content
	2. COMMUNICATION		
2A	Communication difficulties at handover points, borders	high	Actions to improve communication efficiency and transparency at national borders
2B	Poorly functioning interfaces between national IT tools and the RNE tools	medium	Improve functionality and reliability of RNE Tools for RFC Amber
2C	Inadequate coordination and sharing information on capacity restrictions, disturbances	high	Interventions improving coordination in planning and sharing information on capacity restrictions, disturbances
2D	Insufficient language skills of staff	low/ medium	Improve language skills of staff and ease their communication by using standardized forms, messages with IT support
	3. TRAFFIC MANAGEMENT		
3A	Ineffective arrangements, processes at border crossings	high	Coordination and support of processes and procedures at borders

Ref. no.	Bottlenecks	Impact	Proposed measure
3B	Low reliability of RFC trains impacts competitiveness	medium	Interventions to ensure priority and increase punctuality of RFC trains
3C	Competitive re-routing, contingency measures for traffic disturbances/TCRs are not available	high	Develop efficient re-routing options, contingency for disturbances, restrictions
3D	RFC traffic management staff is not adequately prepared	low	Strengthen the role and capacity of RFC traffic management by preparing staff and exchange of experience
	4. ADMINISTRATIVE ISSUES		
4A	Cross-border interoperability difficulties due to lack of harmonisation of national rules	high	Enhance cross-border interoperability by harmonisation/elimination of national rules, requirements and use of common IT platforms
4B	Not transparent, calculable procedures and charging in case of multimodal transport	medium	Simplify procedures in the multimodal transport chains and support freight forwarders in route planning, cost calculation and path reservation
4C	Long technological times of forwarding outside the EU	medium	Harmonisation of rules and provide support to ease administrative burden

Table 66: O&A bottlenecks and measures for improvement

The potential measures in the table are interpreted in more detail with more specific actions giving a short explanation of causes and interdependencies.

Measure to enhance capacity management

Capacity management processes are regulated and declared in coherence with the Regulation (EU) 913/2010 by IMs in the Network Statements and by RFC Amber adopting the Framework for Capacity Allocation (basic requirements regarding PaPs are laid down in Article 14). RNE guidelines, handbooks are published and available to help IMs/AB setting up their own practice in a harmonised way. Also, the entire capacity management process from publishing capacity offer through approval of request (PaP, RC for ad hoc request) is supported by PCS providing a common IT platform for all stakeholders. However, it has been revealed that RFC capacity management is far from being optimal, path allocation via C-OSS fails to truly respond to market demand due to several reasons.

1A Ensure resources and increase role of a competent C-OSS for path allocation and capacity planning

C-OSS service is a major asset to a competitive RFC: customer satisfaction is very much determined by the quality of service, whether the capacity allocation process is aligned with their requirements. It requires cooperation between IMs and also with other RFCs for overlapping sections to enhance the availability and quality of capacities. To ensure added value of RFC C-OSS service, to mitigate conflicts and offer competitive products the level of co-operation in the capacity allocation process between IMs/AB and other RFCs shall be enhanced and dedicated, knowledgeable staff with the required competence and openness to exchange ideas, experience shall be deployed. Higher customer satisfaction can be ensured by extensive application of PCS for international path coordination, creating dossiers in a transparent and simple manner which can be achieved if interoperability with national systems is achieved. Also, training of staff and applicants to use PCS would contribute to a more seamless allocation, capacity management process. However, deadlines for placing path requests should be fitted better to the normal operation of RUs which is an issue addressed by RNE handbooks, TTR project or the recast of Annex VII of the Directive 2012/34/EU and is declared by FCA approved by the Management Board which declares that C-OSS experience, customer feedback, findings of annual user satisfaction survey shall be used to improve the C-OSS path allocation service. It can be claimed that the issue of capacity management via C-OSS is widely considered and guidelines are in place, however the one-stop-shop service procedure still not working up to the expectations of the applicants and can be improved to ensure higher efficiency for IMs, too.

Improved functionality of RFC, more allocated capacity via C-OSS means better coordinated, more efficient use of the infrastructure capacity which interrelates with future infrastructure enhancement needs and may mitigate infrastructure bottlenecks in Slovenia or Poland where the main capacity shortages were indicated or at border stations short of parking tracks. (interdependence with infra developments, sidings at border crossings). Future values of KPI “Ratio of capacity allocated by the C-OSS” is a good indication of the success of measures aimed at improving C-OSS service.

1B Enhance surveying and consideration of RU demand in PaP parameters and RC to offer competitive RFC capacity

National timetables, the priority of passenger trains limit the potentials of providing PaPs and reserve capacity (RCC) for international RFC trains in correspondence with market demand. Therefore, the potentials to increase the number of paths to the most frequented freight destinations and to offer flexible capacity windows for RFC trains (like in Slovenia) should be explored. Harmonisation of timetabling procedure, implementation of the redesign of international timetabling process (TTR) can ensure a focus on real market needs and could increase efficiency in terms of infrastructure capacity utilisation. It would be desirable for the functioning of RFC Amber to establish priority of RFC trains over other trains in capacity offer and allocation. Ad-hoc RFC trains should enjoy quasi preferential treatment in managing reserve capacity to ensure plenty of capacity with competitive transport time. It could result in higher punctuality of RFC trains, a more competitive service. A uniform priority concept for RFC trains in capacity allocation at EU level should be worked out and adopted. In fact, according to Directive 2001/14/EC the Network Statements include cooperation procedures in capacity allocation and set priority rules in case of conflicts on congested infrastructure – they should be tailored to better observe RFC interests.

The capacity needs of the RUs can only be duly considered in the capacity planning, timetabling process if the demand is communicated in time and timely exchange of information between stakeholders (IMS/AB) is ensured. To this end the surveying of capacity needs has to be strengthened, proactively managed, which result in a more competitive timetable construction for RFC trains and higher RU satisfaction. RFC Amber is committed to implement RNE Guidelines and fair capacity allocation and accordingly consider feedback on customer needs. The Framework for capacity allocation envisages ongoing improvement of capacity allocation based on customer feedback and RFC experience which should be consistently carried out to ensure competitive path parameters and capacity for RFC service. Current capacity management KPIs give a strong indication to make efforts for demand driven path parameters: volume of requested, pre-booked capacity, volume of requests will increase if foreseen measures are well designed.

The demand driven process of capacity allocation and competitive path parameters are interconnected, both aspects shall be improved through timely coordination between stakeholders for a competitive rail freight service which is a key endeavour of establishing and operating RFCs

1C Improve applicability of the PCS and reliability of its data content

The success and usability of the Path Co-ordination System (PCS) for international freight transport subject to the reliability and integrity of data. At present, PCS is not readily used either by the IMs or the applicants (RUs). It is because fully interoperable interfaces with national systems are not in place, therefore advantages of the single workflow cannot be taken by IMs/AB, transparency of processing status is not ensured. So, the first task should be to establish interoperability of the systems allowing for a single data input i.e. regular update of data. So, PCS should and can be the primary tool and platform for the RFC, increasing its functionality, attractivity for IMs and applicants alike. When the IT base is in place – full roll-out have been underway – a harmonised and transparent workflow based on the RNE process guidelines can be in place which ensures simpler, more efficient capacity management by C-OSS. Development of the interoperable interfaces requires funding and human resources, commitment on the part of the participating IMs to revise current processes. However, a common platform for transparent processes providing reliable data would contribute to efficiency of C-OSS and customer satisfaction.

Potential measures to improve communication

Communication difficulties between IMs and RUs in managing international freight transport, running of RFC trains, although supported by several RNE IT tools – e.g. CCS common components system, the platform for the standardised exchange of data for IMs/ RUs or, TIS, Incident Management informing IMs and RUs in case of incidents – are generated by lack of common language, poorly functioning interfaces between national systems, limited coordination procedures, failure to use pre-defined messages (adoption of TAF TSI) heavily impact functioning of RFC Amber.

2A Actions to improve communication efficiency and transparency at national borders

Application of harmonised processes and common IT platform like PCS to start with efficient and transparent capacity management could ease communication difficulties and consequently result in shorter dwelling time of international trains at borders. The current practice of assigning new path/train number at handover points to international freight trains interferes with transparent, unambiguous exchange of information, train tracking. The incoherent data in TIS discourage RUs to use the RNE tool which would otherwise contribute to efficient handover of trains at borders. So, introduction of a single path ID (or common RFC train number) could improve efficiency of processes through common use of TIS by all stakeholders. As of today, negotiations between the timetabling experts of ŽSR, MÁV, GYSEV and VPE concerning the train number domain are underway. Language barriers is less of a problem in normal traffic situation, nevertheless some member states indicated that use of a common language (not necessarily English) could ease the processes, reduce the time of handover. Staff having adequate language skills should be secured 24/7 by RUs especially in case of disturbances to reduce unnecessary waiting time and to avoid any misunderstanding that may impact traffic management. If no standardised communication procedures are in place when for example delay or rerouting of trains is to be managed the reliability of international freight service, functioning of RFC Amber suffers. It is to be encouraged to use RNE TIS incident management tool offering pre-defined and translated messages, automatic notification of users which facilitate communication, cooperation of traffic control centres. Deployment of TAF-TSI messages, compliant interfaces are vital for accurate communication of delays, arrivals, for efficient planning and operations, which has been underway and enhances efficiency at borders. Development of interoperable systems and use of TIS improves communication efficiency which favourably impacts traffic management processes and also interrelates with efficient management of administrative procedures at borders.

2B Improve functionality and reliability of RNE Tools for RFC Amber

RNE has developed several IT platforms to support international rail freight across Europe, to enhance functionality of RFCs. IT tools are envisaged to provide timely and accurate data and simplify operational processes for all RFC, so stakeholders including IMs, RUs, terminals can have common platforms that improve exchange of information, enhance efficiency of operations, quality of C-OSS service. Although, RFC Amber is committed to implement tools for efficient rail freight, currently the common IT tools like CIP, TIS, CIS, CCS for RFC Amber is not fully available or applicable. The main reason is that IMs (and other stakeholders) prefer or are required to enter and update data in national systems which are not properly integrated, linked to these IT tools to enable a single upload of data. It is not a realistic and a resource intensive scenario to require IMs/RUs or terminal operators upload data repeatedly. As a consequence, data are often not complete, not regularly updated, so prevent simple and transparent management of business processes. So, it is critical to develop interoperable interfaces that might be a costly action and IMs may not be motivated in lack of direct advantages comparable to the expenses. The RNE tools are TAF TSI compliant, business processes are uniformly applied, data exchange is based on TAF TSI format which can encourage stakeholders to integrate the systems and provide data more readily. Improved reliability of real time communication, better train management (monitoring, reporting), regularly updated information on delays, incidents or infrastructure conditions and availability of terminal services, etc. would enhance attractiveness of the IT tools enabling easier planning and transparent traffic management. Consolidation of train numbering (single path ID) would also urge RUs to use TIS for their operations. RNE efforts to apply uniform codes, to improve user platforms, making data exchange processes more accurate and transparent are also required to achieve reliable data exchange, efficient communication between stakeholders.

2C Interventions improving coordination in planning and sharing information on capacity restrictions, disturbances

Recast of Annex VII of the Directive 2012/34/EU put an obligation on IMs to coordinate TCRs and to consider the needs of the applicants when planning works, rerouting. Bilateral agreements are in place on data exchange, but it is not ensured that RFC is involved in programming works. On the other hand, coordination of works is also difficult because of uncertainties in financing. So, for the functioning of RFC Amber corridor-wide coordination of TCRs, definition of the appropriate timeline and consolidated sharing of information should be achieved. It is which is supposed to be handled through the C-OSS manager. The roll-out of RNE TCR tool will be an asset to TCR coordination, harmonisation providing the platform for sharing current information. In the TTR programme the improved reliability and stability of TCRs contribute to providing capacity in line with market needs and to higher usage of infrastructure capacity improving efficiency for IMs.
It is also important for efficiency and competitive freight service that TCRs are reliable, duration and traffic consequences are stable. Therefore, IMs should be strongly interested to fulfil agreed obligations a way of which could be to impose a compensation regime in case of non-fulfilment.

Communication procedures in case of disturbance should be in line with the RNE “Guidelines for Communication and cooperation between traffic control centres”. The procedure, the communication channel is clearly defined in CID requiring regular update messages for the duration of disturbance. So, the protocol should be followed or revised if necessary.
On the other hand, regular update of information on maintenance works, routing in CIP (which is also addressed by measure 2B above) should be automatically ensured. CIP should be a platform where RUs can get precise information on routing, re-routing options, disturbances, and projects as well.

2D Improve language skills of staff and ease their communication by using standardized forms, messages with IT support

Communication between the staff of RUs or RU and IM not speaking a common language can spoil efficient handover of trains and can lead to longer dwelling times, delays. So, efforts have been made in general to assist staff communication with IT solutions, application of standard TAF TSI compliant predefined messages in IT platforms and translation tools.

The language programme of RNE helps communication in daily operation between IMs, IMs-RUs, RUs-RUs while the staff at train control centres get English training. Such measures undoubtedly ameliorate train management contributing to resource and time savings on the part of both the IMs and RUs. So, such initiatives have to be expanded to all relevant stakeholders.

It has been revealed though that language problems are of different nature and impacts operational processes at various degrees. For example, it is less of a problem at the Slovakian-Polish border but causes difficulties at the handover points between Hungary and Slovak Republic. So, tailor-made solutions would be required to ensure the necessary language skills of staff. English training of staff (as the common language) is an option but where there is not substantial language difference, pre-defined messages can yield sufficient results. Upgraded translation tools integrated in IT platforms can be useful and adequate in daily routine but in case of any deviation certain level of language skills are required from staff.

Potential measures to improve traffic management

Effective **traffic management** of freight transport on RFC Amber (similarly to other RFCs) – in addition to infrastructure capacity constrains – is fundamentally spoiled by low priority and reliability of RFC trains particularly in case of disturbance, TCRs and also by inefficient cooperation of stakeholders at handover points. In fact, traffic management is subject to national operational rules and bilateral agreements are in place to provide for the communication and coordination between TCCs in case of any deviation from the timetable.

Adoption of RNE contingency management handbook, the roll-out of the TTR project and trusted handover of RFC trains are expected to improve competitiveness RFC Amber service. RFC MB is also required by the regulation to put in place procedures for coordinating traffic management which ease current pitfalls.

3A Coordination and support of processes and procedures at borders

The handover of international trains at borders involves several procedures and technological processes which can be time consuming heavily impacting path speed, performance and efficiency. In addition to efficient communication dwelling time can be reduced by harmonisation of border processes, adequate arrangements by RUs for technical inspection of rolling stock. As operational processes subject to local conditions can vary greatly there is not a common solution to be adopted. Bilateral agreements concluded between RUs on trusted train handover could be the most efficient solution to reduce dwelling time avoiding repeated train check, time-consuming inspection of cargo. The process of locomotive and driver change requires technological time however, it can be an unjustifiably long time if resources (e.g. staff, loco) are not available or the train fails to run by the schedule. So, punctuality of train is a major factor, real time information on the estimated time of arrival, tracking of trains (roll-out of TTR project and reliable TIS data) are required to reduce dwelling time for quality service and efficiency. Adoption of homogenous, automatic processes across RFC Amber supported by a common IT platform, an IT application for coordination and communication between stakeholders would be desirable. RUs can use their resources more efficiently, on the other hand, parking trains or locomotives would not block tracks for shunting which interferes with efficient use of capacities. Similar to RFC Orient/East Med, setting up task force for each concerned border crossing to investigate procedures could shed light on actual problems that can be tackled first. At some border stations the need for track capacity increase can be reconsidered if the technological processes can be managed with higher efficiency thanks to better harmonisation of processes and higher reliability of train runs. Priority to RFC trains in case of disturbance could also reduce the waiting time at borders, occupation of infrastructure capacity which is in the interest of all stakeholders. Reducing dwelling time at borders, i.e. improving, harmonising procedures is also interconnected with and subject to other aspects like harmonisation of national rules e.g. on driver certificate, wagon safety, vehicle authorisation, etc.

3B Interventions to ensure priority and increase punctuality of RFC trains

A key to efficient traffic management is to ensure punctuality of trains running on the lines. In general, freight trains have lower preference in traffic management than passenger trains. International RFC trains should enjoy preferential treatment over other domestic freight transport in case of congestion or disturbance – more flexibility in dispatching RFC trains should be ensured by IMs/AB. Today, prioritisation of freight trains is under the competence of the national infrastructure managers and there are no common or harmonised priority rules in place. However, involved IMs committed themselves to ensure high quality and punctuality of international freight trains. Equal treatment is ensured by the liberalisation of the market however, international trains should enjoy priority to achieve EU transport sustainability targets.
This way the punctuality targets (at origin and at destination alike) can be better met, the average path speed can be improved which means a more attractive service. Availability of real time information in TIS, CIP (improved communication, exchange of data) for better planning, timetabling is a prerequisite of increasing service standards. In addition, RUs should secure staff that have line knowledge which is another factor of running trains on schedule. Introduction of a common performance/incentive scheme (or penalty regime) to foster punctuality, to motivate players (RUs/IMs) to reduce delay minutes of RFC trains can be considered to improve performance, reliability (like DB Netze did in Germany). However, it requires reliable data, reports that should be obtained from the common database, TIS OBI.

RNE survey (*Overview of priority rules in operation December 2019*) revealed that priority rules are applied by IMs in the case of international freight trains in Hungary as internal regulation of IMs (MÁV and GYSEV) while in Slovak Republic as national law. International freight trains are delegated to priority category behind all passenger trains but enjoy preference in traffic management over domestic freight, however this procedure does not really enhance service reliability.

3C Develop efficient re-routing options, contingency for disturbances, restrictions

International freight transport suffers the consequences of traffic disturbances due to low priority in traffic management, and lack of commonly applied rules on rerouting process and established scenarios, adequate routing options. There has been only bilateral coordination of contingency measures between IMs/AB in case of incident with international impact. To minimise the impact of disturbances on the network and to ensure reliability and calculability of running international freight trains for RUs, adequate re-routing options (combining national re-routing plans) have to be established in accordance with the guidelines of the contingency management handbook (ICM). In fact, the international contingency plan for RFC Amber was published this summer. So, today we can claim that contingency measures are in place. Now, the awareness of this document among stakeholders, customers has to be ensured (homepage, CIP) and through monitoring of the selection of re-routing possibilities, customer requirements and feedback, the content should be revised to ensure competitive options, reliable and updated information to RUs. In fact, if IMs had more flexibility, legal authority in capacity reallocation in case of disturbance, the RFC service could be better supported by minimising the impact on international freight.

Efficient management, co-ordination of TCRs and demand driven contingency measures requires train performance monitoring activity. RFC Amber set up a dedicated working group for train performance management responsible for the complete TPM process with the ultimate objective to improve performance on the corridor. It is important to have an overall framework of standard procedures supporting traffic and performance management They have to enable the organisation to measure, analyse data and take measures as necessary. Using the common TIS database instead of national systems with different functions, data sources the WG have access to advanced analytics (KPIs, punctuality, amount and distribution of delays, dwelling time details) via Oracle Business Intelligence (OBI) to identify bottleneck areas and plan corrective actions and get feedback on the actions' effectiveness.

Introduction of common coding of delay reasons, TAF TSI is expected to improve the anomalies of data content in different national systems and help consistent interpretation, introduction of common international processes for monitoring. The Traffic Management, Train Performance and Operations Working Group should focus on achieving data consistency first. In addition, training of a competent and responsible IM staff, ensuring the human resource capacity, which is not readily available today, are a must to ensure true and genuine data provision. IMs need to be motivated to provide capacity, resources for data quality management to ensure reliable data TIS OBI input. It is considered a prerequisite of efficient train performance management, the very basics of introducing relevant measures for improvement. Also, it is important to ensure availability of human capacity to analyze train performance data and generate reports that should be useful to develop a common incentive scheme for RFC (to be applicable for RFC trains instead of national compensation schemes).

When defining or correcting improvement measures all relevant parties (IMs, RUs, terminals) need to be involved. In addition to KPIs the Customer Satisfaction Survey provides relevant input for the improvement of corridor performance, however, in the case of RFC Amber such a survey has not been conducted yet. Current KPIs in comparison with that of other RFCs and reports show that there is room for improvement of punctuality or speed, dwell time. The delegated IM performance manager having thorough knowledge of the respective national processes and network capacities can and should make proposals for improvement measures.

New KPIs are proposed to be monitored in addition to the selected ones for improving performance: punctuality at origin/destination, overall number of trains per border.

3D Strengthen the role and capacity of RFC traffic management by preparing staff and exchange of experience

RFC Amber has not got a long history of operation, therefore experience on international traffic management is rather scarce, staff lacks experience which means that traffic management processes could be and should be improved. On the other hand, all IMs have been involved long in providing capacity and managing international rail freight traffic on other RFCs. Efforts should be made to exchange experience with other C-OSS, management staff and have the participating IMs' staff share their views and incorporate lessons learnt in the business processes of RFC Amber. It would be a major contribution to achieve service level corresponding to the market requirements.

The IT platform developed by RNE to replace TCCCom and Park and Run Tool, the Incident Management Tool is expected to be an asset in international management of disturbance and will be used by all IMs adopting the International Contingency Management Handbook.

Incident management will achieve a level when the information of all stakeholders about type, duration, impact of the incident on international traffic is ensured in a timely manner thus enabling efficient management. However, this initiative can only be successful if IMs are motivated, no extra resources are needed for data input.

For the back-up of possible actions in traffic management, train performance monitoring, the regular punctuality reports (monthly, quarterly) should be used more consistently and causes of delays be analysed or customised reports be requested via OBI as necessary. Basic training or RNE helpdesk are in place to support performance management staff in their efforts. They should be taken advantage of by the WG members to enable thorough investigation of rail freight transport performance on the Corridor through the processing and analysis of the data.

Potential measures to mitigate administrative issues

Different national rules e.g. on vehicle authorisation, safety certification, drivers' licence, train composition result in long dwelling time of international freight trains at border crossings heavily impacting competitiveness and reliability of RFC service. Process time can be considerably reduced through harmonisation of national rules as it has been discussed by the sector (Issues Logbook, RFC7 Task Force Report) and targeted by the Sector Statement to enhance cross-border interoperability. The **administrative issues** along RFC Amber are very similar to those of other RFCs and should be tackled either at EU level or through bilateral agreements. Multimodality on RFC Amber and freight transport to third countries are affected by border procedures that can be managed at government level and lack of transparent calculation of transport costs. All in all, harmonisation of rules, procedures applied in partner countries need to be achieved thus making conditions of freight forwarding transparent for customers.

4A Enhance cross-border interoperability by harmonisation/elimination of national rules, requirements and use of common IT platforms

Lack of interoperability at borders, handover points due to different national rules on safety issues, vehicle authorisation or driver certification is a complex issue considerably impacting competitiveness of international rail freight, functioning of rail freight corridors in general. Harmonisation of national rules has been in the forefront of the EU legislation and the sector for long, but national IMs, regulatory bodies in most cases are often not ready to cooperate or being discouraged by the complexity of the issue. So, full harmonisation of national rules cannot be expected to improve cross-border interoperability in the short run. Efforts have been underway at EU level to clean up obsolete not OPE TSI compliant national rules: the Issues Logbook project initiated in 2017 to identify technical and operational barriers of international rail freight did not involve RFC Amber but the issues are applicable, and they have an impact on the functioning of RFC Amber, no doubt. Actions are envisaged at national level to harmonise national rules, or at sector level to apply best practices, harmonised templates – the increased trust in handover processes at borders is also a cornerstone of efficient operations.

Alignment of national rules on train composition requirements in compliance with the provisions of the directive on railway safety should be ensured or perhaps a more flexible approach in the SMS procedures of the RUs can ease the impact of the problem, eliminate unreasonable obligations upon RUs. Lack of commonly used IT platform for handover of trains, different messages, processes can be costly and requires extra RU resources and can lead to mistakes. Application of common or integrated IT platform (TAF-TSI message standardised sharing of information) to make heterogenous processes on safety and vehicle authorisation, language requirements transparent and easy to follow would improve efficiency and reduce resource requirement, administrative burden as well.

4B Simplify procedures in the multimodal transport chains and support freight forwarders in route planning, cost calculation and path reservation

There are complex legal-administrative requirements in place for transloading that adversely impact transparency of the procedures and use of resources on the part of freight forwarders. To make multimodal transport more attractive on RFC Amber – in addition to availability of terminal, transloading services and reliable information on terminal capacities – the alignment of different administrative processes is required ensuring transparency by working out standard IT processes. Different safety and security aspects of multimodal transport legs require administrative procedures that should by simplified and supported by telematics solutions. Effectiveness of logistics chain needs to be improved which can be more readily achieved by local coordination, collaboration of stakeholders at terminals. A common platform – standardised interfaces – to exchange information and data for tracking between all players in the logistic chain would contribute to boosting multimodal transport.
Transparent calculation of total handling cost including rail leg and road leg – last mile costs – provide comparable cost information to users. Currently, the CIS cannot be readily applied for calculating total costs partly because calculation methods differ by member states, and data are not reliable and complete. So, upgrading and making the CIS more user friendly, its integration for consolidated data would encourage market players to opt for multimodal transport on RFC Amber.

4C Harmonisation of rules and provide support to ease administrative burden

At the borders of the Schengen area additional control, administrative procedures of customs, safety and security requirements are in place which increase process time and often results in unjustified waiting of trains. These border control procedures are complex, often erratic therefore it is the interest of all players to establish standard procedures in collaboration of border authorities. IT tools need to be developed, RNE IT tools should be upgraded to handle procedures applicable outside the EU and have them approved by third country authorities. Competitiveness of outbound rail freight is affected by high vehicle and staff authorisation/license requirements compared to road transport, and RUs often fail to have the appropriate staff. Bilateral agreements with IMs in third countries on administrative and technical requirements, authorisation can also mitigate the problem.

9.3.4 Evaluation of potential measures

Evaluation of the potential overall measures described above was carried out according to the methodology considering feasibility and potential impact. (see scoring in Chapter 9.3.1)

Each one of the measures get a total score that indicates the actual potential of the envisaged intervention to improve RFC functionality and thus its contribution to achieve a competitive RFC service. Note that the estimated impact of the measure corresponds with the agreed impact and relevance of identified bottlenecks which is reasonable (see table below).

Ref. no.	Identified bottleneck	Impact	Proposed measures	Impact on RFC functioning	Interdependence	Total impact score	Complexity, resource requirement	Short term feasibility	Total feasibility score	TOTAL SCORE
	1. CAPACITY MANAGEMENT									
1A	Path allocation procedure via C-OSS is inadequate	medium	1A Ensure resources and increase role of a competent C-OSS for path allocation and capacity planning	3	3	***6***	3	3	***6***	**12**
1B	PaP parameters and RC fail to meet market requirements	high	1B Enhance surveying and consideration of RU demand in PaP parameters and RC to offer competitive RFC capacity	5	5	***10***	3	5	***8***	**18**
1C	Limited applicability of the PCS and reliability of data	low	1C Improve applicability of the PCS and reliability of its data content	1	3	***4***	1	3	***4***	**8**
	2. COMMUNICATION									
2A	Communication difficulties at the national and IM network operative borders	high	2A Actions to improve communication efficiency and transparency at national borders	5	5	***10***	5	3	***8***	**18**
2B	Poorly functioning interfaces between national IT tools and the RNE tools	medium	2B Improve functionality and reliability of RNE Tools for RFC Amber (RFC train/cargo tracking in TIS, PCS, CIP, CCS etc.)	5	3	***8***	3	3	***6***	**14**
2C	Inadequate coordination and sharing information on capacity restrictions, disturbances	high	2C Interventions improving coordination in planning and sharing information on capacity restrictions, disturbance	5	5	***10***	3	3	***6***	**16**
2D	Insufficient language skills of staff	low/medium	2D Improve language skills of staff and ease their communication by using standardized forms, messages with IT support	3	3	***6***	3	3	***6***	**6**

Ref. no.	Identified bottleneck	Impact	Proposed measures	Impact on RFC functioning	Interdependence	Total impact score	Complexity, resource requirement	Short term feasibility	Total feasibility score	TOTAL SCORE
	3. TRAFFIC MANAGEMENT									
3A	Ineffective arrangements, processes at border crossings	high	3A Harmonisation of processes and procedures at borders	5	3	***8***	3	5	***8***	**16**
3B	Low reliability of RFC trains impacts competitiveness	medium	3B Interventions to ensure priority and increase punctuality of RFC trains	5	5	***10***	3	3	***6***	**16**
3C	Competitive re-routing, contingency measures for traffic disturbances/TCRs are not available	high	3C Develop efficient re-routing options, contingency for disturbances, restrictions	3	5	***8***	3	5	***8***	**16**
3D	RFC traffic management staff is not properly prepared	low	3D Strengthen the role and capacity of RFC traffic management by preparing staff and exchange of experience	1	1	***2***	5	5	***10***	**12**
	4. ADMINISTRATIVE ISSUES									
4A	Cross-border interoperability difficulties due to lack of harmonisation of national rules	high	4A Enhance cross-border interoperability by harmonisation/elimination of national rules, requirements and use of common IT platforms	5	5	***10***	3	3	***6***	**16**
4B	Not transparent, calculable procedures and charging in case of multimodal transport	medium	4B Simplify procedures in the multimodal transport chains and support freight forwarders in route planning, cost calculation and path reservation	5	1	***6***	1	3	***4***	**10**
4C	Long technological times of forwarding outside the EU	medium	4C Harmonisation of rules/legislation to ease administrative burden	3	1	***4***	1	1	***2***	**6**

Table 67: Impact, feasibility and total score of the O&A measures

9.3.5 Ranking and prioritisation of measures

Simple and homogenous hierarchy of scoring categories were set up to ensure coherent rating. Three score ranges were identified that assign the three priority groups of interventions as follows:

Priority category	**Desirable**	**To be considered**	**Proposed**
Total score range	**4-9**	**10-14**	**15-20**

Table 68: Definition of O&A priority groups

The measures having the highest scores are assumed to be the most feasible and desirable (low cost, strong stakeholder support, maturity – ongoing RNE action – and the highest impact), therefore they are proposed to be implemented in the first place, while the implementation of those in the second category are to be considered. Limited potential is attributed to measures that target bottlenecks with lower impact coupled by weak feasibility. Ranking of potential measures is summarised in the matrix hereunder:

feasibility / **impact**		**unrealistic**			**complex**			**feasible**		
		2	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
high	**10**					**2C; 3B; 4A**		**1B; 2A**		
	9									
	8					**2B**		**3A; 3C**		
medium	**7**									
	6			**4B**		**1A; 2D**				
	5									
low	**4**	**4C**		**1C**						
	3									
	2									**3D**

Table 69.: Impact and feasibility score matrix of the O&A measures

A theoretical order of measures is shown below, however, it is not intended to suggest any order of implementation priority. They do not apply uniformly to procedures of all member states, IMs or handover points. The assessment and ranking of the potential measures are a substantiated recommendation for RFC Amber on how and what aspects of corridor functionality should be targeted for material result in the short-medium run.

Ref. no.*	Proposed measures	Issue impact	Total score	Priority category
1B	Enhance surveying and consideration of RU demand in PaP parameters and RC to offer competitive RFC capacity	high	18	proposed
2A	Actions to improve communication efficiency and transparency at national borders	high	18	proposed
2C	Interventions improving coordination in planning and sharing information on capacity restrictions, disturbances	high	16	proposed
3A	Harmonisation of processes and procedures at borders	high	16	proposed
3B	Interventions to ensure priority and increase punctuality of RFC trains	medium	16	proposed
3C	Develop efficient re-routing options, contingency for disturbances, restrictions	high	16	proposed
4A	Enhance cross-border interoperability by harmonisation of national rules, requirements and use of common IT platforms	high	16	proposed
2B	Improve functionality and reliability of RNE Tools for RFC Amber	medium	14	to be considered
1A	Ensure resources and increase role of a competent C-OSS for path allocation and capacity planning	medium	12	to be considered
2D	Improve language skills of staff and ease their communication by using standardized forms, messages with IT support	medium	12	to be considered
3D	Strengthen the role and capacity of RFC traffic management by preparing staff and exchange of experience	low	12	to be considered
4B	Simplify procedures in the multimodal transport chains and support freight forwarders in route planning, cost calculation and path reservation	medium	10	to be considered
1C	Improve applicability of the PCS and reliability of its data content	low	8	desirable
4C	Harmonisation of rules/legislation to ease administrative burden	medium	6	desirable

*reference numbers of measures are identical with that of the corresponding operational bottleneck for transparency

Table 70: Ranking of O&A interventions by impact and feasibility score

9.4 General conclusions on interventions

Efficient functioning of rail freight corridors (among them RFC Amber) largely contributes to the implementation of the Single European Railway Area; free movement of freight trains, overcoming national borders, achieving interoperability. Therefore, it is vital to identify infrastructure deficiencies, capacity shortages and operational, administrative issues that interfere most with operational efficiency of international rail freight service along the corridor. Initiatives, commitments and actions at European level, such as publication of the Sector Statement on RFCs, development of RNE IT platforms, the introduction of the 4th Railway Package in addition to the implementation of RFC Amber set the framework, the preconditions for improving bottlenecks to achieve competitive, fully functioning RFC Amber. Also, coherence with the Implementation Plan of RFC Amber (CID Book 5) including main line infrastructure bottlenecks, the conclusions of the TMS was observed throughout the elaboration of the Bottleneck Study.

This Study gives a thorough inventory and evaluation of current infrastructure, capacity bottlenecks on the line sections of RFC Amber based on the data input of member state IMs. They have been identified and prioritised considering their compliance with TEN-T requirements, network role and traffic potentials and several intervention types corresponding with the technical and capacity problems, section priority have been proposed for improvement. They are categorised to bring the assumed highest benefit to the functioning of RFC Amber (value-added service: higher efficiency, reliability, simpler procedures), however national considerations, other network developments, availability of funding, etc. can affect implementation preferences, feasibility of individual actions. Even the corridor authorities might suggest countries to give investments higher priority or project maturity can allow for earlier funding.

It has to be pointed out that it is beyond the means of this Study to set an exact priority list of interventions either for the entire corridor or for the relevant national lines, stations within the individual member states. However, the three priority groups of interventions clearly indicate what sections and connecting stations or nodes and at what level of development could mostly improve functioning, competitiveness of RFC Amber. Therefore, the focus of developments is established keeping a close eye on the efficient functioning of RFC Amber which is in line with national network development priorities of IMs. Because the main objective is to remove and develop most crucial bottlenecks, the developments should be focused but it is also important to reach homogenous network/lines along the Corridor.

For any more detailed definition of the interventions, technical content or implementation framework, specific studies, designs have to be prepared. Similarly, actual developments at stations, marshalling yards, terminals require detailed analysis of technical conditions of tracks, capacity, layout, etc. and they are also very much subject to the connecting line's role in freight transport, track number, daily train runs, etc. and consequential impact on traffic which is beyond the scope of this Study. Station capacity developments, no doubt, can ensure flexibility for traffic management, the necessary puffer capacity for efficient and competitive international service.

RFC Amber went operational in 2019, so IMs/AB and RUs have limited experience with regard to the adequacy and efficiency of RFC Amber capacity and traffic management processes, border procedures communication, collaboration between national players. Therefore, operational and administrative issues where identified, ranked and then converted into proposed interventions based on the main causes of the issues mostly in consideration of experience in general international freight train forwarding and other RFC operations.

Operational or administrative inefficiencies and technical condition of infrastructure, capacity problems often interrelate. Measures improving traffic management, communication or coordination can result in more efficient operation potentially mitigating the need for costly infrastructure investments. However, interdependence is rather between operational or administrative measures which were taken into consideration in ranking measures by the impact. A wider impact or collateral improvement of some other issue invites higher priority of the particular measure. Impact score coupled with feasibility determined if the measure was proposed or found not that promising for RFC Amber. All in all, it has been found that preferential treatment of RFC trains (understanding priority of passenger transport), market driven capacity allocation procedures, better communication and cooperation between IMs (co-ordination of timely information on TCRs) and RUs (trusted train), use of common IT platforms (RNE) and harmonisation of national rules at handover points would improve efficiency, competitiveness of RFC trains. We can be confident - thanks to the common efforts - that RNE IT tools, like PCS for efficient capacity management or OBI for train performance management will soon be commonly used for the benefit of a more competitive RFC Amber service improving operational efficiency for RUs and IMs alike.

The assessment, ranking of the potential measures is a substantiated recommendation for RFC Amber on how and what aspects of corridor functionality should be targeted for material result in the short-medium run. Nevertheless, it is a theoretical categorisation of potential measures, it is not intended to suggest any order of implementation priority. Interventions for improvement do not apply uniformly to procedures, member states, IMs or handover points. National particularities, level of implementation of OPE TSI, transposition of legislation, capacities of individual border crossings can considerably affect implementation potential and priority or resource requirements. Thus, implementation often require in depth consideration of processes and procedures, investigation of regulatory compliance and seeking compromises. RFC Amber stakeholders are committed, regulatory and policy framework as well as IT support are mostly in place to implement most of the proposed measures, however future implementation is subject to investigation of local conditions, national particularities or the level of harmonisation, collaboration. Further preparatory efforts, in-depth assessments are required to determine the implementation potentials of each measure and priorities at national level.