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Alpine-Western Balkan
rail freight corridor

Alpine-Western Balkan
Rail Freight Corridor No. 10

"Capacity Improvement and Operational Bottleneck Study"

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GLOSSARY

A – Austria
AC – alternating current
AWB – Alpine-Western Balkan
BCA – Border Crossing Agreement
BCP – Border Crossing Point
BG – Bulgaria
BS – Bottleneck Study
CID – Corridor Information Document
CIM – International Consignment Note
CIS – Charging Information System
CIT – International Rail Transport Committee
CUV – Contracts of Use of Vehicles in International Rail Traffic
DC – direct current
EDI – electronic data interchange
ECN – electronic consignment note
ERA – European Union Agency for Railways
ERTMS – European Railway Traffic Management System
ETCS – European Train Control System
EU – European Union
EUCU – European Union Customs Union
GSM-R – Global System for Mobile Communications-Railway
GTkm – gross-tonne kilometres
HEROS – Hermes Open Services
HR – Croatia
HŽ-I – Hrvatske željeznice-Infrastruktura
ICT – information communication technologies
ISR – International Service Reliability
IŽS – Infrastruktura železnice Srbije
km – kilometre
kV – kilo voltage
m – metre
N/A – not available
NCTS – New Computerised Transit System
NRIC – National Railway Infrastructure Company (Bulgaria)
ORFEUS – Open rail freight EDI user system
OSS – one-stop shop
ÖBB-I – ÖBB-Infrastruktur AG
PCS – Path Coordination System
RAG – Undertaking Advisory Group
RFC – Rail Freight Corridor

RIM – Rail Infrastructure Manager
RNE – Rail Net Europe
S.B. – State Border
SLO – Slovenia
SMGS – Agreement on International Railway Freight Communications consignment note
SRB – Serbia
SŽ-I – Slovenske železnice-Infrastruktura
t – tonne
TAG – Terminal Advisory Group
TAF – Telematics Applications for Freight
TAP – Telematics Applications for Passenger
TCDD – Turkish State Railways
TEN-T – Trans-European Transport Network
TIS – Train Information System
TR – Turkey
TSI – Technical Specifications for Interoperability
UIC – Union des Chemins de Fer, International Railway Union
UIRR – International Union for road-rail combined transport
UTC – Coordinated Universal Time
VPN – virtual private network
WP – Work Package

Authorities – in this study these refer to governments, police, customs, veterinarian and phytopathological inspectors, mostly on the cross-border sections.

Regarding the numbers in this study, which follow European conventions:
. (dot) – represents thousands, **so 2.500 means two thousand five hundred**
, (comma) – represents decimal numbers, **so 1,5 means one and a half**

1 INTRODUCTION

The **Capacity Improvement and Operational Bottleneck Study** ("Bottleneck Study") has been carried out based on the definition of bottlenecks set out in (15) of Definitions Article 2 of Regulation (EU) No 1316/2013. A 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 and thus overcome the bottleneck constraints. Some of the bottlenecks at border crossings could be eliminated by administrative means or with the optimisation of cross-border procedures.

Figure 1-1: The principle of a bottleneck in rail transport

According to Article 39 of Regulation (EU) No 1315/2013, the following infrastructure requirements for the key technical parameters shall be met by the infrastructure of the TEN-T core network:

- full electrification of the line tracks and, as far as necessary for electric train operations, sidings;
- at least 22,5 t axle load;
- 100 km/h line speed;
- possibility of running trains with a length of 740 m;
- full deployment of ERTMS (ETCS + GSM-R);
- nominal track gauge for new railway lines: 1435 mm

The route of the AWB RFC, Salzburg-Villach-Ljubljana-/Wels/Linz-Graz-Maribor-Zagreb-Vinkovci/Vukovar-Tovarnik-Beograd-Sofia-Svilengrad (Bulgarian-Turkish border), connects four EU Member States, namely Austria, Slovenia, Croatia and Bulgaria, and runs through the EU Candidate State Serbia.

The AWB RFC does not fully belong to the TEN-T core network, but the corridor's aim is to comply, as much as possible, with the core network requirements for the infrastructure parameters.

The Bottleneck Study assess the current conditions of the railway infrastructure along the AWB RFC. It cover an in-depth analysis of the measures needed in order to improve the infrastructure and the capacity offer. Special attention is given to the implementation of the TEN-T minimum requirements for the core network. Another focus of the study is the identification of operational bottlenecks, including border operations. The main output of the study is a clear definition of the measures needed to improve the railway infrastructure along the corridor in order to attract more traffic.

Background

For the purpose of establishing a European network for competitive rail freight, the European Commission prepared the suitable legal basis for their implementation. The Regulation (EU) 913/2010 is the basic document in this regard, and stipulates the implementation of nine initial rail freight corridors as well as measures to improve the competitiveness of rail freight transport mode. In 2017 the member states concerned proposed the establishment of the new Alpine-Western Balkan Rail Freight Corridor (AWB RFC) to raise the rail modal split in this region. AWB RFC was established on 22nd March 2020 with its registered office in Ljubljana / Slovenia.[1]

The European Commission has decided to award a grant the Alpine-Western Balkan RFC for the action “Establishment of the Alpine-Western Balkan Rail Freight Corridor RFC10”, action number 2016-PSA-RFC10, for the purpose of the implementation of activities for the establishment and development of the AWB RFC in accordance with the Regulation.

The action laid down in Activity 2, the elaboration of the capacity improvement and operational bottleneck study, will cover an in-depth analysis of the measures needed in order to improve the infrastructure and capacity offer, the implementation of the TEN-T requirements as well as identification of operational bottlenecks (including border operations) of the AWB RFC.

To comply with the provisions in the action, the General Assembly of the AWB RFC decided on a public tender for the selection of a suitable consultant for the AWB RFC capacity improvement and operational bottleneck study. In the tender selection procedure, the Prometni Institut Ljubljana was selected as consultant for the study.

To support the capacity improvement and operational bottleneck study project an AWB RFC ad-hoc working group has been established from the participating infrastructure managers that prepared the required input data for the study provider.

[1] Commission Implementing Decision (EU) 2018/500 of 22 March 2018 on the compliance of the proposal to establish the Alpine-Western Balkan rail freight corridor with Article 5 of Regulation (EU) No 913/2010 of the European Parliament and of the Council (notified under document C(2018) 1625)

2 OBJECTIVES OF THE STUDY

The aim of the AWB RFC is to improve infrastructure use with the advanced cooperation of the rail sector (and when required also with the state authorities at the border stations), and to improve operational processes with the aim of harmonising them to the highest possible level. When required, the technical parameters along the corridor will also be adjusted to the TEN-T core requirements, which will allow smooth international rail freight transport along the corridor. Therefore, the Bottleneck Study should identify the capacity constraints and propose the measures necessary to be implemented to overcome these and to enhance the capacity of the corridor.

The Bottleneck Study (BS):

- analysed the most important parameters that have the highest impact on the capacity in order to identify bottlenecks. This includes both the infrastructure sites and operational sites at the border crossings;
- proposed the most pragmatic and efficient measures – infrastructural, technical and operational – the implementation of which may lead to improved capacity along the entire corridor, and to remove the bottlenecks identified;
- identified the cost estimation and benefits of the measures, and of the infrastructure investments needed;
- included medium and long-term traffic forecasts for 2030 and 2050.

The BS included analyses of the following infrastructure parameters:

- train length, profile (loading gauge), axle load (loading capacity), speed, electrification, ERTMS and border stations operations.

Interoperability,[2] in the context of the trans-European railway system, refers to the ability of the system to ensure safe, uninterrupted rail travel and is characterised by a required level of performance. Interoperability depends on the legal, technical and operating conditions, which must be met in order to enable efficient movement along the trans-European railway network.

In practice, this means that interoperable rolling stock can travel using interoperable railway infrastructure and move between the railway networks of individual countries (administrators of the infrastructure) without the need to stop at borders, change locomotives or replace drivers, and without drivers having to take any actions specific to a given element of the infrastructure.

[2] Source: Security of railway border crossing within the East-West railway corridor, UIC Paris, April 2019

3 METHODOLOGY

3.1 BASELINES FOR THE STUDY ELABORATION

The elaboration of all BS tasks requires the analysis and processing of various technical, technological and economic indicators. This requires a wide range of statistical and analytical information stemming from several sources:

- EU and national legislation of the AWB RFC member states,
- annual reports from the infrastructure managers and allocation bodies of AWB RFC member states,
- network statements from the infrastructure managers and allocation bodies of AWB RFC member states,
- traffic and transport performances provided by corridor infrastructure managers,
- traffic and transport performances from statistical offices of AWB RFC member states,
- data from Eurostat,
- economic indicators provided by the statistical offices of AWB RFC member states,
- reports and studies on TEN-T Core Network Corridors,
- other available economic, traffic and transport information necessary for study elaboration,
- information and data from surveys sent to rail carriers and terminal operators,
- sector publications (articles, reports, press releases, etc. with relevance for RFC),
- scientific literature.

The statistical and analytical data required for elaborating the individual parts of the BS of the AWB RFC, with which it was possible to elaborate the individual parts of the study and then to propose the optimal strategy, are:

- **Technical indicators:** train length, loading gauge, axle load, speeds, electrification system, ERTMS and border handover station.
- **Operational indicators:** travel/run times, border waiting times, cross border procedures
- **Transport indicators:** volume of cargo, volume of passenger and freight trains, terminal transhipment
- **Economic indicators:** infrastructure upgrading costs, future demand and cargo growth rates

3.2 METHOD USED IN STUDY ELABORATION

The individual partial objectives of the BS of the AWB RFC were worked out using the following methods:

- method of investigating written sources used for selecting appropriate literature for processing the theoretical and legislative part of BS,
- method of information gathering and processing – used for information collection and its subsequent processing,
- benchmarking – in comparison of some transport and technical statistical data,
- method of analysis – in processing and searching the required transport and technical statistical data,
- method of graphic representation – used for graphic and visual layout of the acquired and processed statistical data and other results of the study,
- method of comparative analysis – comparison in the analytical part,
- method of synthesis – for summarising the information and data obtained,
- method of induction and deduction – used in all parts of the BS, in creating logical judgements based on theoretical, legislative and empirical knowledge,
- brainstorming – consultations with practitioners,
- methods of statistical analysis – used in searching and processing the required transport, technical and economical statistical data,
- prognostic method – used in the development of BS prognostic scenarios.

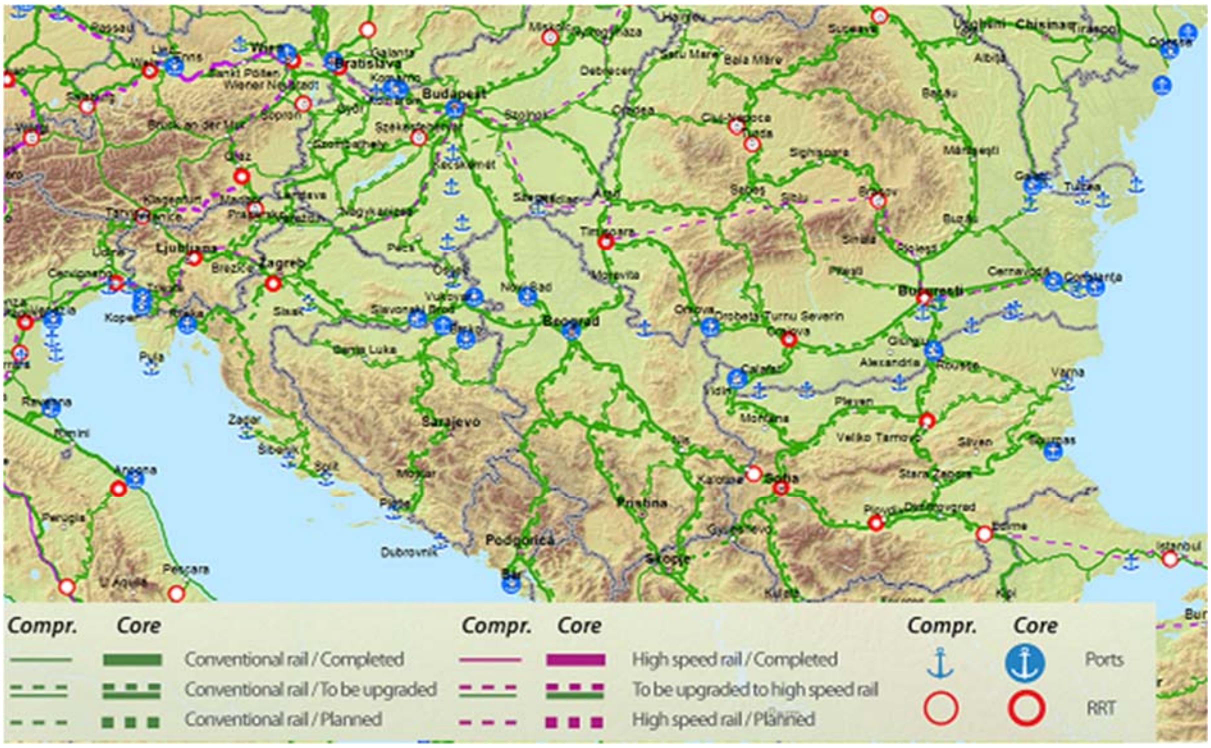
4 ANALYSIS OF RAIL INFRASTRUCTURE

The Trans-European Transport Network (TEN-T) is a planned set of road, rail, air and water transport networks in the European Union. The TEN-T networks are part of a wider system of Trans-European Networks (TENs), including a telecommunications network (eTEN) and a proposed energy network (TEN-E or Ten-Energy). TEN-T envisages coordinated improvements to primary roads, railways, inland waterways, airports, seaports, inland ports and traffic management systems, providing integrated and intermodal long-distance, high-speed routes.

For each individual structural subsystem, several parameters have been analysed, including those which are essential for determining the conformity of the individual subsystems with the TEN-T requirements (Regulation No. 1315/2013, Regulation No. 1316/2013). In accordance with the mentioned regulations, the most important demands are for the lines of the core network, which should be realised by the year 2030, and relate to the treated structural subsystems, i.e. the following:

- deployment of the ERTMS (ETCS+GSM-R),
- electrification of the line tracks,
- nominal track gauge 1435 mm,
- at least 22,5 t axle load,
- 100 km/h line speed, and
- possibility of running trains with a length of 740 m.

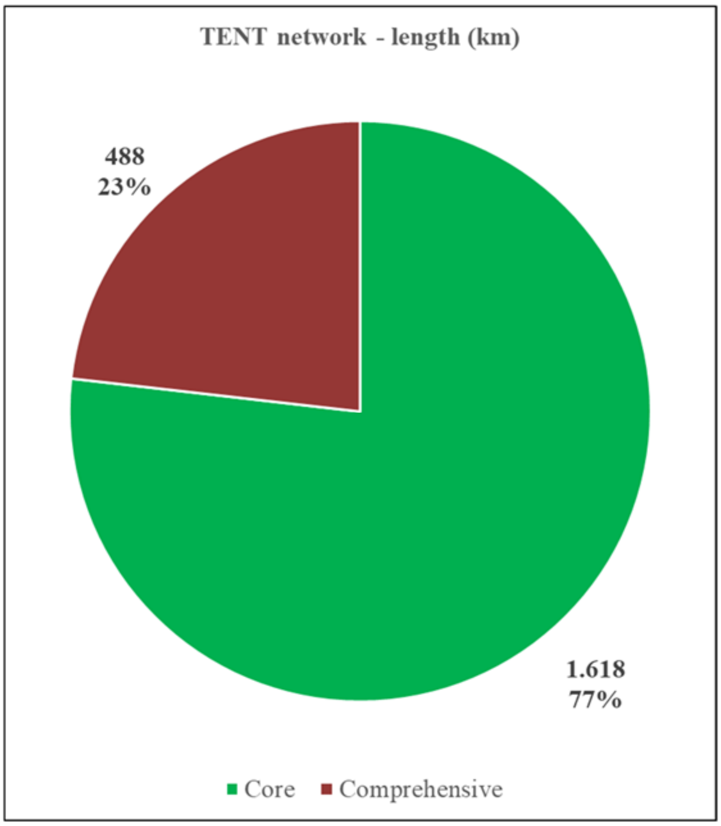
Figure 4-1: Core and comprehensive TEN-T rail network



Source: TEN-T requirements (Regulation No. 1315/2013, Regulation No. 1316/2013)

77% of AWB RFC belongs to the TEN-T core network, presented on the following figure.

Figure 4-2: AWB RFC TEN-T core and comprehensive network



The percentage of the TEN-T core network along the AWB RFC by member state.

	ÖBB-I	**SŽ-I**	**HŽ-I**	**IŽS**	**NRIC**
CORE network (%)	21	76	100	100	100

According to the tender, the railway infrastructure parameters are divided into seven WPs:

WP1: Train length

WP2: Loading gauge

WP3: Axle load and load per metre

WP4: Speeds

WP5: Line electrification

WP6: ERTMS (ETCS + GSM-R)

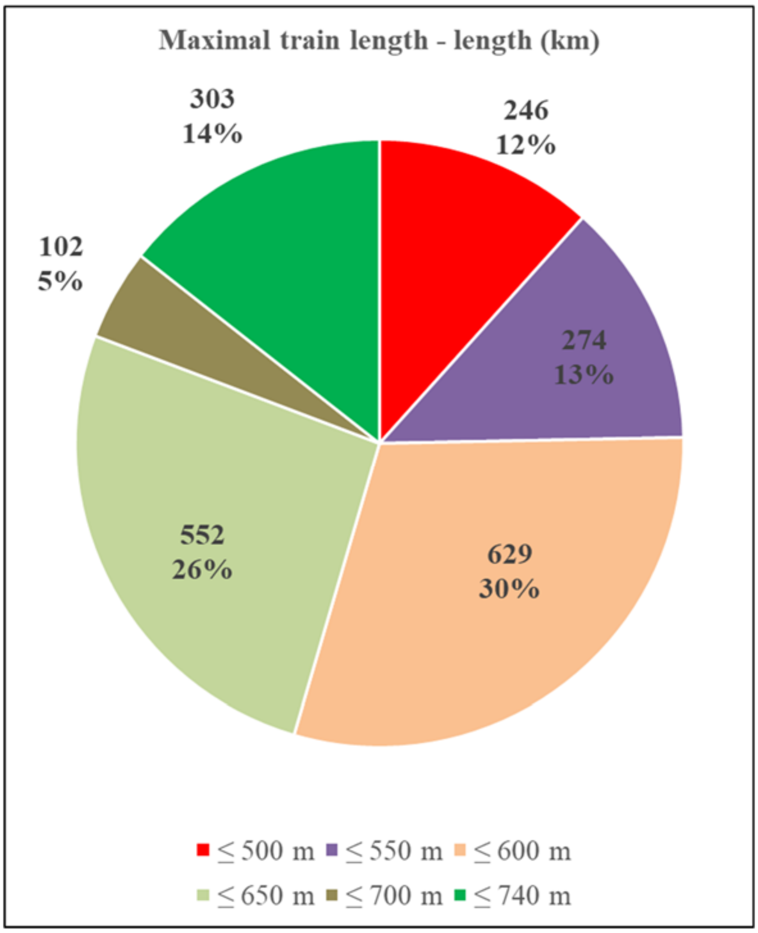
WP7: Border station operations

4.1 WP1: TRAIN LENGTH

The length of a train is measured in metres and includes wagons and locomotives, and depends on the usable lengths of the station tracks at starting and ending points (stations or marshalling yards). The EU standard is to operate freight trains with a length of 740 metres on the TEN-T core network.

Train length is very important in freight railway transport in order to ensure competitiveness with other modes and reduce the operational costs per unit. Many freight trains (container trains, empty trains, car trains…) could be extended with additional wagons, but the usable track length at many railway stations is not long enough.

Figure 4-3: Maximal train length



According to the TEN-T core network standards, the rail lines should have possibility of running trains with a length of 740 m.

The next table presents the current average freight train length (m) for each RIM AWB RFC section.

Table 4-1: Current average freight train length at AWB sections (m)

RIM	Average length (m)
ÖBB-I	550
SŽ-I	450
HŽ-I	353
IŽS	363
NRIC	397

Source: RIMs – ÖBB-I, SŽ-I, HŽ-I, IŽS, NRIC

The current maximal train length along AWB RFC lines is divided into six classes, from 500 to 740 metres

Figure 4-4: Map of current maximal train length

Current 740 m long freight trains at unrestricted sections

- Austria (ÖBB-I):
  - Wels-Marchtrenk-Linz-Traun
  - Selzthal-Bruck a.d. Mur
- Slovenia (SŽ-I):
  - railway section border A/SLO Maribor-Pragersko
- Bulgaria (NRIC):
  - railway section Krumovo-Svilengrad

740 m freight trains can operate at unrestricted sections at only 14% of the length of the AWB RFC.

	ÖBB-I	SŽ-I	HŽ-I	IŽS	NRIC
740 m (%)	22	12	0	0	40

4.2 WP2: LOADING GAUGE

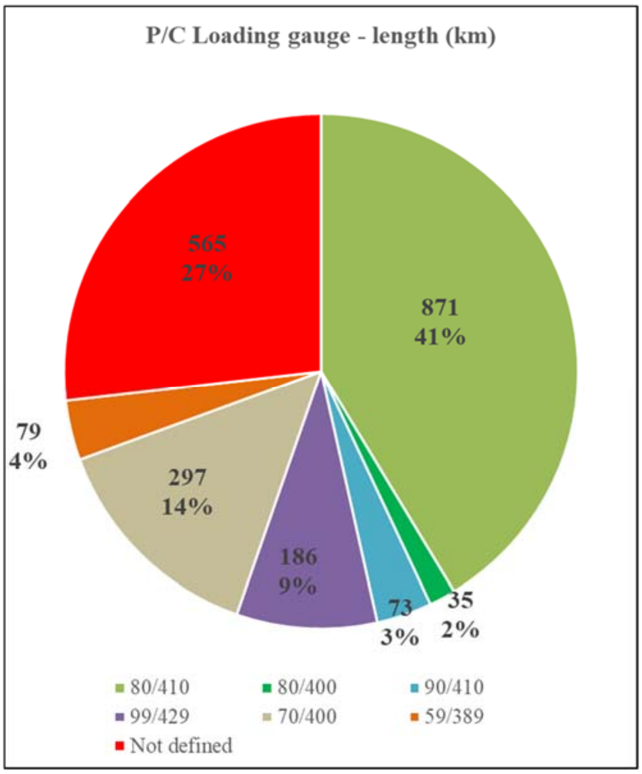
Railway lines across Europe are codified by the Infrastructure Managers according to a predefined coding system for combined transport, based on IRS 50596-6. During the transport of intermodal transport units (ITU), loaded on special combined wagons, it is generally possible to exceed the valid loading profiles, especially in their upper part. As a result, these ITU belong to the group of exceptional consignments. The point of the codification system is that ITU can be transported on coded wagons along coded routes as ordinary consignments, without previous registration for transport, without wasting time waiting for consent and without high fees at states with a codification system.

Alongside the codification regime for railway lines, a system of codification of loading units and wagons has been established to enable the smooth flow of combined transport trains. The research in this area will be focused on intermodal loading gauge P/C:

- P stands for the transportation of semi-trailers, and
- C stands for the transportation of containers and swap bodies.

The railway lines or sections have their own line codifications according to the P/C gauge. At some lines the trains with containers, swap bodies and semi-trailers operate as exceptional consignments due to the condition of the railway infrastructure and its loading gauges. The base value for the P/C loading gauge limit[3] is 70/400.

Figure 4-5: Current P/C loading gauge



[3] Tender documentation for the AWB RFC Bottleneck study

Figure 4-6: Map of current P/C loading gauges

Current loading gauge below P/C 70/400

- Serbia (IŽS):
  - No necessary P/C codification has been performed.
- Bulgaria (NRIC):
  - SRB/BG border Dragoman-Kazichene and Plovdiv-Krumovo.

The P/C loading gauges in the next table are all available codes on AWB RFC, and impact the harmonisation of transport conditions.

Table 4-2: P/C intermodal loading gauge – length (km)

P/C Loading gauge	ÖBB-I	SŽ-I	HŽ-I	IŽS	NRIC
80/410	526	0	345	0	0
80/400	0	35	0	0	0
90/410	0	73	0	0	0
99/429	0	186	0	0	0
70/400	0	0	0	0	297
59/389	0	0	0	0	79
Not defined	0	0	0	565	0
Total (km)	**526**	**294**	**345**	**565**	**376**

Source: RIMs – ÖBB-I, SŽ-I, HŽ-I, IŽS, NRIC

4.3 WP3: AXLE LOAD AND LOAD PER METRE

The maximum axle load is related to the strength of the track, which is determined by the weight of rails, density of sleepers and fixtures, train speeds, amount of ballast, and strength of bridges. The axle load has many categories, based on the combination of mass per axle and mass per unit length, as presented in the following table.

Table 4-3: Axle load categories

Classification	**Mass per axle**				
	A	B	C	D	E
Mass per unit length	16,0 t	18,0 t	20,0 t	22,5 t	25,0 t
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	E4
8,8 t/m					E5

4.3.1 Axle load

According to the TEN-T core network standards, the rail lines should have at least 22,5 t axle load. The current axle load along AWB RFC lines.

Figure 4-7: Current axle load

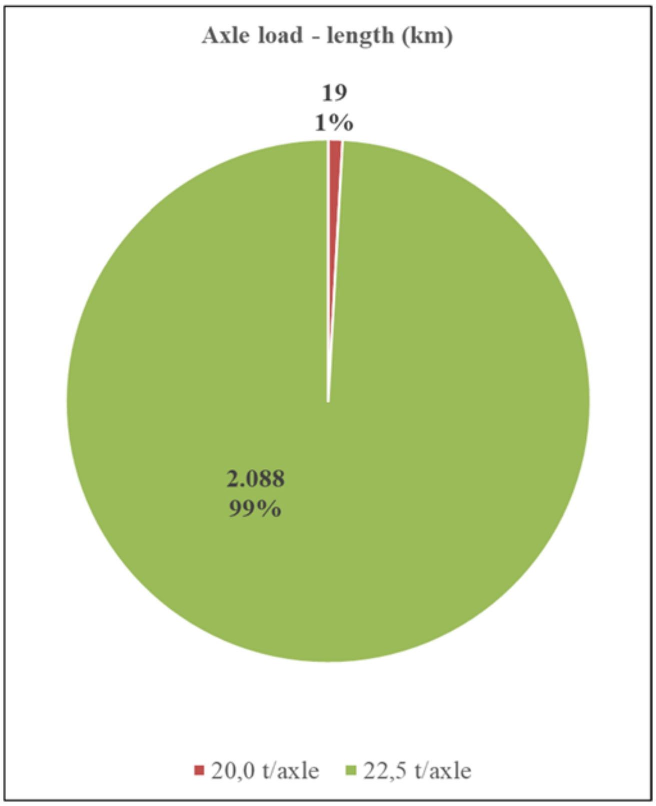


Figure 4-8: Map of current axle load

Current 20,0 t/axle load

- Croatia (HŽ-I):
  - Vinkovci-Vukovar

Axle load 22,5 t/axle is available for 99% of the length of the AWB RFC.

	ÖBB-I	SŽ-I	HŽ-I	IŽS	NRIC
22,5 t/axle (%)	100	100	95	100	100

4.3.2 Load per metre

Current load per metre along AWB RFC lines.

Figure 4-9: Current load per metre

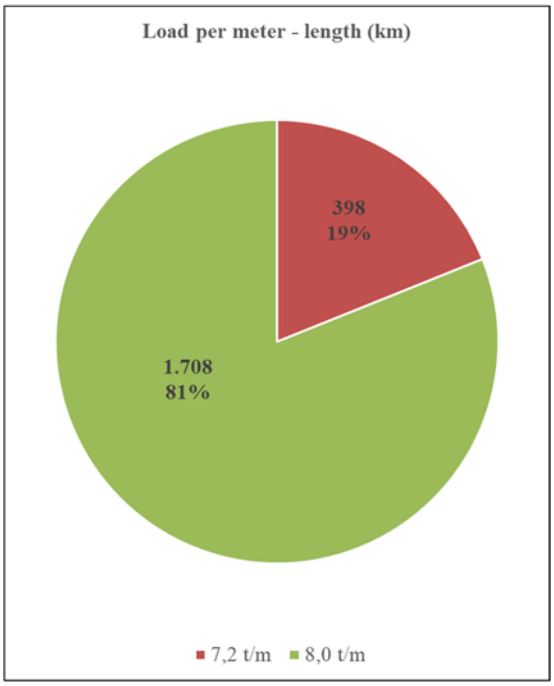


Figure 4-10: Map of current load per metre

Current load per metre 7,2 t/m

- Austria (ÖBB-I):
  - some sections on the line Schwarzach-St. Veit - Spittal-Milstättersee
- Slovenia (SŽ-I):
  - rail section A/SLO border Jesenice-Ljubljana-Dobova border SLO/HR
- Serbia (IŽS):
  - HR/SRB border Šid-Batajnica
  - Niš ranžirna-Dimitrovgrad

Load per metre 8,0 t/m is available for 81% of the length of the AWB RFC.

	ÖBB-I	SŽ-I	HŽ-I	IŽS	NRIC
8,0 t/m (%)	98	37	100	64	100

4.3.3 Traction and train mass

Maximal train mass depends on the line gradients and type of locomotives (maximum hook load and loco power). Many AWB RFC rail sections exceed a 20‰ gradient, especially in Austria (ÖBB-I) and Bulgaria (NRIC). Maximal longitudinal gradients per RIMs are presented in the next table.

Table 4-4: Maximal longitudinal gradients

RIM	Line section	‰
ÖBB-I	Linz - Traun	26
	Traun - Selzthal	21
	Villach - AT/SLO border Jesenice	22
	Schwarzach/St.Veit - Spittal/Millstättersee	29
SŽ-I	AT/SLO border Jesenice - Ljubljana	19
	AT/SLO border Šentilj - Celje	10
HŽ-I	Zagreb RK - Sesvete Novska - Strizivojna Vrpolje Vinkovci - Tovarnik	6
IŽS	Beograd Ranžirna - Resnik	15
	Resnik - Velika Plana	17
NRIC	SRB/BG border Dragoman - Sofia	21
	Kazichene - Vakarel	29

Source: AWB RFC CID Book 5 Implementation plan 2020/2021

Approximately 27% of the AWB RFC in some cases requires two locomotives (double traction) per freight trains (not all trains), if the gross mass of the train exceeds the locomotive load at high longitudinal gradients.

Figure 4-11: Single/double traction

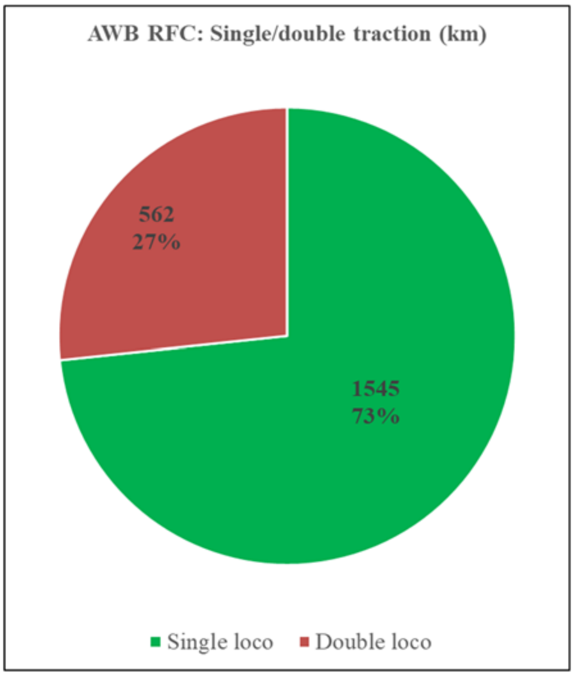


Figure 4-12: Map of single/double traction

Double traction is required at all RIMs, with the exception HŽ-I because of the “flat country”, with none of the line gradients exceeding 6‰.

Traction type	ÖBB-I	SŽ-I	HŽ-I	IŽS	NRIC
Single (km)	321	223	345	389	266
Double (km)	205	71	0	175	110
% of Double	39	24	0	31	29

The next table presents the maximal train mass range for the freight trains with a single locomotive. The loads per locomotive present those for the most representative locomotives on the railway networks of every RIM.

Table 4-5: Maximal train mass (gross tonnes)

RIM	Loads per locomotive (gross tonnes)	Max. gradient ‰
ÖBB-I	615 – 3.200	29
SŽ-I	1.100 – 2.500	19
HŽ-I	2.440 – 5.000	6
IŽS	1.420 – 3.000	17
NRIC	560 – 1.880	25

Source: RIMs – ÖBB-I, SŽ-I, HŽ-I, IŽS, NRIC

The next table present current average freight train gross mass (t) for each RIM AWB section.

Table 4-6: Current average freight train mass for each AWB section (t)

RIM	Average mass (t)
ÖBB-I	1.165
SŽ-I	982
HŽ-I	1.009
IŽS	963
NRIC	973

Source: RIMs – ÖBB-I, SŽ-I, HŽ-I, IŽS, NRIC

The main reasons for limited of freight train weights along the AWB RFC are as follows.

- Line longitudinal gradients:
    - double traction is requested on defined line sections at ÖBB-I, SŽ-I, IŽS and NRIC,
    - only HŽ-I without double traction.
- Locomotive loads:
    - traction adhesion,
    - 6-axle locos with better hauling characteristics than 4-axle locos.
- Maximal permitted freight mass varies:
    - from 1.880 gross tonnes (NRIC),
    - to 5.000 gross tonnes (HŽ-I).
- Train length limits do not permit additional wagons.

4.4 WP4: SPEEDS

In terms of the maximum line speed, the rail lines are categorised as high-speed and conventional lines up to 160 km/h. All railway lines on the AWB RFC route belong to the category of conventional lines. Line speeds are divided based on the different types of trains.

According to the TEN-T core network standards, the railway lines should be available for the freight train speed of 100 km/h.

4.4.1 Maximal line speed

For every defined AWB RFC line section the V_{max} is elaborated, without conditions about the real length of the V_{max}. **This is just a statistical presentation of current maximal speeds and is not relevant for achievement of TEN-T standards regarding the freight train speed of 100 km/h.** Maximal line speeds for freight transport are divided into four speed classes: up to 70 km/h, ≤ 80 km/h, ≤ 90 km/h and 100 km/h or over. Usually the V_{max} for loaded freight trains is 100 km/h (if the loco and wagons allow) and for empty trains (without load) up to 120 km/h.

Figure 4-13: Maximal line speed (freight transport) – length (km)

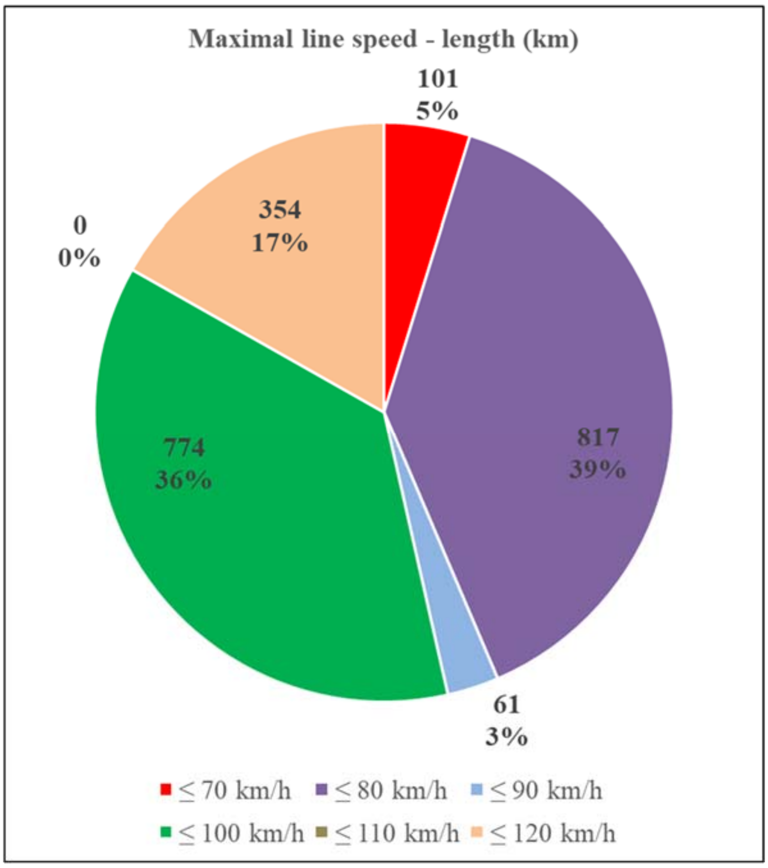


Figure 4-14: Map of maximal line speeds (freight transport)

Maximal line speed of 100 km/h or over for freight transport is available for 54% of the length of the AWB RFC.

	ÖBB-I	**SŽ-I**	**HŽ-I**	**IŽS**	**NRIC**
100 km/h (%)	92	78	61	0	54

4.4.2 Average line speeds

Information on the average line speed for freight transport is much more useful than that on maximal line speed. Average line speeds for freight transport are divided into 5 speed classes: up to 60 km/h, $\leq$ 70 km/h, $\leq$ 80 km/h, $\leq$ 90 km/h and 100 km/h. Usually the V_{max} for loaded freight trains is 100 km/h (if the loco and wagons allows) and for empty wagons (without load) up to 120 km/h.

Average line speed 91-100 km/h for freight transport is available at 22% of the length of the AWB RFC.

	ÖBB-I	**SŽ-I**	**HŽ-I**	**IŽS**	**NRIC**
91-100 km/h (%)	39	18	58	0	0

Figure 4-15: Average line speed (freight transport) – length (km)

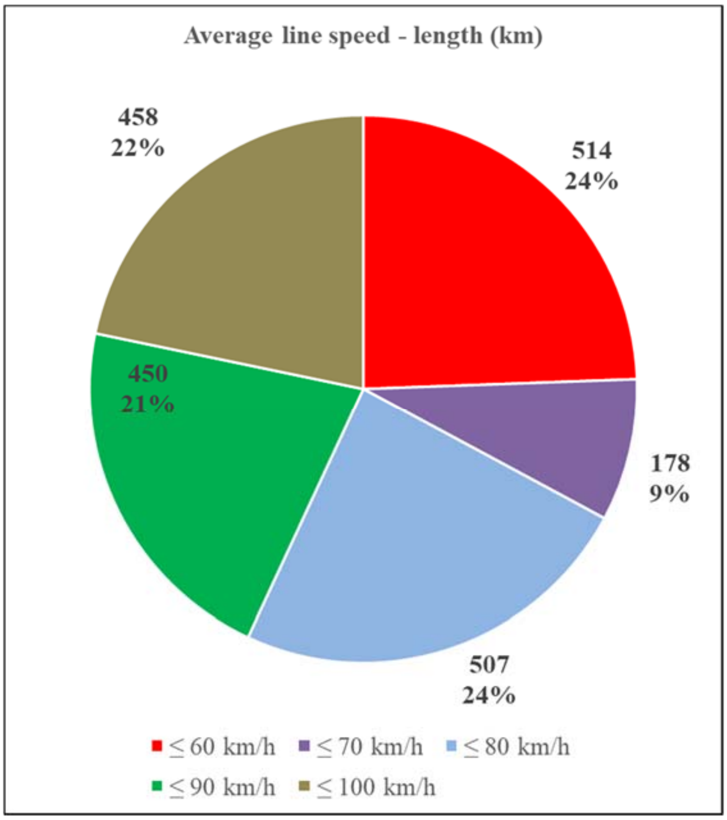


Figure 4-16: Map of average line speeds (freight transport)

4.4.3 Permanent speed restrictions

Some potential bottlenecks for rail transport are speed restrictions. Such restrictions can be temporary or in place for a longer time period. Speed restrictions are usually introduced because of railway infrastructure conditions or maintenance works. The focus of this study is on long-term restrictions due to the bad conditions of the railway infrastructure.

Table 4-7: Total length of permanent speed restrictions for each RIM on the AWB RFC

Speed restrictions	ÖBB-I	SŽ-I	HŽ-I	IŽS	NRIC
Total length (m)	7.873	7.100	98.374	113.589	9.088
% AWB RFC	1,5	2,4	28,5	20,1	2,4

Source: RIMs – ÖBB-I, SŽ-I, HŽ-I, IŽS, NRIC

Permanent speed restrictions are incurred at 11,2% of the length of the AWB RFC.

The total length of permanent speed restrictions is **about 236 km.** The main reason for permanent speed restrictions is the bad condition of the railway infrastructure (due to lack of maintenance), with regard to switches, bridges, tracks, tunnels, avalanches along lines, sensors, etc. The next table presents the reasons for the speed restriction.

Table 4-8: Reasons for permanent speed restrictions and the length (m) of track affected

Speed restrictions reasons	ÖBB-I	SŽ-I	HŽ-I	IŽS	NRIC	Total (m)
switches	1.328	0	0	47.661	2.914	**51.903**
bridge	1.960	0	0	637	0	**2.597**
tracks	200	0	98.374	59.217	5.948	**163.739**
tunnel	4.385	0	0	6.056	0	**10.441**
avalanche	0	6.500	0	0	0	**6.500**
switches, bridge	0	600	0	0	0	**600**
radioactivity sensors	0	0	0	18	0	**18**
disinfection frame	0	0	0	0	10	**10**
X-ray detector system, border signaling	0	0	0	0	216	**216**
Total (m)	**7.873**	**7.100**	**98.374**	**113.589**	**9.088**	**236.024**

Source: RIMs – ÖBB-I, SŽ-I, HŽ-I, IŽS, NRIC

The length of permanent speed restrictions for IŽS is over 113 km, and for HŽ-I over 98 km. Other RIMs have less than 10 km of line sections with speed restrictions.

4.4.4 Average train speeds

The average freight train travel speed is divided into two classes:

- **Actual average freight train travel speed – commercial speed:** this takes into account the actual travel speed from origin to final destination, including all stops of the train for different reasons, such as locomotive change, brake tests, speed restrictions, driver change, and avoiding peak passenger hours.
- **Calculated average freight train travel speed:** based on the calculation of line section length and average line speed for freight trains. It does not include any train stops.

The commercial speed is very different from the values of average or even maximal line speeds, due to various different reasons and obstacles in railway transport. The next table present the current commercial and calculated speeds on AWB RFC.

Table 4-9: Average freight train speeds (km/h)

RIM	Current average freight train travel speeds (km/h)	
	Commercial	Calculated
ÖBB-I	63	89
SŽ-I	41	82
HŽ-I	19	79
IŽS	34	63
NRIC	38	73

Source: RIMs – ÖBB-I, SŽ-I, HŽ-I, IŽS, NRIC

The differences between commercial and calculated speeds are due to the following reasons.

- Train stops because of different reasons: change of locomotive, change of driver, driver lunch, brake tests, obstacle in traffic, avoiding the passenger peak hours, train marshalling (add/remove wagons), etc.
- Bottlenecks on infrastructure: lack of the capacity at some sections, such as single-track lines with train crossings. Crossing times depend on the transport conditions on the lines. Line gradients: high gradients – lower speeds.
- Speed restrictions because of bad conditions of the lines or maintenance works extending travel times.
- Different types of locomotives with different travel times (4-axle, 6-axle locos, engine power from 2 to 6 MW, maximal speeds 80-120 km/h).
- Lack of locomotives at rail carriers. At some sections, two locos operate for one train. If one loco is missing, the train waits.

4.5 WP5: LINE ELECTRIFICATION

The traction system can be classified as non-electric (diesel, steam, hydrogen) or electric. The two types of electric traction systems that exist are as follows:

- Direct current electrification system with: 600, 750, 1200, 1.500 and 3.000 Volts
- Alternating current electrification system with: 15.000 and 25.000 Volts

Different types of traction systems in Europe could be harmonised with the use of multisystem locomotives. On electrified lines, electric traction is provided. This leads to more efficient train operations because of the better technical characteristics of electric locomotives, such as a lack of the gas exhausts seen with diesel locomotives. State-of-the-art locomotives could operate under different voltages, and because of the installed diesel engine could also operate on non-electrified lines. **According to the TEN-T core network standards, the railway lines should be electrified.**

In general, the states along the AWB RFC operate with the following power supplies:

- Austria (ÖBB-I) 15 kV, 16,7 Hz AC
- Slovenia (SŽ-I) 3 kV DC
- Croatia (HŽ-I) 25 kV, 50 Hz AC
- Serbia (IŽS) 25 kV, 50 Hz AC
- Bulgaria (NRIC) 25 kV, 50 Hz AC

Figure 4-17: Current line electrification

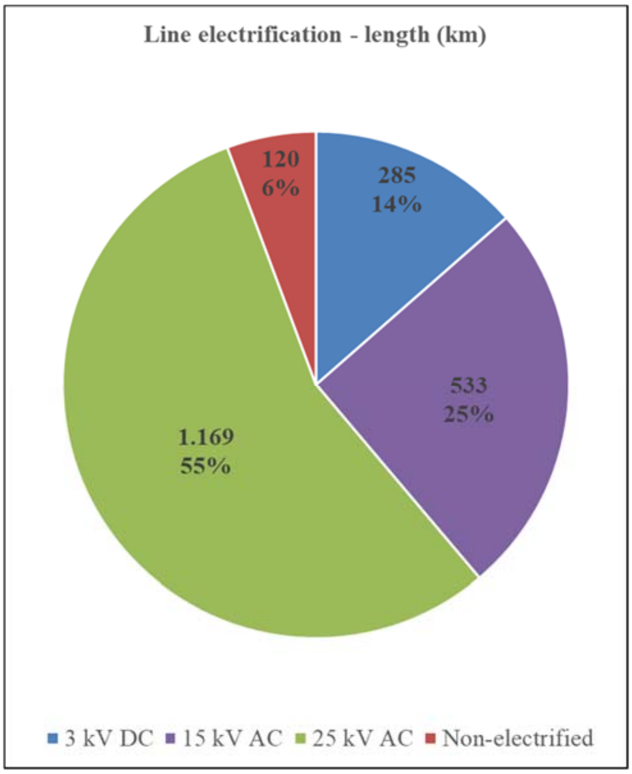


Figure 4-18: Map of current line electrification

Current non-electrified railway sections

- Croatia (HŽ-I):
  - Vinkovci-Vukovar
- Serbia (IŽS):
  - Niš ranžirna-Dimitrovgrad

Electrified rail sections account for 94% of the length of the AWB RFC.

	ÖBB-I	SŽ-I	HŽ-I	IŽS	NRIC
Electrif. (%)	100	100	95	82	100

4.6 WP6: ERTMS

The European Rail Traffic Management System is the system of standards for the management and interoperation of signalling for railways developed by the EU. It is directed by the ERA and is the organisational umbrella for the separately managed parts of

- European Train Control System (ETCS, signalling) and
- GSM–R (communication).

The main target of ERTMS is to promote the interoperability of trains in the EU. It aims to greatly enhance safety, increase efficiency of train transport and enhance cross-border interoperability of rail transport in Europe. This is done by replacing former national signalling equipment and operational procedures with a single new Europe-wide standard for train control and command systems.

4.6.1 ETCS

ETCS is specified at the following levels:

- Level 1: is installed on lineside and on board; spot transmission of data from track to train (and versa) via Eurobalises or Euro loops.
- Level 2: Eurobalises are only used for the exact train position detection. Continuous data transmission via GSM-R with the Radio Block Centre (RBC) gives the required signalling information to the driver's display.
- Level 3: train location and train integrity supervision no longer rely on trackside equipment such as track circuits or axle counters.

According to the TEN-T core network standards, the ETCS should be installed on the lines.

At present, ETCS Level 1 is already deployed on some lines of the AWB RFC in Slovenia, Croatia and Bulgaria, as follows.

- Slovenia (SŽ-I):
  - Ljubljana-Zidani Most-Dobova
  - Maribor (Pragersko)-Zidani Most
- Croatia (HŽ-I):
  - Novska-Okučani
  - Vinkovci-Tovarnik HR/SRB border
- Bulgaria (NRIC):
  - Septemvri-Svilengrad

Figure 4-19: Current ETCS installation

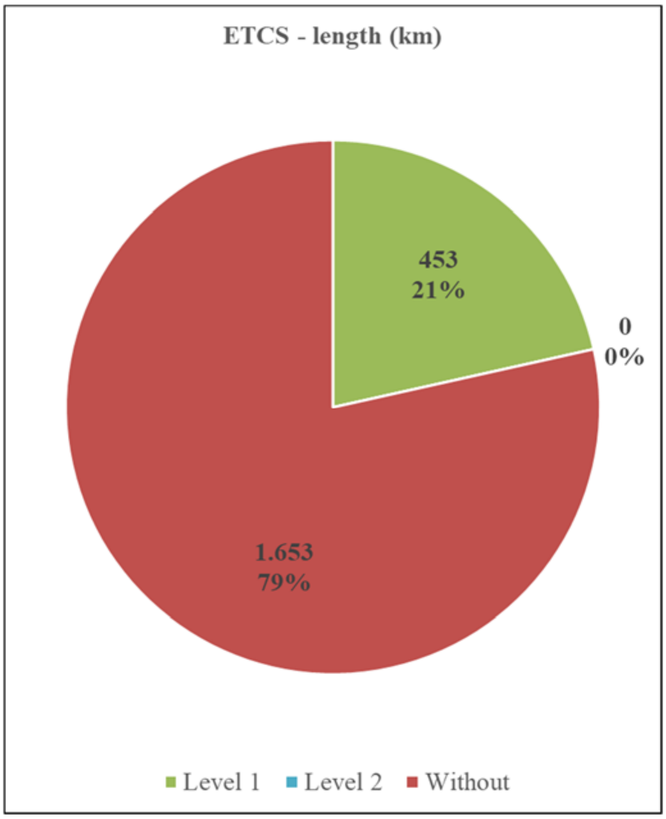


Figure 4-20: Map of current installation of ETCS

Current railway sections of the AWB RFC without ETCS.

- Austria (ÖBB-I):
  - all railway sections
- Slovenia (SŽ-I):
  - A/SLO border Jesenice-Ljubljana
  - A/SLO border-Maribor (Pragersko)
- Croatia (HŽ-I):
  - SLO/HR border Savski Marof-Novska
  - Okučani-Vinkovci
  - Vinkovci-Vukovar
- Serbia (IŽS):
  - all railway sections
- Bulgaria (NRIC):
  - SRB/BG border Dragoman-Septemvri

ETCS is only installed at 21% of the length of the AWB RFC.

	ÖBB-I	SŽ-I	HŽ-I	IŽS	NRIC
ETCS (%)	0	70	15	0	52

4.6.2 GSM-R

GSM-R, the Global System for Mobile Communications – Railway, or GSM-Railway, is an international wireless communications standard for railway communication and applications. A sub-system of the ERTMS it is used for communication between train and traffic management/control centres. The system is based on GSM and EIRENE – MORANE specifications, which guarantee performance at speeds up to 500 km/h, without any communication loss. **According to the TEN-T core network standards, the GSM-R should be installed on the lines.**

Another communication device along the AWB RFC is analogue radio system (ARS). It is an older system, used for operational communication between dispatchers in traffic management/control centres (TCC) and the drivers. The dispatch areas are divided by railway lines and the traffic control centres. At present, GSM-R is already deployed on AWB RFC lines in Austria, Slovenia and Bulgaria, as follows.

- Austria (ÖBB-I):
  - GSM-R at all sections
- Slovenia (SŽ-I):
  - GSM-R at all sections
- Bulgaria (NRIC):
  - GSM-R at section Sofia-Svilengrad

Figure 4-21: Current communication devices

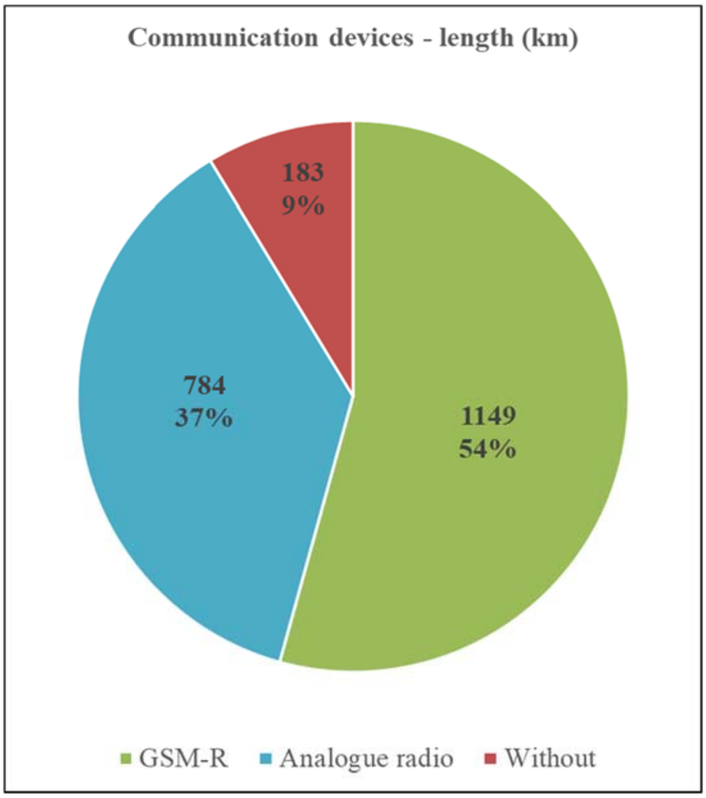


Figure 4-22: Map of current communication devices

Current railway sections of the AWB RFC without GSM-R

- Croatia (HŽ-I):
  - all railway sections
- Serbia (IŽS):
  - all railway sections
- Bulgaria (NRIC):
  - SRB/BG border Dragoman-Sofia

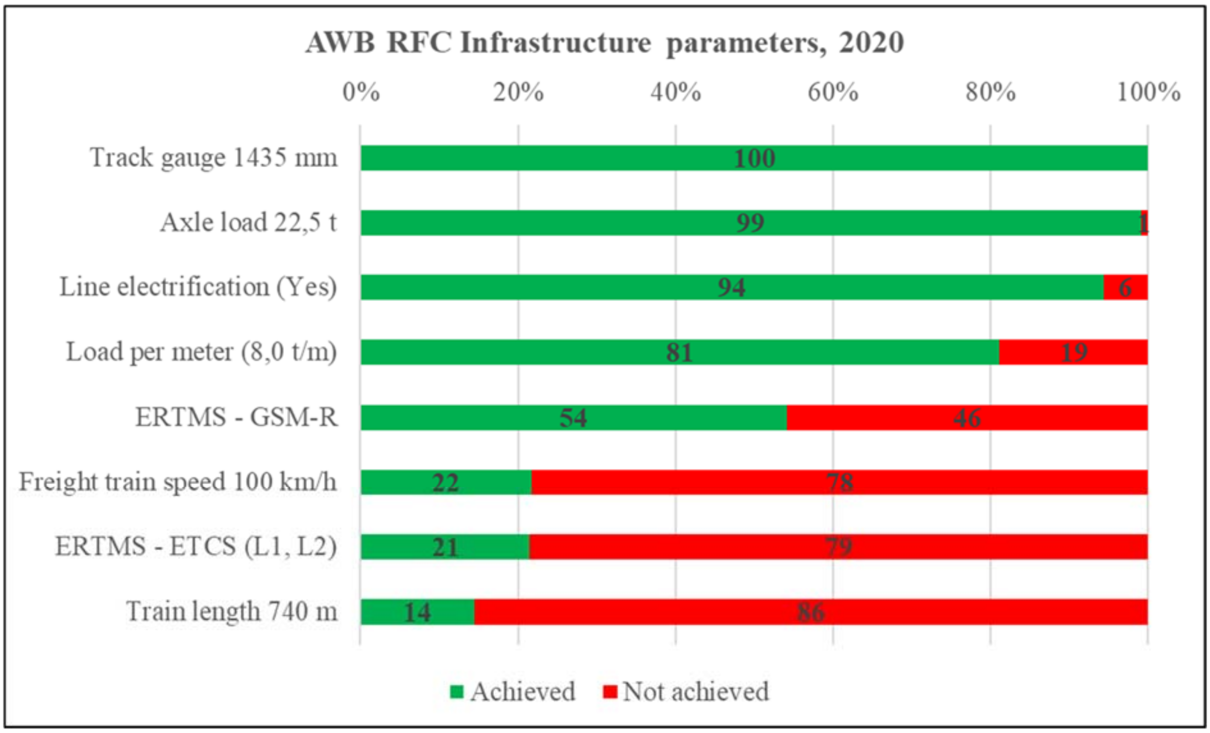
GSM-R is installed on only 54% of the length of the AWB RFC.

	ÖBB-I	SŽ-I	HŽ-I	IŽS	NRIC
GSM-R (%)	100	100	0	0	85

4.7 INFRASTRUCTURE PARAMETER ACHIEVEMENT IN 2020

The next figure presents infrastructure parameter achievement in 2020. Track gauge is the only parameter that was 100% achieved. Axle load and line electrification were achieved to over 90%, while GSM-R communication was achieved to over 50%. The scope of work in the future with regard to the infrastructure parameters will focus on train speed, ETCS and train length, because they have all been less than 25% achieved.

Figure 4-23: Infrastructure parameter achievement in 2020



4.8 CAPACITY CONSUMPTION

The UIC 406 leaflet provides an international standard for evaluating capacity, to be used in developing common values for international corridors sharing different railway networks in different countries. In order for capacity utilisation (consumption) values to best represent the corresponding infrastructure, the following conditions can be used as a guideline:

- The capacity consumption values reflect the infrastructure characteristics of the defined train path line sections.
- The line section with the highest capacity consumption value along the train path line section is the representative line section.
- Acceptable quality of service is represented by capacity consumption up to 100%.
- Capacity consumption values beyond 100% represent a bottleneck, which means a lower quality of service, and should be subject to timetable or infrastructure improvement measures.
- Capacity consumption values below 100% represent available capacity, and thus the potential for additional train paths along the defined train path line section.

Capacity consumption between 80 – 100% on the following line sections in Austria: Salzburg-Bischofshofen, Marchtrenk-Wels, Bruck a.d. Mur-border A/SLO (Maribor) and in Slovenia: Jesenice-Ljubljana.

Figure 4-24: Capacity consumption 2018

4.9 WP7: BORDER STATION OPERATIONS

4.9.1 Border operations

4.9.1.1 EU and Schengen Area

The EU is a political and economic union of 27 member states that are located in Europe. The EU has developed an internal Single Market through a standardised system of laws that apply in all member states in those matters, and only those matters, where members have agreed to act as one. EU policies aim to ensure the free movement of people, goods, services and capital within the internal market, enact legislation in justice and home affairs and maintain common policies on trade, agriculture, fisheries and regional development.

The Schengen Area is an area comprising different European states that have officially abolished all passport and all other types of border control at their mutual borders. The area mostly functions as a single jurisdiction for international travel purposes, with a common visa policy. The area is named after the 1985 Schengen Agreement. Four EU members that are not part of the Schengen Area, Bulgaria, Croatia, Cyprus and Romania, are legally obliged to join the area in the future.

Figure 4-25: Map of EU and Schengen

Source: https://www.schengenvisainfo.com/wp-content/uploads/2020/02/schengen_area_eu_countries.png

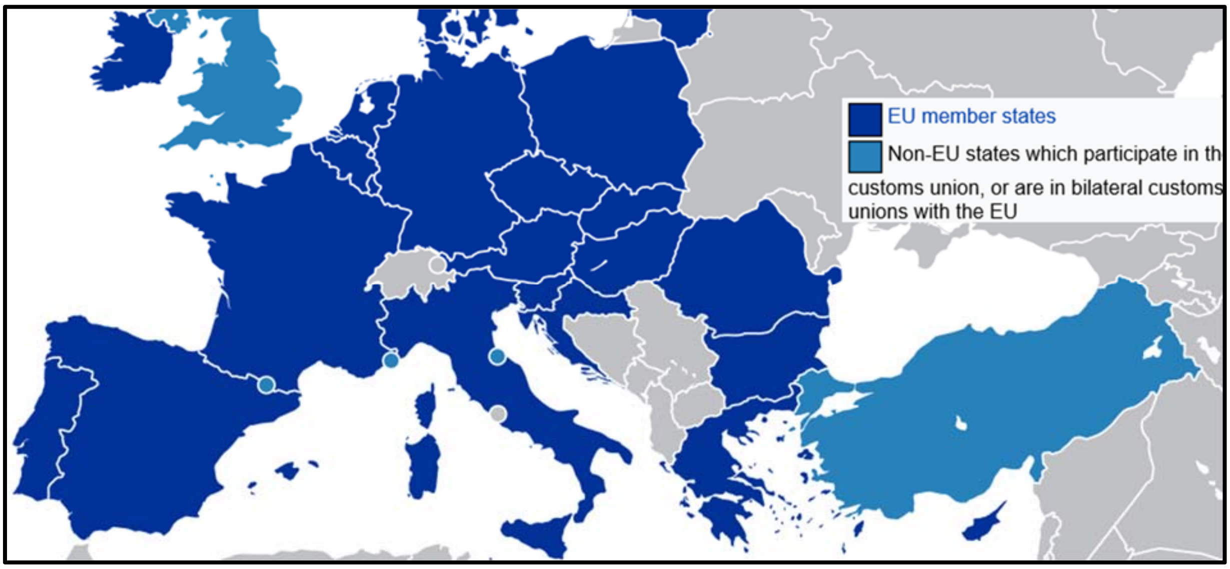
Systematic passport control at an internal border of the EU is subject to restrictive conditions under the Schengen Agreement – for example, due to the danger of terrorism, hooliganism, illegal migration flows or special events. To manage the risk of criminal activity between EU member states, cooperation between police authorities has been strengthened and more focus has been given to monitoring the EU's external borders. This way of working is at present best practice and means that no passport controls within the Schengen space are carried out. Border police use of a number of intelligence sources and watch-lists established at both national and international levels, such as the Schengen Information System (Watch-list), Interpol/Europol (Watch-list), and national databases (Watch-list). Border police usually also have access to technical equipment such as passport readers and inspection equipment.

4.9.1.2 EU Customs Union

The European Union Customs Union is a customs union that consists of all the member states of the EU. Some detached territories of EU members do not participate in the customs union, usually because of their geographic separation. In addition to the EUCU, the EU is in customs unions with Andorra, San Marino, and Turkey (with the exception of certain goods), through separate bilateral agreements.

The Customs Union has been a principal component of the European Union, since its establishment in 1958 as the European Economic Community. There are no tariffs or non-tariff barriers to trade between members of the customs union and – unlike a free-trade area – members of the customs union impose a common external tariff on all goods entering the union.

Figure 4-26: Map of EU Customs Union



Source: https://en.wikipedia.org/wiki/European_Union_Customs_Union#/media/File:EU_Customs_Union.svg

The next table presents the AWB RFC states with regard to membership of the EU, Schengen Area and Customs Union.

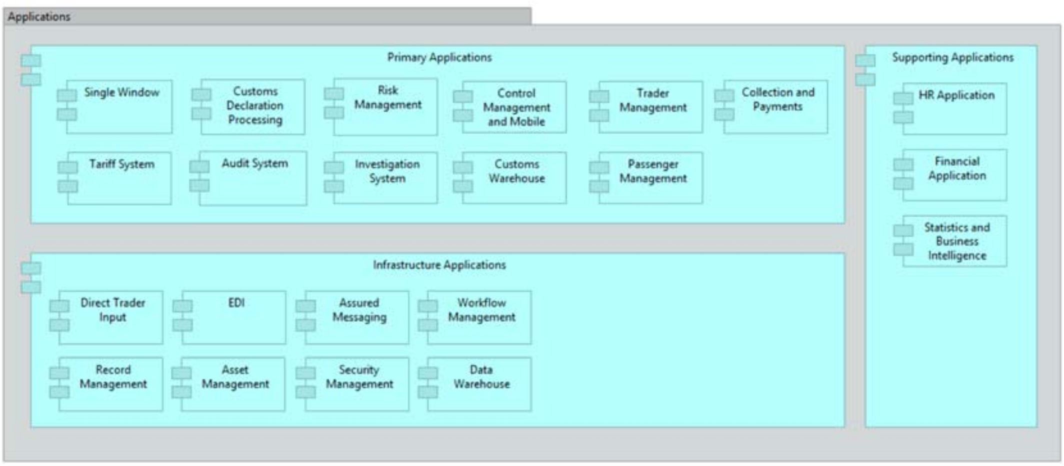
Table 4-10: Membership of the EU, Schengen Area and Customs Union

State	EU	Schengen	Customs Union
Austria	✓	✓	✓
Slovenia	✓	✓	✓
Croatia	✓	✗	✓
Serbia	✗	✗	✗
Bulgaria	✓	✗	✓

Customs procedures at the border can be summarised as follows. Depending on the mode of transport a pre-arrival and pre-departure declaration is submitted by the party responsible for the transport, or his/her representative within a stipulated time before arrival at the border (for rail this is two hours); this applies to goods entering or leaving the EU. Risk analysis using the pre-arrival and pre-departure information is performed to identify consignments that need to be controlled. At the arrival of the goods at the border, the party responsible for the transport notifies Customs and presents the goods to Customs, which then declares a customs procedure such as transit, import, export or some special process. The customs declaration required for clearance can be submitted electronically or in hard copy, and risk assessments for fiscal purposes can be carried out. Goods are released when they are present at the border and customs formalities have been finalised. This process exists in alternative flows depending on the status of the trader, the customs procedure in question, and mode of transport, among other factors. Other controls (phytosanitary, sanitary or radiology) can be performed by other authorities present at the border.

The exchange of information between customs authorities requires enabling national legislation and a regulatory framework. Often a Customs Mutual Assistance Agreement needs to be in place as well as subsequent agreements on data confidentiality detailing the type of information to be shared and in what manner. A coordinated border management agreement is one way to further enhance cross-border cooperation. Customs often have extensive ICT solutions. The next figure presents a general customs ICT portfolio.

Figure 4-27: Customs ICT portfolio

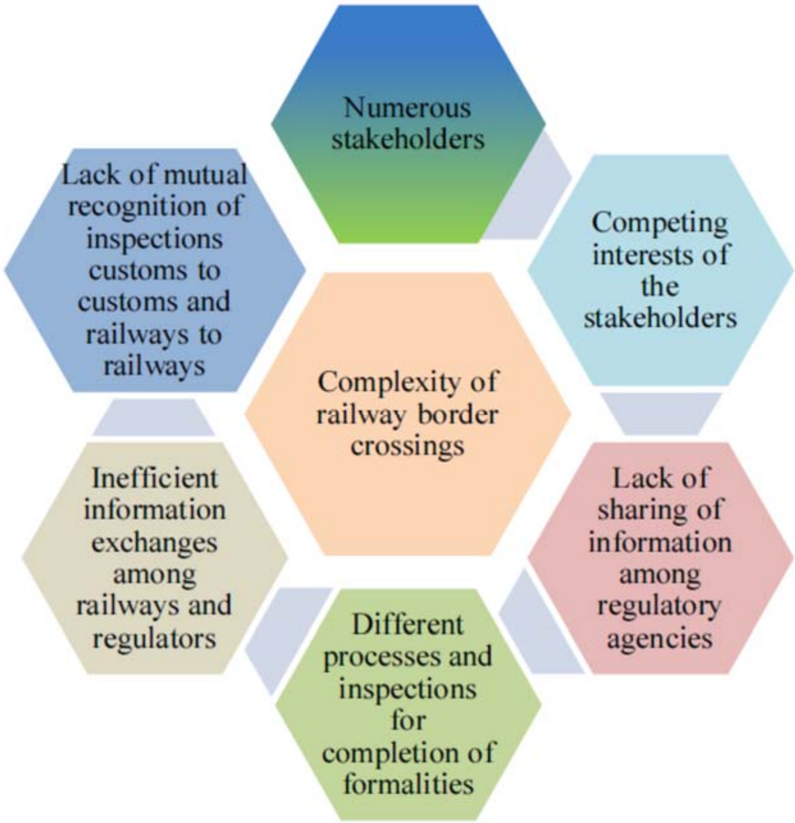


Source: KGH Group AB, Rail EDI at a border crossing point in South East Europe, May 2015

4.9.1.3 Stakeholders at railway border crossings and interactions

A railway border crossing has numerous stakeholders performing diverse functions. These stakeholders can be broadly divided into three categories: railways, regulatory authorities and other companies, including those in the private sector.

Figure 4-28: Complexity of railway border crossings



Source: United Nations, Economic and Social Council, Economic and Social Commission for Asia and the Pacific, Committee on Transport, Bangkok, November 2018

Railways are the main stakeholders at railway border crossings. Several operations must be carried out by adjacent railways at the border crossings, involving the technical, commercial and operational handover from one railway to another. The technical part involves inspection of rolling stock, and the commercial handover includes information on goods being transported.

Many regulatory authorities are stationed at railway border crossings to ensure that rules and regulations for cross-border movement of freight trains are complied with. Other companies are also there to complete those formalities. The number of authorities at the border crossing depends on the type of border crossing and the freight handled.

Customs is a major government authority at railway border crossings. Its primary concern is to ensure compliance of the customs regulations related to the import, export and transit of goods. Concurrently, it is also responsible for preventing smuggling and ensuring security during the transport process.

Some other government authorities at border crossings are border guards and police from the immigration department. Their main objective is to control the movement of people at railway border crossings. Phytosanitary, sanitary and radiology authorities are also present at some railway border crossings.

The interface between authorities and railways at railway border crossings can be complex, and the requirements for completion of the formalities need substantial harmonisation among the countries involved. Customs seals or inspections are not mutually recognised unless there is an arrangement to that effect.

Lack of an appropriate mechanism for sharing information and mutual recognition of inspection results among the regulatory authorities leads to duplication of many processes at railway border crossings. For example, if the results of rolling stock inspections and related certification are not mutually acceptable, this leads to duplication of inspections and inordinate delays to complete the border crossing formalities.

The private sector stakeholders present at railway border crossings include shippers or their representatives, such as freight forwarders or customs brokers who organise the shipment and comply with the formalities related to the transportation of goods from origin to destination. The forwarders and brokers further contract with the carriers for the transport of goods. At some railway border crossings, companies under the control of railways have been mandated to support railway operations, such as shunting or train marshalling.

4.9.1.4 Main processes undertaken at railway border crossings

Railway border crossings are potentially major bottlenecks for seamless international railway transport. Inefficient railway border crossing processes and procedures are the main causes of significant delays and increased transport costs, which reduce the comparative advantages of railway transport. Several critical processes and procedures take place at railway border crossing points, including the transfer of wagons and goods between neighbouring railways, change of locomotive and crews, technical inspections and control of compliance with railway transport standards. Neighbouring railways often operate under different legal regimes and standards.

A freight train normally goes through five processes after arriving at a railway border crossing:[4]

- commercial handover from one railway to another,
- technical handover,
- customs formalities,
- border guard and immigration formalities and
- other government authority formalities.

[4] Source: United Nations, Economic and Social Council, Economic and Social Commission for Asia and the Pacific, Committee on Transport, Bangkok, November 2018

The commercial handover is completed between the railways. The primary document for this is the railway consignment note, which contains details of the consignee and the description of the goods, including their value. The consignment note along international railway corridors is usually a Carriage of Goods by Rail Convention (CIM) consignment note. At many railway border crossings, the consignment note is paper-based, but increasingly the railways in the region are exploring the exchange of electronic consignment notes. The use of electronic consignment notes has great potential to expedite border crossing formalities.

The technical handover of the wagons is required when they need to cross over to the neighbouring railways. The details of the required processes and documentation are specified in bilateral and multilateral railway agreements. These introduce a standardised procedure for completing the handover formalities at border crossings. The form of the wagon list is prescribed along with the rules for checking the numbers of the wagons, signing and stamping the list of wagons during the handover process. The rules relating to technical admission of vehicles to circulate in international traffic, technical requirements and standards are also provided.

Customs formalities at railway border crossings include pre-arrival intimation followed by a risk analysis of the information submitted to arrive at the decision on the level of customs control that needs to be applied to the goods. After the arrival of goods, the party or the party's agent files the customs declaration for import or export or transit, as required, and goods are cleared from the customs control after completion of the necessary formalities.

The immigration controls are conducted by border police or by the designated immigration officials. Their duties include checking the illegal flow of migrants and providing protection against terrorism and crime. Border controls also depend on the arrangement among the countries. For example, no passport controls are undertaken within the Schengen Area in Europe. Immigration controls for the railway staff from neighbouring countries can be minimised through common approaches, such as special identity cards that are mutually recognised by the railways.

Controls by other government authorities depend on the nature of goods transported from the border crossing. Depending on the need, some border crossings have extensive controls, including phytosanitary, sanitary and radiology controls, which are managed by other government authorities. International railway carriage is a common product of two or more railway companies, and its efficiency directly depends on the cooperation among those companies and the control authorities responsible for clearance.

4.9.1.5 Border crossing procedures

Border crossing processes: To structure and compare the processing of freight trains at different border crossings with diverse conditions, so-called standard processes have been agreed upon, referring to typical tasks to be carried out for transferring a freight train from one side of the border to the other. This listing, as shown in the following example, includes 31 individual processes, which are assigned to four cross border procedures:

1) Pre-border processes,
2) Transport document processes,
3) Train operating processes and
4) Customs and authorities procedures

Table 4-11: An example of processes for freight trains crossing borders

Process cluster	N°	Standard process
(1) Pre-border	1.1	Info about train arrival
	1.2	Preparation-meeting for train arrival
Tasks/Processes after train arrival		
(2) Transport documents	2.1	Check of consignment list by RU
	2.2	Input of commercial data into IT system
	2.3	Input of technical data into IT system
	2.4	Calculation of freight
	2.5	Elaboration of waggon list
	2.6	Elaboration of a brake sheet
	2.7	Handing over papers to the train driver
(3) Train operation (with respect to border crossing)	3.1	Take over train and train papers
	3.2	Commercial train check
	3.3	Uncoupling locomotive from the train
	3.4	Technical train check
	3.5	Compilation of notes for technical/commercial repairs
	3.6	Technical and commercial repairs
	3.7	Control of technical and commercial repairs
	3.8	Elaboration of a shunting list
	3.9	Sorting out damaged waggons
	3.10	Coupling locomotive to the train
	3.11	Brake test
	3.12	Fixing tail signal
	3.13	Adding the transit labels to the waggons
	3.14	Solving additional problems
	3.14	Preparation for train departure
(4) Customs/Authorities	4.1	Processing of custom papers (by RU)
	4.2	Handing over papers to customs
	4.3	Processing of the papers by customs
	4.4	Customs train check
	4.5	Receiving papers from the customs
	4.6	Border police control
	4.7	Phyto-sanitary control

Source: The CREAM Project, HaCon Ingenieurgesellschaft mbH, Hannover, Germany, July 2012

All procedures needed to handle a freight train at individual border stations without considering exceptional events, such as wagon detachments or technical locomotive defects, are allocated to the previously defined standard border processes. To show how the scheduled border stopping time is used, these standard processes are assembled in a process sequence chart. This chart shows:

- which standard processes are carried out when processing a freight train,
- which company and which staff are in charge to conduct the respective process,
- what is the required (theoretical) time value to conduct the respective process,
- in which sequence are processes carried out, and
- as a result what is the minimum required total (theoretical) border stopping time.

4.9.1.6 Interoperable trains

The Agreement on the Running of Interoperable Trains Crossing Borders applies between two rail carriers. In addition to other conditions for the smooth running of interoperable trains, timely and accurate exchange of information must be ensured. The status of an interoperable train is not lost if only the train number is changed, but all other parameters must remain unchanged. Trains cross borders based on a mutual trust agreement (technical confidence). A complete brake test is usually not performed on acceptance.

In both directions, the type of wagon brakes are generally in the “P” position. The rear signals are used that are allowed according to the regulations of both states. Exceptional consignments must be announced with prescribed rules. Transport documents and other documents shall remain on the train locomotive for interoperable trains in both directions. As an example, the following codes are used to define the types of interoperable trains:

- 0 – the train is not interoperable,
- 1 – no train operations*, no change of locomotive,
- 2 – train operations*, no change of locomotive,
- 3 – no train operations*, change of locomotive,
- 4 – train operations*, change of locomotive.

Note operation* means;

- technical inspection of the train,
- performing a brake test,
- add/remove wagons,
- commercial train inspection and / or commercial tasks.

4.9.1.7 Commercial train/wagon check

A commercial inspection of a train (or a single wagon) implies checking the prescribed order and recording irregularities:

- on individual loads on uncovered wagons (including the distribution of loads on axles),
- on tarpaulins (including correct installation and attachment),
- regarding the disposal or loss of goods or individual parts of loads,

- that the goods are loaded and secured under the provisions of Annex II. RIV,
- the wagons are marked with the prescribed marking sheets,
- any wagon accessories are correctly installed,
- the doors on the wagons are properly closed,
- concerning the consistency of transport documents with train check documents.

The commercial inspection of the train must be carried out directly:

- before the train leaves the departure station;
- after arrival of the train at the arrival, shunting or handover stations, but only if the train is to be handed over to the next rail carrier.

A commercial inspection shall be carried out at a handover station if the train has a timetabled stop of more than 50 minutes.

A commercial inspection of each wagon must be carried out immediately upon arrival at:

- a railway station only for wagons decoupled from the train for that station. If only a change of locomotive is required (e.g. due to traction system, a change of direction…) at a station at which a commercial train inspection is to be carried out, without other tasks being performed on the train (adding or removing wagons, repairing of the loading or a technical malfunction on the wagon, etc.), then as an exceptional circumstance it is not necessary to carry out a commercial inspection of the train,
- at the final arrival destination and
- at stations with foreseen or unforeseen wagon manipulations.

During the commercial inspection of the freight train some other procedures operate in parallel, such as the delivery of consignment notes between different railway staff at the railway station that could be a handover or final arrival station.

4.9.1.8 Mutual trust agreement

In order to speed up international freight transport, rail carriers have concluded multilateral and bilateral pre-technical mutual trust (inspection) agreements for the handover of freight wagons and freight trains based on technical trust, based on UIC Publication 471-2.

The agreements defines the rules and conditions for the pre-technical inspection of freight trains, set up by the first carrier and recognised as a valid by the second, without having carried out a technical inspection upon acceptance at the handover railway station. Freight wagons must be delivered in the prescribed conditions in accordance with:

- Conditions for the handover of freight wagons,
- Inscriptions and markings on freight wagons,
- The applicable UIC loading guidelines.

The mutual trust agreements for the exchange of freight wagons are based on the defined train number and route. In accordance with the conditions to be fulfilled by the technical trusted trains under agreements, the following measures must be taken into account.

- Technical trusted trains must be marked from arrival to destination station with the same train number, and thus a change of the number is prohibited.
- Technical trust trains may only operate on the route specified for them. When such trains run on a bypass route, information must be provided in a timely manner by the transferring carrier on the necessary characteristics to keep the status of train.
- After trains have passed the pre-technical inspection for technical confidence, marshalling operations are prohibited. If marshalling operations are required after a pre-shipment inspection has been completed, then after completion of these operations in accordance with a contract a proper inspection of the train for damage that may result because of marshalling must be carried out, along with an appropriate braking test. If these measures are carried out, the train does not lose the status of technical confidence.
- Exceptional consignments could be transported on mutual trust agreement trains under the following conditions:
    - if they have been approved in accordance with UIC Publication 502-1,
    - if they have been inspected and allowed to be boarded,
    - if the acquiring carrier has been informed in advance
    - if they have a valid transport announcement with the date of the journey, the train used and details of the transport conditions.

For partners of other train agreements, the classification of extraordinary consignments on trains is not allowed. Consignments transported in combined traffic, which are in principle treated as exceptional consignments, may operate as part of the train composition under the status of technical trust if the published international timetable provides the necessary information for combined traffic.

In practice, there are cases where, for various reasons, deviations from the applicable operating timetable, train assemblies and the aforementioned agreements occur:

- modification of the train path and no timely notification by the dispatch carrier,
- loading of consignments on trains, which are not permitted under the agreements.

The aforementioned deviations result in the loss of the train's status of mutual trust (technical confidence) and a pre-technical inspection is required for the train at the handover station.

4.9.2 Electronic data interchange

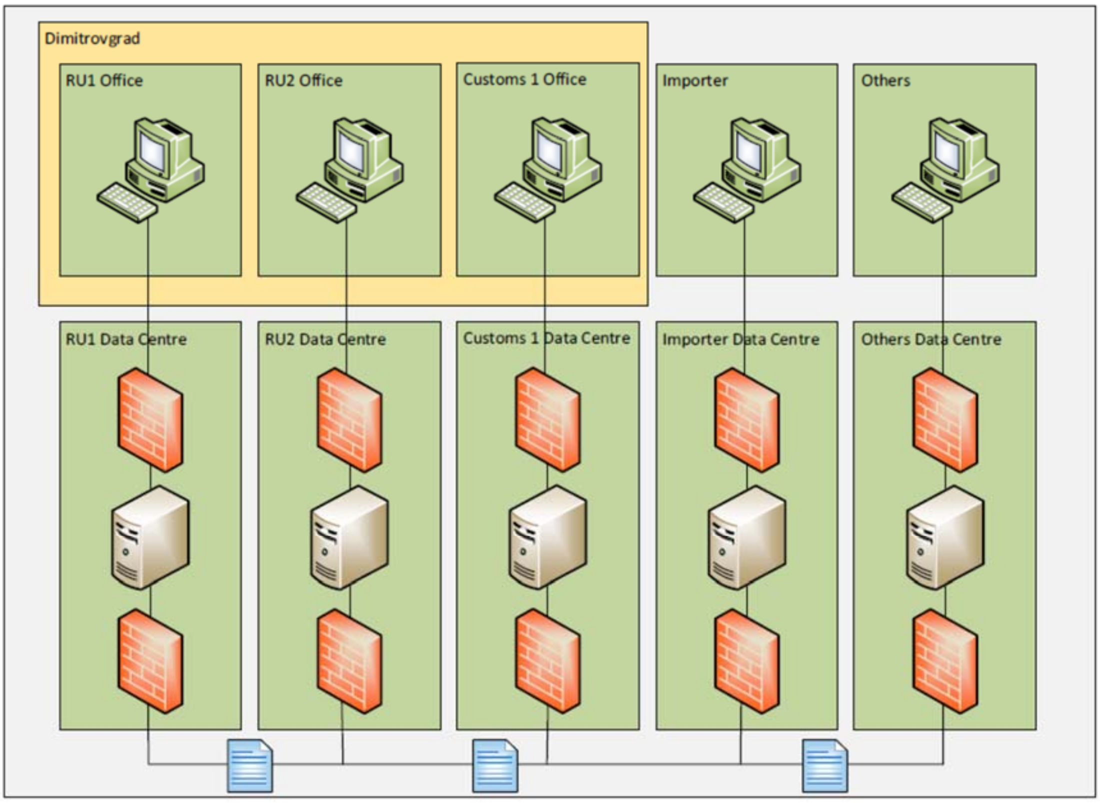
Handling of paper transport documents is very costly and presents serious technological limitations for railway transport. With the intention of adopting paperless technology, major European railway undertakings have deployed information systems to collect and process data about their consignments. A further step has been to interconnect national companies' systems to exchange consignment information with regard to international transports.

4.9.2.1 General

Automated exchange of data or electronic data interchange (EDI) is defined as the automated exchange of structured electronic messages for use in another system or organisation. By using a defined protocol both sender and receiver can verify that the message is formally correct and can be used for further processing. EDI communication is characterised as an exchange of information between two server applications, and usually between two organisations or parties. EDI between two parties must be initiated by some kind of event or information – for example, this can be a train passing a certain position or information within a document pointing out the next BCP, or a lead rail carrier receiving the assignment from a customer, transferring a consignment note to an rail carrier and a pre-arrival declaration to Customs.

EDI requires a common network and defined interfaces, both to transfer information and to interpret the information received. Standards defined by the United Nations Centre for Trade Facilitation and Electronic Business and World Customs Organization may be used to simplify integration with customs administrations, especially for actors having interchanges with many customs administrations. Technical protocols must be established across a range of factors – including the network, security, messages structure, as well as the content of the message – in order to be able to exchange electronic information.

Figure 4-29: Electronic Data Interchange

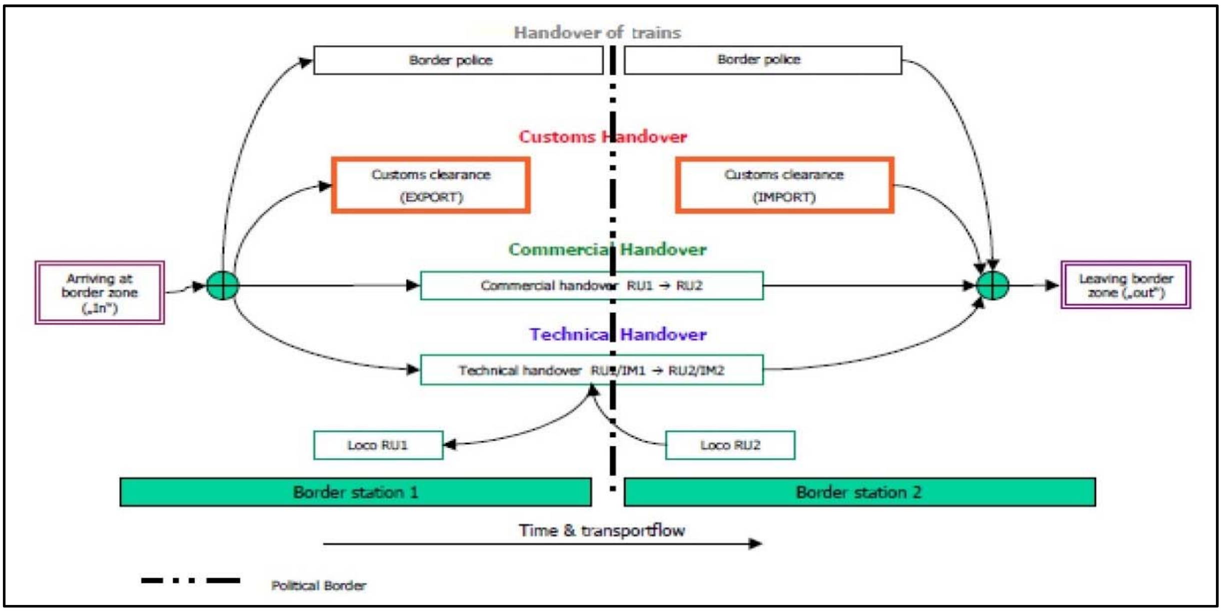


Source: KGH Group AB, Rail EDI at a border crossing point in South East Europe, May 2015

A number of parties are involved in a railway BCP, and normally include the following:

- RIMs: two or more infrastructure managers are concerned, one in each country. The technical handover is the responsibility of the RIMs.
- Rail carriers: two or more carriers, one in each country. They are partly responsible for the train and the goods being transported. The commercial and operational handover are the responsibilities of the carriers.
- Customs: if the BCP is an EU/non-EU border then two Customs Administrations are involved.
- Border police: if the border is an external border (not internal as defined in the Schengen Agreement), two border police administrations are concerned.
- Other government authorities: other border authorities, such as phytosanitary, sanitary, radiology authorities. In many cases the customs authorities are responsible to work on their behalf.
- Shipper or freight forwarder: a shipper or freight forwarder is a person or company that organises shipments to get goods from the start point to a final point of distribution. A forwarder normally contracts with carriers to move goods/cargo.
- Traders (importer, exporter, or owner of transit goods): normally cannot be observed at the BCP but they play a significant role as the holder of the goods and the main source of information concerning the goods in question.

Figure 4-30: Handover Procedures at a BCP



Source: SEETO (2009), Rail EDI at a border crossing point in South East Europe, May 2015

4.9.2.2 ORFEUS

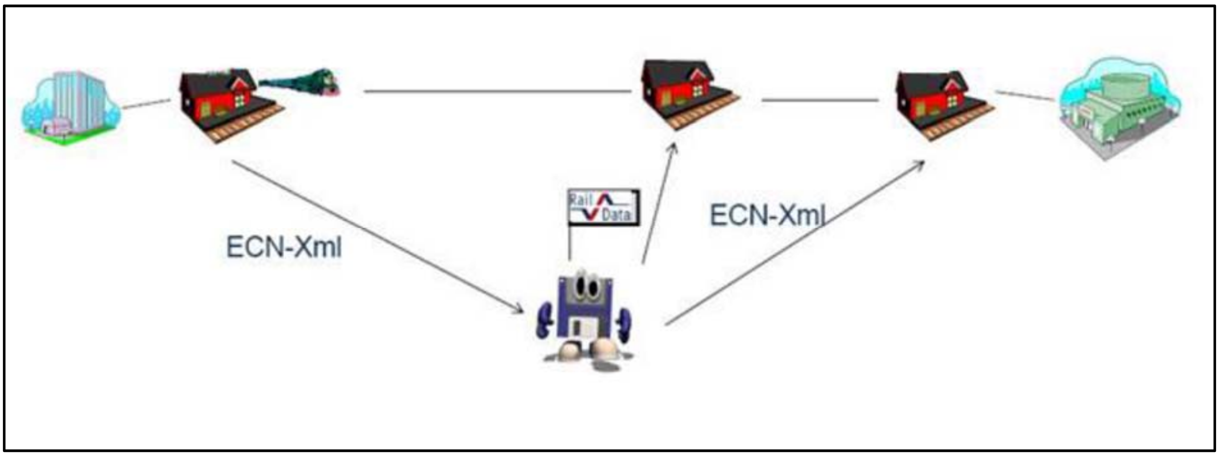
ORFEUS is an information system developed and operated by RailData. Since 1995, ORFEUS has provided the electronic data exchange of the consignment note data between the co-operating rail carriers using its central database. In the first step the data is sent in parallel to the paper CIM consignment note (or CUV wagon notes data for empty wagons). In 2006 the ORFEUS was migrated to the XML-CTD message system, in particular to fulfil the requirements related to the coming into force of the new international rail transport law CIM. In 2009, the system was extended with the ECN message format and new message flows.

ORFEUS enabled re-engineering of the European freight rail logistics. Data is delivered by the forwarding rail carriers to ORFEUS and from there distributed to other rail carriers involved in the transportation. With ORFEUS it is no longer necessary to collect the consignment or wagon note data on the borders or at handover. This way the system improves the speed and reliability of international freight rail transport and enables significant cost savings.

ORFEUS ensures the exchange of railway CIM consignment note and CUV wagon note data between the co-operating rail carriers using a Central Data System (CDS) with the following components:

- Central part CDS (Central Data-management System). It acts as a message broker for collection and distribution of information, including specific logic and verifications.
- National Information Systems (NISes) of the connected railway undertakings, and this is the common name for the information system of a freight railway company, which covers both commercial and production functions.

Figure 4-31: Data exchange in the ORFEUS system



Source: https://www.raildata.coop/orfeus-objectives

ORFEUS is in real and daily use. Consignment and wagon note data are exchanged between the information systems of user rail carriers on a regular basis, using the central application (CDS). It runs in a computer centre in Aubervilliers with a hot backup centre in Paris. The stability of both the central system and national applications is excellent thanks to the service management and redundancy of all components.

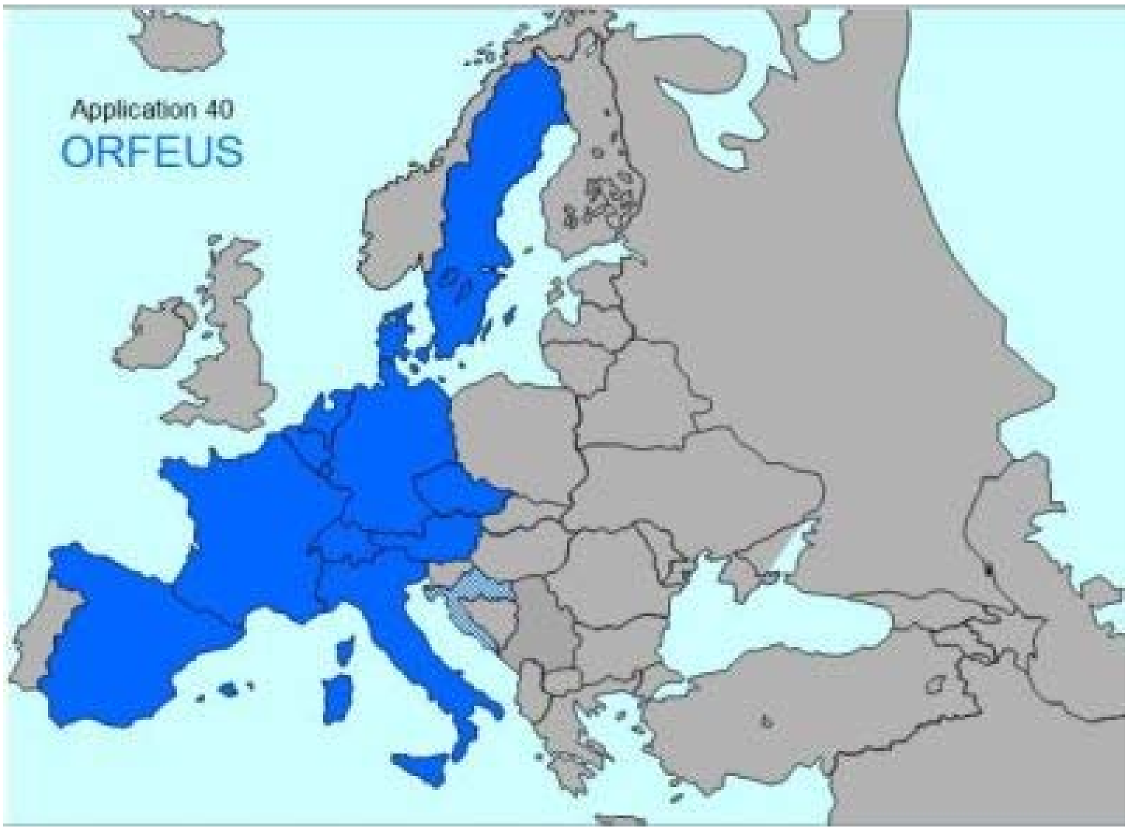
A huge amount of consignment data is exchanged among the ORFEUS users, with some example average volumes shown below:[5]

- in total on average about 110.000 messages with consignment notes are sent by the users to ORFEUS each month,
- in the opposite direction, a similar (but greater) amount of messages with consignment notes are sent by ORFEUS to the users,
- ORFEUS processes more than about 2,7 million messages yearly.

The ORFEUS users use the consignment data for incoming traffic procedures. Many railway companies take part in this process, with the biggest being as follows: ČD Cargo, DB Cargo, Euro Cargo, Transfesa, Green Cargo, LINEAS, Mercitalia Rail, Rail Cargo Austria, RENFE MERCANCÍAS, SBB CFF FFS Cargo, SNCF MOBILITES – Fret and HŽ Cargo (only receiving).

States where the "national" freight railway carrier sends messages through the ORFEUS central system are shown on the next figure.

Figure 4-32: States with the ORFEUS system



Source: https://www.raildata.coop/orfeus-objectives

[5] Source: https://www.raildata.coop/

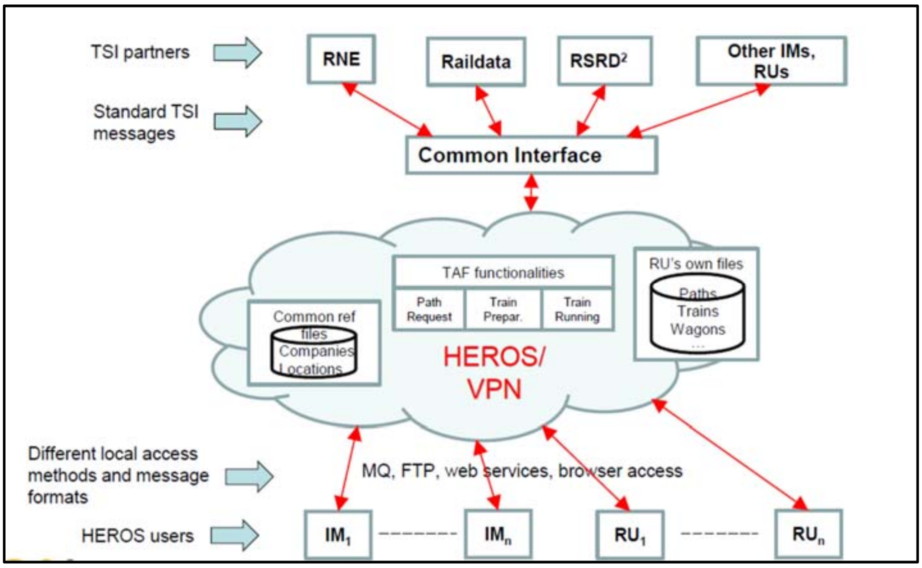
4.9.2.3 Hermes / HEROS

Hit Rail is a company based in the Netherlands that operates communications infrastructure and delivers messaging services for its customers throughout Europe. In 2013, the company launched its HEROS platform as a family of solutions that delivers benefits to the railway companies across Europe, by enabling message interoperability across disparate platforms and among railway applications in passenger, freight and infrastructure for IT communications.

Hermes VPN is a platform that enables the interconnection and interoperability of disparate rail reservation and rail freight messaging services despite the use of varying standards in different countries. It is used by more than 50 railway companies in 21 countries, who have already chosen the cybersecure Hermes VPN to create an ecosystem that extends the reach of interoperable TAF-TSI compliant communications, improving freight services across Europe.

The operators use the Hermes VPN for the exchange of H30 train composition messages, the well-known standard defined by the UIC, whose latest version is almost identical in content to that of the TAF TSI Train Composition message. For this reason, the ERA has established a task force discussing, among other things, whether such H30 messages can be considered TAF (soft) compliant.

Figure 4-33: HEROS – Hermes Open Service, cloud concept



Source: 7th Regional TAF TSI Workshop, 7th - 8th March, Bucharest, 2018

The Hermes VPN has built-in cybersecurity with a range of measures to ensure the highest levels of protection – a significant and vital benefit for sensitive information passing between rail organisations. An increasing number of railway companies are signing up to use Hit Rail's Hermes VPN network, allowing them to communicate with other rail companies seamlessly. Independent freight operators and smaller rail carriers can make use of the Hermes IP-based virtual private network and its 24/7/365 operational and maintenance support services.

4.9.3 Cross-border sections

Border crossings are the points of fracture in continuity in transport services. There are many forms used by railways for the organisation of activities at border crossings, but the key factor should only be the level of interoperability achieved. For evaluating the levels of interoperability, the following three main modes of organising border-crossing activities can be defined:[6]

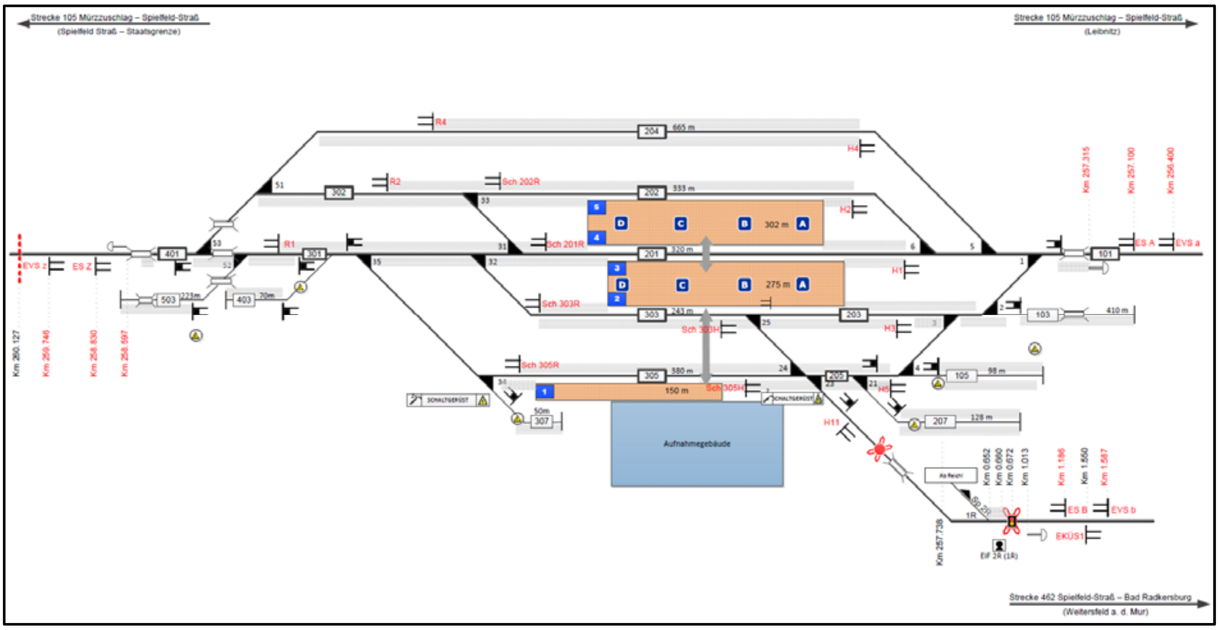
1) the various authorities of the two neighbouring states carry out their procedures separately, sequentially, first in the exit border station and then in the entry border station;
2) the two neighbouring states agree to designate one single common border station, where the procedures of the authorities of both countries take place in parallel;
3) the two neighbouring states decide to implement common procedures for border crossing without the train stopping; the specific border crossing activities are organised in designated major stations on the route of the train, agreed upon by the two neighbouring states, in parallel with the procedures of the railway companies for processing the train (locomotive change, technical inspection of wagons, etc.).

4.9.3.1 Station of exchange of traffic Spielfeld-Straß (Austria)

Spielfeld-Straß is the border handover station between Austria and Slovenia. The station is managed by the ÖBB-Infrastruktur AG and it is open for passenger and freight transport. The station is located at the two EU member states inside the Schengen area. Spielfeld-Straß is a junction station for the local line Spielfeld-Straß – Bad Radkersburg. At the station the traction system of voltage is changed from 3 kV DC (SŽ-I) to 15 kV AC (ÖBB-I). The Slovenian national rail freight carrier SŽ-TP changes the locomotives for all trains. Other rail carriers do not change locomotives. At Spielfeld-Straß there are no customs or police procedures. Phytosanitary and veterinary agents are not present. All trains operate in accordance with a mutual trust agreement.

[6] Source: Enhancing interoperability for facilitation of international railway transport, United Nations, ESCAP, Bangkok, 2018

Figure 4-34: Spielfeld-Straß station layout



Source: ÖBB-I

The station has five tracks, four of which are located along passenger platforms.740 m trains cannot use sidings in this station, but they can run only on the main running track. The longest track has a length of 665 metres. The station has the following main tracks.

Table 4-12: Main tracks at Spielfeld-Straß station

Track No.	Usable length (m)	Passenger platform
305	380	Yes
303	243	Yes
201	320	Yes
202	333	Yes
204	665	/

Source: ÖBB-I

Station Spielfeld-Straß has the shortest stopping times in freight transport along the AWB RFC. Average stopping times for freight trains are:

- Timetable plan → 20 min
- Actual → 40 min

Table 4-13: Cross-border procedure durations at Spielfeld-Straß station

No.	Type of procedure	Done by	Time (min)			
			10		20	
1	Uncoupling locomotive	Carrier	5			
2	Shunting movements, document exchange	RIM + carrier		10		
3	Coupling locomotive	Carrier			5	
4	Order of departing	RIM				5
Spielfeld-Straß border procedure duration (min)			**20**			

The reasons for delays at the handover station are:

- wagon inspection due to damaged wagons,
- brake tests,
- lack of locomotives.

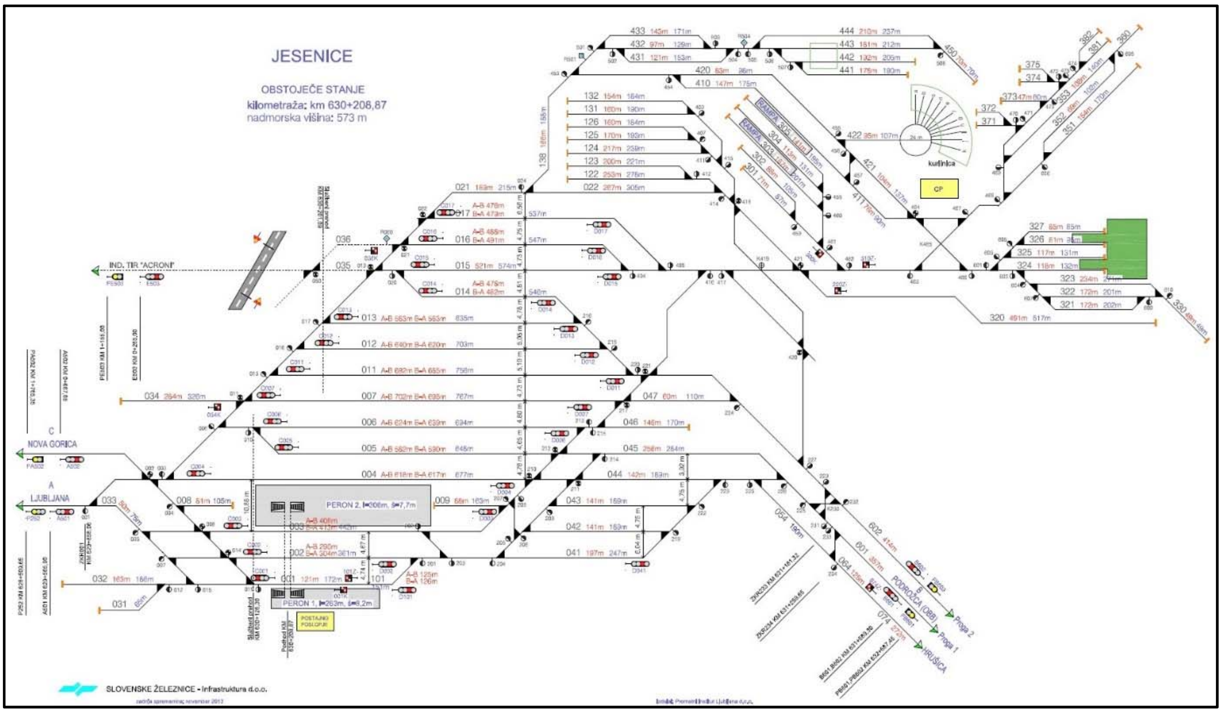
Figure 4-35: Spielfeld-Straß handover station

Source: https://www.bahnbilder.de/1024/viel-betrieb-spielfeldstrass-am-1722006-374130.jpg

4.9.3.2 Station of exchange of traffic Jesenice (Slovenia)

Jesenice handover station is the border station between Slovenia and Austria. The station is managed by the SŽ-Infrastruktura and it is open for passenger and freight transport. The station is located at two EU member states inside the Schengen Area. Jesenice is a junction station for the regional line Jesenice-Nova Gorica-Sežana. At the station the traction system of voltage is changed from 3 kV DC (SŽ-I) to 15 kV AC (OBB-I). The station is secured with an electro-relay signal safety device.

Figure 4-36: Jesenice station layout



Source: SŽ-Infrastruktura, d.o.o.

The station has many railway tracks for freight trains, but none of them has a usable length of 750 m that could be used for 740 m trains. Three rail tracks have passenger platforms and the other 11 tracks are used for freight trains. The longest track has a length of 702 metres. The station has the following main tracks.

Table 4-14: Main tracks at Jesenice station

Track No.	Usable length per direction (m)		Passenger platform
	A → B	B → A	
1+101	295	298	Yes
2	290	304	/
3	408	413	Yes
4	618	617	Yes
5	582	590	/
6	624	639	/
7	702	695	/
11	692	685	/
12	640	620	/
13	583	583	/
14+114	478	482	/
15	521	521	/
16	488	491	/
17	476	479	/

Source: SŽ-Infrastruktura, d.o.o.

The Slovenian national rail freight carrier changes the locomotives on the most of trains. Other rail carriers do not change the locomotives. At Jesenice station there are no customs or police procedures, and no problems related to the migrant crisis. Phytosanitary and veterinary agents are not present. All trains operate in accordance with a mutual trust agreement. The main reason for train delays are a lack of locomotives at rail carriers. Almost all trains have a mutual trust agreement and thus are seen as "trusted-trains". If the wagon set is changed, the wagon inspection is only for the added wagons.

Average stopping times for freight trains at Jesenice station:

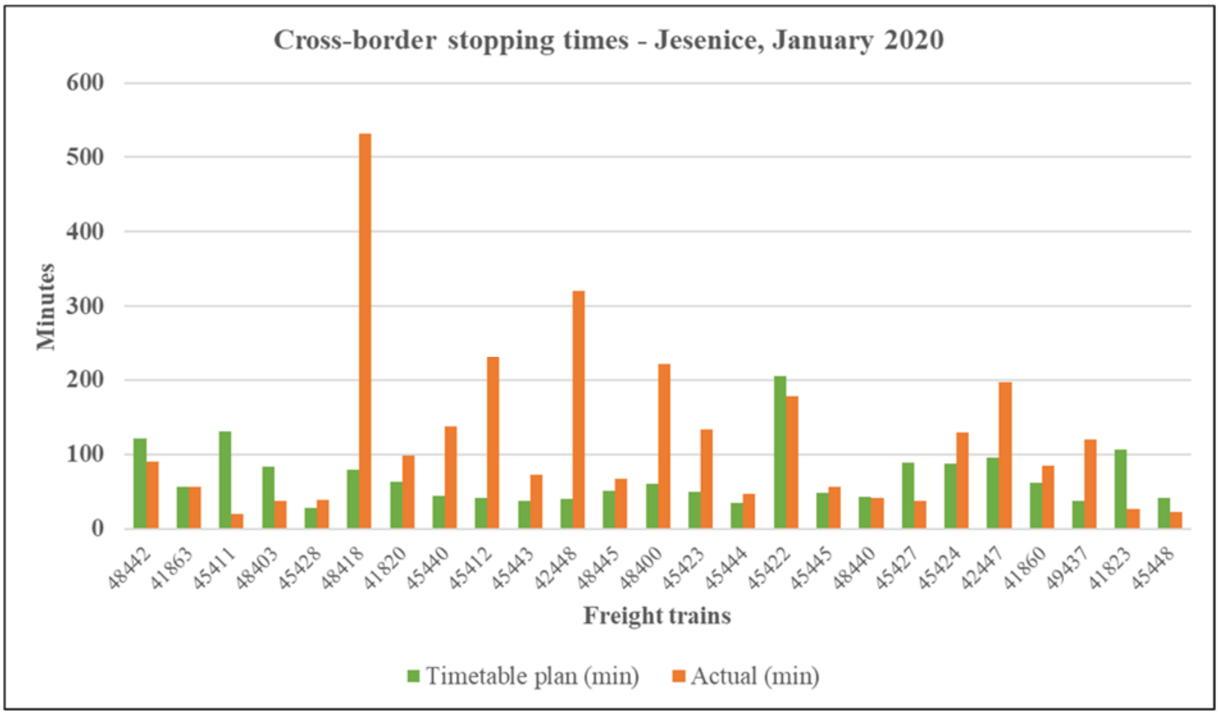
- Timetable plan → 80 min
- Actual → 180 min

Table 4-15: Cross-border procedure durations at Jesenice station

No.	Type of procedure	Done by	Time (min)							
			10	20	30	40	50	60	70	80
1	Info about train arrival	RIM	5							
2	Bring in the documents and consignment notes	Carrier 1	5							
3	Uncoupling locomotive	Carrier 2	5							
4	Shunting movements	RIM + carrier 2	10							
5	Coupling locomotive	Carrier 2		5						
6	Carrier 1 commercial check	Carrier 1	20							
7	Carrier 2 technical check	Carrier 2	30							
8	Train listing	Carrier 2	30							
9	Checking the accounting in advance	Carrier 2		5						
10	Hand over Carrier 1 accounting to Carrier 2	Carrier 1		15						
11	Take over Carrier 2 accounting to Carrier 1	Carrier 2				5				
12	Accounting the consignment notes	Carrier 2				20				
13	Listing the commercial data	Carrier 2				35				
14	Brake test	Carrier 2					30			
15	Delivering the consignment notes	Carrier 2							5	
16	Order of departing	RIM								10
Jesenice border procedure duration (min)			**80**							

The next figure presents an example of cross-border stopping times at Jesenice handover station for January 2020.

Figure 4-37: Cross-border stopping times at Jesenice



Source: SŽ-Infrastruktura, d.o.o. and Prometni institut Ljubljana, d.o.o.

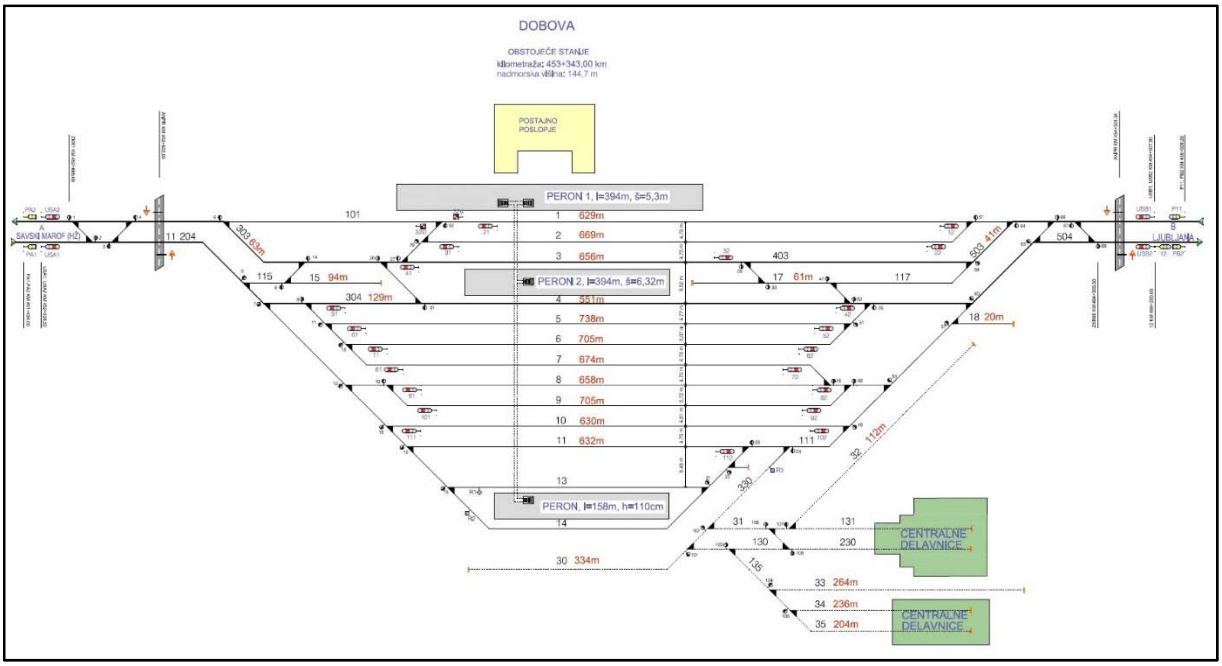
Figure 4-38: Jesenice handover station

Source: https://www.radio1.si/img/Gallery/Photo/el_b8631bca-2c11-4c39-9f66-1be1a8c53e99.jpg

4.9.3.3 Station of exchange of traffic Dobova (Slovenia)

Dobova handover station is the border station between Slovenia and Croatia. The station is managed by SŽ-Infrastruktura and it is open for passenger and freight transport. The station is located at the border of two EU Member States, but with only one in the Schengen Area (Slovenia). At the station the traction system of voltage is changed from 3 kV DC (SŽ-I) to 25 kV AC (HŽ-I). The station is secured with an electro-relay signal safety device.

Figure 4-39: Dobova station layout



Source: SŽ-Infrastruktura, d.o.o.

The station has many railway tracks for freight trains, but none of them has a usable length of 750 m that could be used for 740 m trains. Three rail tracks have passenger platforms and the other eight tracks are used for freight trains. The longest track has a length of 737 metres. The station has the following main tracks.

Table 4-16: Main tracks at Dobova station

Track No.	Usable length direction (m)		Remarks
	A → B	B → A	
1	674	674	Passenger platform
2	656	656	
3	394	394	Passenger platform
4	550	550	Passenger platform
5	737	737	
6	704	704	
7	673	673	
8	658	658	
9	705	705	
10	630	630	Police inspection
11	433	433	
13	330	330	Veterinarian and phytopathological insp.
14	330	330	Veterinarian inspection

Source: SŽ-Infrastruktura, d.o.o.

Many rail carriers (especially the national carriers SŽ-TP and HŽ Cargo) change the locomotives at all trains.

Technological process of works at Dobova station:

- It the locomotive is not interoperable it must be changed due to different types of traction system voltage between the Slovenian and Croatian electric power supply systems.
- Border control point of Slovenian police in accordance with EU Schengen legislation.
- The migrant crisis and security issues have caused much more detailed checks of the trains, which causes additional delays.
- Every train is expected to be checked in 15 minutes (shorter inspection) or up to 90 minutes (detailed review). The length of the review is in the judgment of the police.
- During the detailed inspection, the freight train is moved to track 9 or 10, where the voltage is switched off and the wagons chassis, interior and wagon roof checked.

Average stopping times for freight trains at Dobova station:

- Timetable plan → 110 min
- Actual → 240 min

Table 4-17: Cross border procedure durations at Dobova station

No.	Type of procedure	Done by	Time (min)										
			10	20	30	40	50	60	70	80	90	100	110
1	Info about train arrival	RIM	5										
2	Transfer of documents and consignment notes	Carrier 1	5										
3	Uncoupling locomotive	Carrier 2	5										
4	Shunting movements	RIM + carrier 2		10									
5	Coupling locomotive	Carrier 2			5								
6	Carrier 1 commercial check	Carrier 1		20									
7	Carrier 2 technical check	Carrier 2		30									
8	Border police control	Police	30										
9	Train listing	Carrier 2			30								
10	Checking the accounting in advance	Carrier 2				5							
11	Officialy hand over of the train	Carrier 1				15							
12	Officialy take over of the train	Carrier 2						10					
13	Carrier 2 commercial check	Carrier 2							20				
14	Listing the commercial data	Carrier 2							35				
15	Brake test	Carrier 2							30				
16	Delivering the consignment notes	Carrier 2										5	
17	Order of departing	RIM											10
	Dobova border procedure duration (min)		**110**										

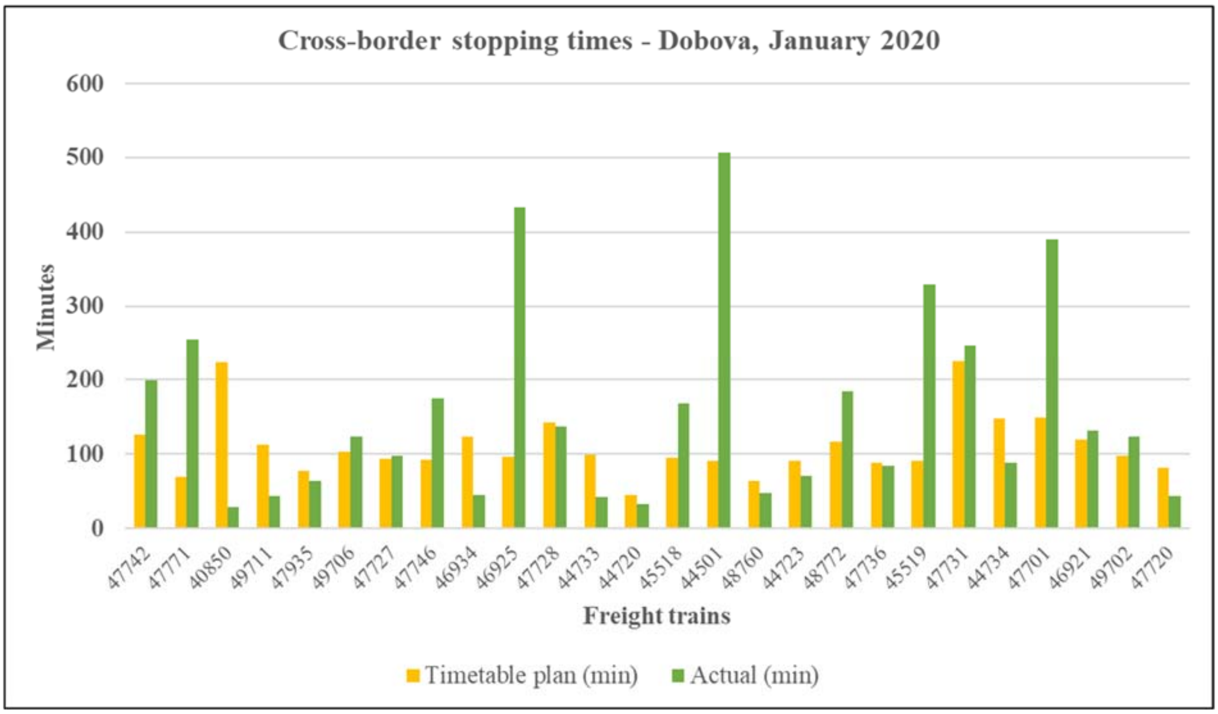
Border police are present at Dobova station. Phytosanitary and veterinary agents are not always present, but only when required. They are located at the road border crossing.

Table 4-18: An example of the border authority time norms at Dobova

Type of procedure (Dobova)	Unit	Time (min)			
		10	20	30	40
Border police control	train	30			
Veterinarian inspection	wagon	10			
Phytopathological inspection	wagon	10			
Phytosanitary control	wagon	10			

The next figure presents an example of cross-border stopping times at Dobova handover station from January 2020.

Figure 4-40: Cross-border stopping times at Dobova



Source: SŽ-Infrastruktura, d.o.o. and Prometni institut Ljubljana, d.o.o.

The delays in freight transport at Dobova station are mainly due to delays caused by the neighbouring infrastructure manager or (previous or sequential) rail carriers, which also take into consideration trains that are detained due to uneven arrival in Dobova because of the work of other infrastructure managers (causing police and capacity procedures). The main reasons for delays are:

- Non-implementation of the timetable (running of missed trains, especially transit trains) and the consistency of successive railway carriers,
- Receiving delayed trains from the neighbouring infrastructure manager,
- Provision of locomotives (lack of locomotives).

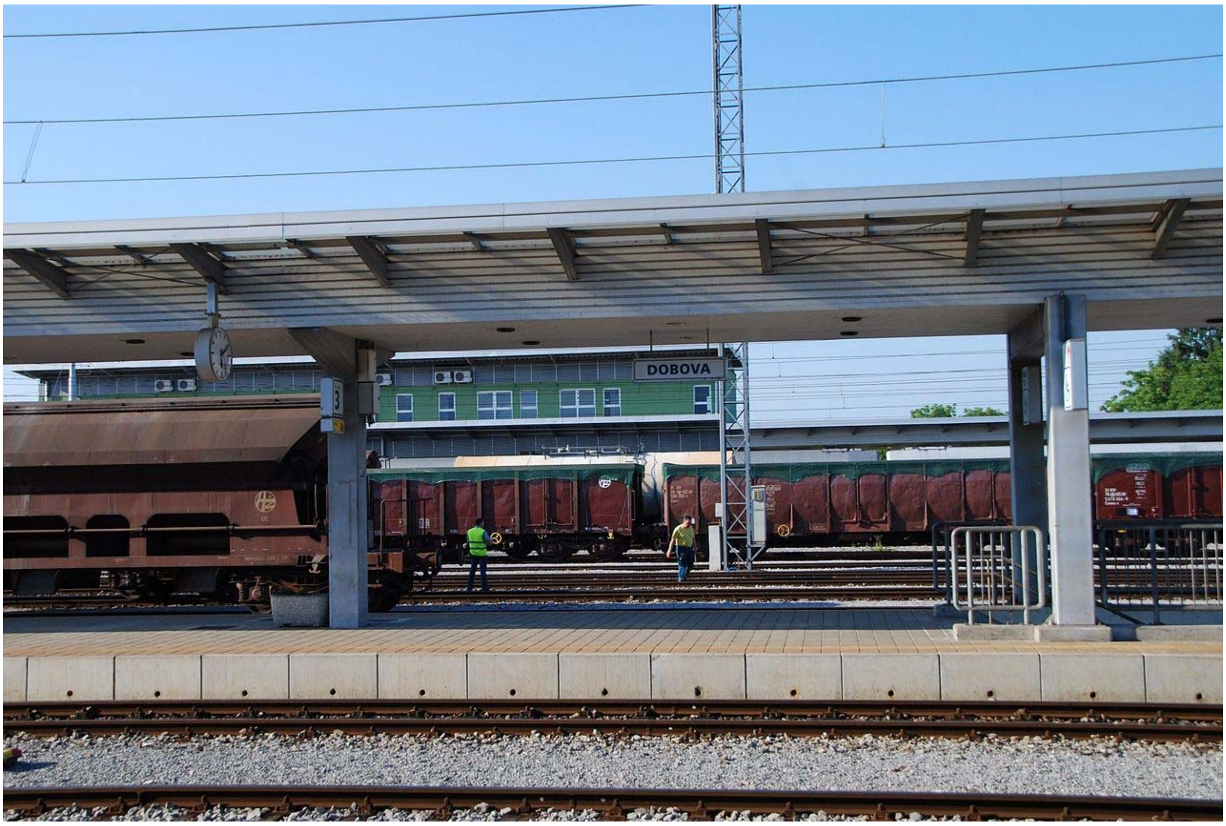
Causes of delays at Dobova railway station:[7]

- Infrastructure managers 32%
- Rail carriers 26%
- External causes – Schengen 16%
- Locomotives 15%
- Secondary causes 9%
- Maintenance 2%

[7] Source: Analysis of the delays at the Dobova rail border station, SŽ-Infrastruktura, 2019

The neighbouring railway station, Savski Marof, is located at the border between Croatia and Slovenia. The Slovenian and Croatian Authorities work together at the Dobova handover station, which is located in the Slovenian territory, where all the controls and procedures are performed.

Figure 4-41: Dobova handover station



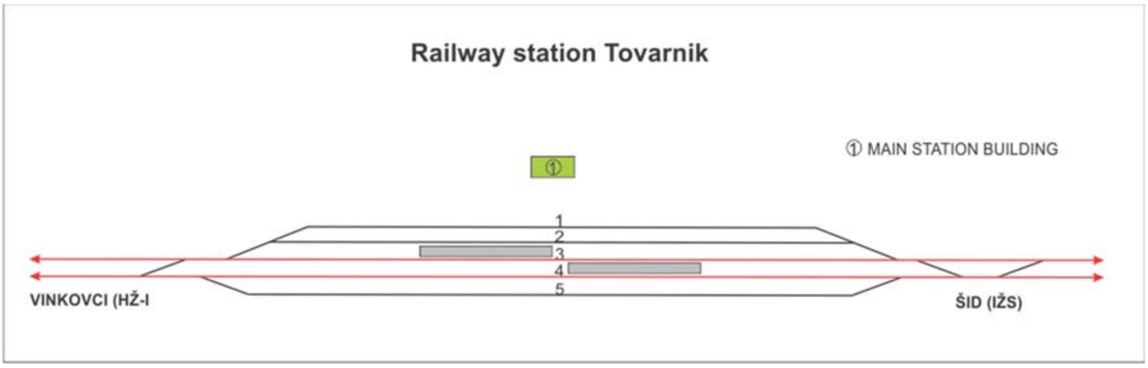
Source: By Eleassar, CC BY-SA 4.0, https://commons.wikimedia.org/w/index.php?curid=40808482

4.9.3.4 Cross-border section Tovarnik (Croatia) – Šid (Serbia)

Tovarnik border station (Croatia)

Tovarnik station is a border station between Croatia and Serbia. The station is managed by the HŽ-I and it is open for passenger and freight transport. The station is located on the border of an EU member (Croatia) and non-EU member (Serbia). The crossover border section between Tovarnik (HŽ-I) and Šid (IŽS) has a voltage of 25 kV AC. The station is secured with an electronic signal safety device. The authorities present at the station are customs and police, all working 24/7. Veterinarian and phytopathological inspectors are not constantly present at the station, and are located at the road border crossing (30 min away). Tovarnik is not a handover station, and trains stop because of customs, police and brake inspection.

Figure 4-42: Tovarnik station layout



Source: HŽ-I

Tovarnik station has five railway tracks, three of them have a length over 740 m. Three rail tracks have passenger platforms, tracks 3 and 4 are running tracks. Tovarnik has the following track lengths.

Table 4-19: Tracks at Tovarnik station

Track No.	Length (m)	Comments
1	697	manipulative, loading/unloading
2	684	arrival/departure, passenger platform
3	777	running track, passenger platform
4	802	running track, passenger platform
5	802	arrival/departure

Source: HŽ-I

Average stopping times for freight trains at Tovarnik:

- Timetable plan
  - Serbia → Croatia = 120 min
  - Croatia → Serbia = 90 min
- Actual
  - Serbia → Croatia = 76 min
  - Croatia → Serbia = 141 min

Table 4-20: Actual stopping times at Tovarnik station

Reasons for actual average border stop per freight train:	**Stopping time (min)**	
	Šid-Tovarnik	**Tovarnik-Šid**
Customs	46	76
Police	72	22
Trains driver change	1	/
Refusal of admission[8]	/	67
Total (with other activities)	**76**	**141**

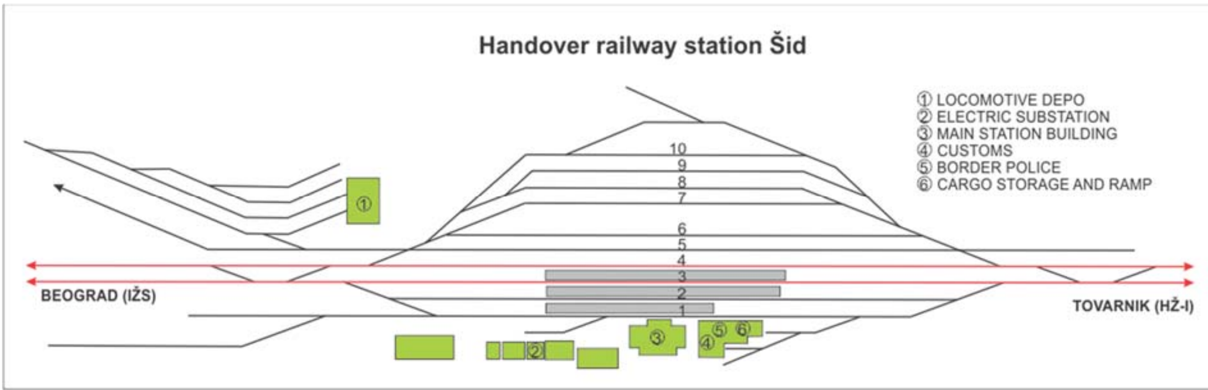
Source: HŽ-I

[8] Waiting for approval for departure (in the direction Tovarnik-Šid) from Šid handover station (IŽS).

Šid handover station (Serbia)

Šid handover station is a border station between Croatia and Serbia. The station is managed by the IŽS and it is open for passenger and freight transport. The station is located on the border of an EU member (Croatia) and non-EU member (Serbia). The crossover border section between Tovarnik (HŽ-I) and Šid (IŽS) has a voltage of 25 kV AC. The station is secured with an electro-relay signal safety device. Five industrial tracks are connected with the station. The authorities present at the station are customs working and police, both working 24/7. Phytosanitary and veterinary agents are not constantly present, but only when required. They are located at the road border crossing.

Figure 4-43: Šid station layout



Source: IŽS

The station has many railway tracks for freight trains, but only two running tracks (3, 4) have a usable length over 800 m that could be used for 740 m freight trains. Three rail tracks have passenger platforms and the other seven tracks are used for freight trains. The longest (running) track has a length of 837 metres. Šid station has the following important tracks.

Table 4-21: Tracks at Šid station

Track No.	Usable length (m)	Comments
1	593	loading/unloading of cargo
2	700	arrival/departure; passenger platform
3	837	running track; passenger platform
4	832	running track; passenger platform
5	742	arrival/departure;
6	633	arrival/departure; marshalling
7	553	arrival/departure; marshalling
8	522	marshalling
9	544	marshalling
10	353	marshalling

Source: IŽS

For the freight trains going in the direction Tovarnik (HŽ-I)-Šid (IŽS) the time needed for all the controls and procedures to be performed is just over 2 h according to the timetable, but actually about 10 h, during which all the documents are checked as well as controls and the change of the locomotive and train staff. For those running in the opposite direction the time needed according to the timetable is about 2 h, but actually about 8 h.

Average stopping times for freight trains at Šid station:

- Timetable plan → 131 min
- Actual → 537 min

Table 4-22: Cross-border procedure durations at Šid (export)

No.	Type of procedure	Done by	Time (min)										
			10	20	30	40	50	60	70	80	90	100	110
1	Bring in the documents and consignment notes	Carrier	5										
2	Technical check	Carrier		30									
3	Commercial check	Carrier		25									
4	Customs document inspection	Customs		20									
5	Border police control	Police			30								
6	Return of documents	Customs			5								
7	Results of inspection, prepare for marshalling	Carrier				5							
8	Refused wagons marshalling	RIM + Carrier				10							
9	Customs wagon inspection	Customs							60				
10	Train listing	Carrier					20						
11	Handover of the train	Carriers										10	
12	Brake test	Carrier						30					
13	Delivering the consignment notes	Carrier								10			
14	Order of departing	RIM											5
	Šid border procedure duration (min)		**110**										

Source: IŽS

The next table presents the cross-border delays at Šid handover station for the first three months in 2020.

Table 4-23: Delays at Šid station

Direction	Month 2020	Total		Average		Timetable stopping time
		Trains	Actual delay (hours)	Trains (daily)	Actual delay (hours/train)	
Tovarnik-Šid	January	131	1.362	4,23	10:24	02:13
	February	149	1.698	5,14	11:24	
	March (1- 26)	131	1.064	5,04	8:07	
	Average	**137**	**1.375**	**4,80**	**9:58**	
Šid-Tovarnik	January	129	9.03	4,16	7:00	02:09
	February	146	9.68	5,03	6:38	
	March (1- 26)	134	1.344	5,15	10:02	
	Average	**136**	**1.072**	**4,78**	**7:53**	

Source: IŽS

The delays in freight transport at Šid station are mainly due to delays caused by:

1. Lack of railway carrier traction vehicles,
2. Customs and inspection operations,
3. Untimely handover of trains between the railway carriers,
4. Due to third parties (illegal migrants…),
5. Border police operations, other

The authorities of Šid station have established daily communication with the neighbouring station Tovarnik (HŽ-I) in Croatia through meetings, telephone and internet, mainly for information concerning the timetables of the trains and the expected traffic.

The main problems[9] the authorities face concern the obsolete infrastructure and lack of sufficient and well-trained staff. The authorities highlight the necessity of reconstructing the majority of the existing infrastructure as well as the necessity of the station to be properly equipped with modern and updated IC tools and technologies.

Figure 4-44: Šid handover station

Source: Sokolrus CC BY-SA 3.0, https://commons.wikimedia.org/w/index.php?curid=19812187

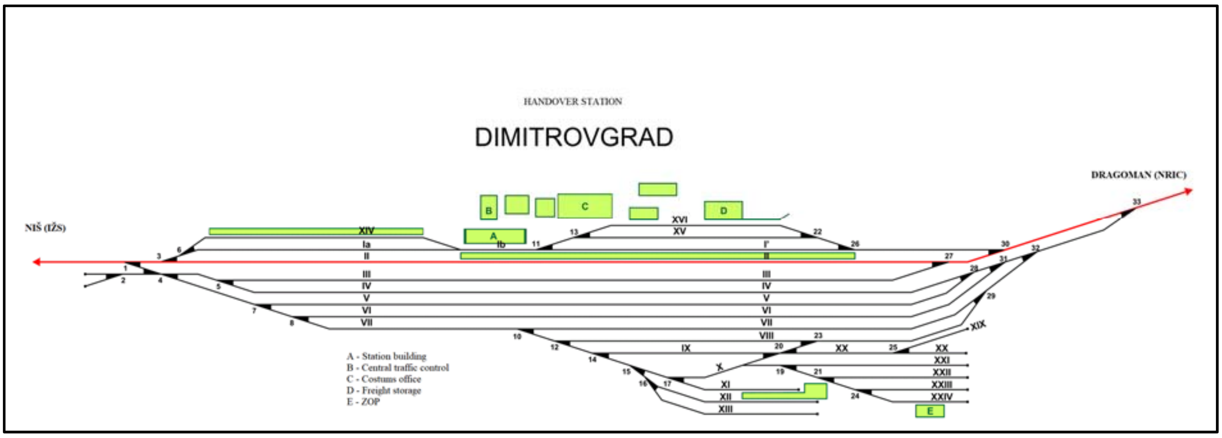
4.9.3.5 Cross-border section Dimitrovgrad (Serbia) – Dragoman (Bulgaria)

Dimitrovgrad handover station (Serbia)

Dimitrovgrad handover station is a border station between Serbia and Bulgaria. The station is managed by the IŽS and it is open for passenger and freight transport. The station is located on the border of an EU member (Bulgaria) and non-EU member (Serbia). The crossover-border section between Dimitrovgrad (IŽS) and Dragoman (NRIC) has a voltage of 25 kV AC. The station is secured with an electronic signal safety device. The authorities present at the station are customs and police, both working 24/7. Phytosanitary and veterinary agents are not constantly present but only when they are required.

[9] Source: ACROSSEE: Surveys at border crossings, WP5 "Cross border analysis", June 2014

Figure 4-45: Dimitrovgrad station layout



Source: IŽS

The station has many railway tracks for freight trains, but only one running track (2) has a usable length over 740 m. Two rail tracks have passenger platforms and the other four tracks are used for freight trains. Dimitrovgrad station has the following important tracks.

Table 4-24: Tracks at station Dimitrovgrad

Track No.	Usable length (m)	Comments
I	621 / 381	arrival/departure; passenger platform
II	745 / 746	running track; passenger platform
III	696 / 701	arrival/departure
IV	720 / 718	arrival/departure
V	649 / 655	arrival/departure
VI	644 / 646	arrival/departure
VII	352 / 384	bypass

Source: IŽS

According to the authorities, there are controls performed on board at both passenger and freight trains. Moreover, border police perform simultaneous controls of the passenger trains along with other authorities. Based on bilateral agreements between the operators of the Serbian and Bulgarian railways, the locomotives are changed at Dimitrovgrad.

Some data concerning the characteristics of the traffic flows through BCP is as follows.[10]

- The annual number of freight trains that crossed the cross-border section is about 5.000 trains.
- The percentage of transit annual tonnage carried is 98%.
- Most popular origin/destination points for the freight trains are Turkey and Germany.
- The traffic volumes come to their peak during July and August, on Friday and Saturday from 20:00 to 21:00.

[10] Source: ACROSSEE: Surveys at border crossings, WP5 "Cross-border analysis", June 2014

The authorities have established communication with the neighbouring BCP in Bulgaria (Dragoman) on a daily basis through meetings, telephone and internet mainly for information concerning the timetables of the trains and expected traffic.

The main problem according to the authorities is lack of locomotives to service the demand. However, the authorities also suggest that the number of customs agents must be increased.

For freight trains in direction Dragoman (NRIC)-Dimitrovgrad (IŽS) the time needed for all the controls and procedures to be performed is over 3 h according to the timetable, but actually over 15 h, during which the documentation and locomotive are checked and changed, respectively. For those running in the opposite direction the respective time according to the timetable is about 4 h, but actually about 15 h.

Average stopping times for freight trains at Dimitrovgrad station:

- Timetable plan → 215 min
- Actual → 922 min

The next table presents cross-border delays at Dimitrovgrad handover station for the first three months in 2020.

Table 4-25: Delays at Dimitrovgrad station

Direction	**Month 2020**	**Total**		**Average**		**Timetable stopping time**
		Trains	**Actual delay (hours)**	**Trains (daily)**	**Actual delay (hours/train)**	
Dragoman - Dimitrovgrad	January	131	2.017	5,04	15:24	03:08
	February	104	1.678	4,00	16:08	
	March (1- 26)	108	1.691	4,15	15:39	
	Average	**114**	**1.795**	**4,40**	**15:43**	
Dimitrovgrad -Dragoman	January	134	2..242	5,15	16:44	04:01
	February	104	1.472	4,00	14:08	
	March (1- 26)	108	1.490	4,15	13:48	
	Average	**115**	**1.735**	**4,44**	**14:53**	

Source: IŽS

The delays in freight transport at Dimitrovgrad station are mainly due to delays caused by:

1. Lack of railway carrier traction vehicles (late arrival of locomotives).
2. Untimely handover of trains between the rail carriers[11].
3. Customs and personnel (shunting and station personnel).

[11] Rail carriers from Bulgaria come to pick up the train in Dimitrovgrad if they have a train which they need to haul to Dimitrovgrad, causing a long delays

Table 4-26: Cross-border procedure durations at Dimitrovgrad (import)

No.	Type of procedure	Done by	Time (min)																				
			10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190	200	210
1	Bring in the documents and consignment notes	RIM (NRIC)	5																				
2	Border police locomotive check	Police	5																				
3	Uncoupling locomotive	Carrier 2	10																				
4	Technical check	Carriers	40																				
5	Commercial check	Carriers	40																				
6	Train listing	Carrier 2	30																				
7	Manual import of the documents to computer	Carrier 1	55																				
8	Physical train inspection	BG/SRB Police	40																				
9	Veterinarian and Phytopathological inspection	BG Veter. / Phyto.	10																				
10	Delivering the documents to BG customs	Carrier 1		5																			
11	BG Customs inspection	BG Customs			40																		
12	Delivering the documents from BG Customs	Carrier 1							5														
13	Listing the commercial data	Carriers							25														
14	Comparison of wagons list and customs seals w	Carrier 2					20																
15	Consignment notes listing and stamping	Carrier 1		70																			
16	Consignment notes calculations	Carrier 1									25												
17	Consignment notes inspection	Carrier 2									45												
18	Delivering the documents to SRB Customs	Carrier 2														5							
19	SRB Customs inspection	SRB Customs														60							
20	Veterinarian and Phytopathological inspection	SRB Veter. / Phyto.														30							
21	Coupling locomotive	Carrier 2																10					
22	Brake test	Carrier 2																	30				
23	Delivering the documents from SRB Customs	Carrier 2																				5	
24	Delivering the documents to engine driver	Carrier 2																					5
25	Order of departing	RIM																					5
	Dimitrovgrad border procedure duration (min)		210																				

Source: IŽS

Technological operations for Dimitrovgrad station also include the activities of the customs authorities, police and inspection services of the Republic of Bulgaria. This is because the Dimitrovgrad station, according to an agreement between Serbia and Bulgaria, is intended to be a common station. However, Bulgaria withdrew from this agreement, and only Serbian railway staff are present at Dimitrovgrad.

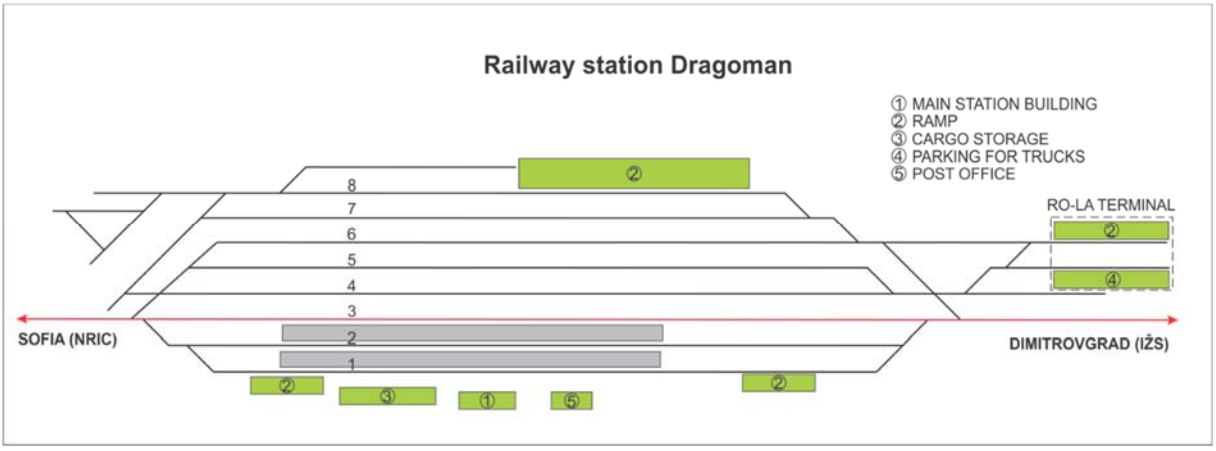
Figure 4-46: Dimitrovgrad handover station

Source: https://mapio.net/images-p/52082484.jpg

Dragoman & Kalotina zapad border stations (Bulgaria)

Dragoman & Kalotina zapad are the border stations between Serbia and Bulgaria. The stations are managed by the NRIC and open for passenger and freight transport. The stations are located on the border of an EU member (Bulgaria) and non-EU member (Serbia). The crossover border section between Dimitrovgrad (IŽS) and Dragoman (NRIC) has a voltage of 25 kV AC. The station is secured with a signal safety device. The authorities present at the stations are: customs (Dragoman) and police (Kalotina zapad). Veterinarian and phytopathological inspectors are not present at the stations. Dragoman & Kalotina zapad are not handover stations, and trains stop because of customs, police and brake inspection. A RO-LA terminal is located at Dragoman station.

Figure 4-47: Dragoman station layout



Source: NRIC

Dragoman station has many railway tracks for freight trains, but none of them has a length over 740 m. Three rail tracks have passenger platforms and the other five tracks are used for freight trains. Dragoman has the following important tracks.

Table 4-27: Tracks at Dragoman station

Track No.	Length (m)	Comments
1	615	passenger platform
2	640	passenger platform
3	680	passenger platform
4	643	arrival/departure freight
5	611	arrival/departure freight
6	517	arrival/departure freight
7	453	only for train departure in IŽS (Serbia) direction
8	348	storage siding

Source: NRIC

The maximum length of the tracks at Kalotina zapad is 660 m.

Average stopping times for freight trains at Dragoman + Kalotina zapad:

- Timetable plan → 90 + 25 min
- Actual → 139 + 25 min

The delays in freight transport at Dragoman station are mainly due to delays caused by:

1. Customs inspections,
2. Border with next RIM and rail carriers,
3. Lack of railway carrier traction vehicles.

Table 4-28: Cross-border procedure durations at Dragoman (export)

No.	Type of procedure	Done by	Time (min)													
			10		20		30		40		50		60		70	
1	Info about train arrival	RIM	5													
2	Bring in the the documents	Carrier	5													
3	Customs inspection	Customs		60												
4	Brake test	Carrier														5
5	Order of departing	RIM														5
Dragoman border procedure duration (min)			**70**													

Source: NRIC

Table 4-29: Cross border procedure durations at Kalotina zapad

No.	Type of procedure	Done by	Time (min)				
			10		20		
1	Bring in the the documents	RIM	5				
2	Border control	Border police		15			
3	Order of departing	RIM					5
Kalotina border procedure duration (min)			**25**				

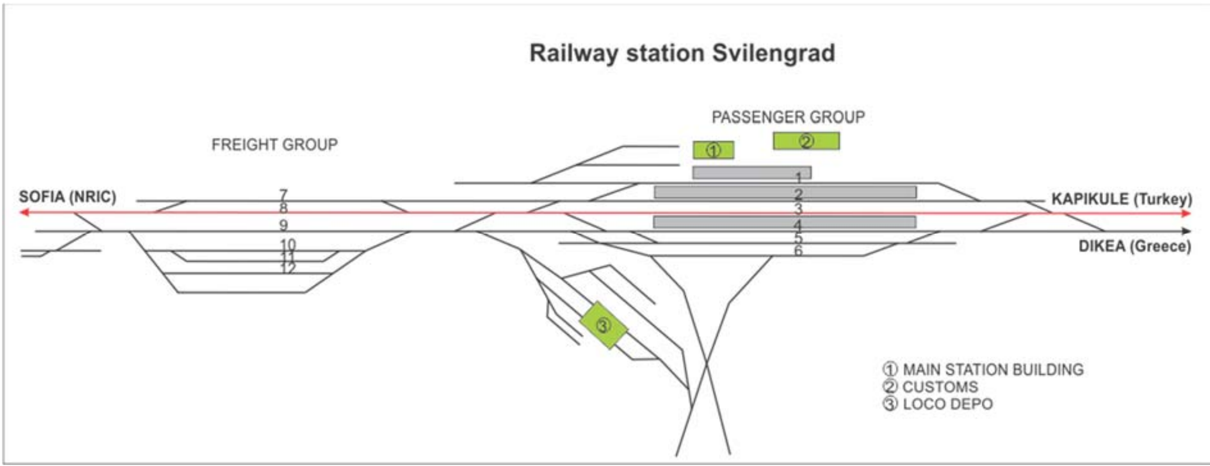
Source: NRIC

4.9.3.6 Svilengrad (Bulgaria) – Kapikule cross-border section (Turkey)

Svilengrad border station (Bulgaria)

Station Svilengrad is a border station between Bulgaria and Turkey. The station is managed by the NRIC and is open for passenger and freight transport. The station is located on the border of an EU member (Bulgaria) and non-EU member (Turkey). The crossover border section between Svilengrad (NRIC) and Kapikule (Turkey) has a voltage of 25 kV AC. The station is secured with a signal safety device. Svilengrad is a junction station for the international line to Greece (Dikea). The authorities present at the station are customs and police, both working 24/7. Veterinarian and phytopathological inspectors are not present at the station. Svilengrad is not a handover station, and trains stop because of customs and police.

Figure 4-48: Svilengrad station layout



Source: NRIC

The Svilengrad station is divided into two track groups for passenger and freight trains. All passenger trains stop in Svilengrad station at the passenger group and pass transit through the freight group. All freight trains stop in Svilengrad station at the freight group and pass transit through the passenger group. At the freight group is a portal crane owned by NRIC that can be used for containers up to 20 t.

The station has many railway tracks for freight trains, but only one track in the freight group has a usable length over 740 m. Two rail tracks in the passenger group (2, 3) have lengths over 740 m. Four tracks have passenger platforms. Svilengrad station has the following important tracks.

Table 4-30: Tracks at Svilengrad station

Track No.	Length (m)	Comments
1	709	passenger platform
2	822	passenger platform
3	920	passenger platform
4	730	passenger platform
5	560	passenger group
6	247	passenger group
7	622	freight group
8	622	freight group
9	750	freight group
10	604	freight group
11	605	freight group
12	590	freight group

Source: NRIC

Average stopping times for freight trains at Svilengrad station:

- Timetable plan → 145 min
- Actual → 140 min

The delays in freight transport at Svilengrad station are mainly due to delays caused by:

1. Customs inspections,
2. Police border inspections,
3. Border with next RIM and rail carriers,
4. Lack of railway carriers traction vehicles,
5. Problems with migrants (one or two times per week).

Table 4-31: Cross-border procedure durations at Svilengrad (export)

No.	Type of procedure	Done by	Time (min)						
			10	20	30	40	50	60	70
1	Info about train arrival	RIM	5						
2	Bring in the the documents	Carrier	5						
3	Custom inspection	Customs				60			
4	Brake test	Carrier							5
5	Order of departing	RIM							5
Svilengrad border procedure duration (min)			**70**						

Source: NRIC

Kapikule handover station (Turkey)

Kapikule is not an official part of the AWB RFC. The technical specifications of the railway border crossing are:

- The length of the railway line between Svilengrad station and the state border is 18.862 m; The length of the railway line between the state border and Kapikule station is 1.272 m;
- Maximum allowed speed of the trains is 160 km per hour, from km 313+853 to the state border (315+664) it is 130 km per hour and from the state border to Kapikule station it is 40 km per hour.
- The predominant gradient from Svilengrad station to Kapikule station is 7‰ acclivity.
- The trains running between the two stations are hauled by locomotives of the Bulgarian railway carrier operating on the border crossing.

The traffic of trains and other rolling stock between the stations of Svilengrad and Kapikule is managed by the NRIC traffic managers on duty deployed in Svilengrad and Kapikule stations in compliance with the railway transport regulations of the Republic of Bulgaria.

The train dispatcher gives orders regarding to the traffic of trains on the open track between the two stations from the Plovdiv Regional Traffic Department of NRIC, which is responsible for this section.

The TCDD traffic manager on duty in Kapikule border station and the NRIC traffic manager on duty exchange preliminary information daily at 08:00 and 20:00 h on the trains and other vehicles that will run in both directions during the next 12 hours. The information should contain the following data:

- The number of the trains, the tonnage and the number of freight wagons/coaches,
- The number of empty and loaded wagons of each administration, number of loaded wagons and number of wagons carrying livestock and perishable goods and their destination countries.

When a train is ready to be dispatched from Kapikule to Svilengrad, the NRIC traffic manager on duty shall verbally inform his Turkish colleague about the readiness of the train. Afterwards, the TCDD traffic manager fills in the form EK 1 in two copies, writing down the date, time, train number, number of axles, locomotive type, tonnage and the track on which the departing train is located. One of these copies shall be handed over to the NRIC traffic manager on duty in Kapikule. The NRIC traffic manager on duty in Kapikule shall request by phone the consent for the dispatch of the train from the traffic manager on duty in Svilengrad. The traffic manager on duty in Svilengrad shall grant the permission by means of the SAI (Semi-automatic interlocking (SAI), ensuring the compulsory interdependence between the station interlocking systems through a physical cable pair in Kapikule station if there is a possibility to accept the train. After the NRIC traffic manager on duty receives the consent from Svilengrad, he shall submit the permission to his TCDD colleague, by pressing the DPS push-button (granting the received permission). There will be then a light indicating this on the MRC board in the office of the TCDD, and an exit signal can be given for the departure of the train from Kapikule station to Svilengrad station.

Figure 4-49: Kapikule handover station (Turkey)

Source: http://www.balo.tc/SFR/200x250/933/TCDD_Terminal_-_Kapikule_Sinir.jpg

The operation of the safety equipment (such as switch points, exit and entrance signals, warning signals and the electrical switch for cutting the power supply to the catenary) in Kapikule station is the duty of the TCDD officers.

In case of interruption of all types of communications, the movement of trains is suspended until restoration of the same. The use of official mobile phones for ensuring the movement of the trains is allowed.

In case of delay of the trains running towards the border crossing, NRIC and TCDD will inform each other in due time about the time of delay.

HANDOVER OPERATIONS

The railway border crossing of Svilengrad-Kapikule is open for transport of passengers, freight, wagons/coaches and other rolling stock. The handover and takeover of trains, wagons/coaches and other rolling stock between the railway carriers is fulfilled at Kapikule Exchange Border Station.

The passport, customs and health controls of passenger and railway personnel on the freight and passenger trains, in addition to the customs, phytosanitary and veterinary controls of freight, are carried out by the competent Bulgarian authorities at Svilengrad, and by the competent Turkish authorities at Kapikule. The competent authorities of both countries can perform the above-mentioned passenger and staff control during the trains' movement on their own territory.

All activities of the railway carriers shall be under the responsibility of the representative of the related railway carrier at Kapikule. The representative of TCDD in coordination with the representative of the railway carrier shall solve all operational issues.

The locomotives of the Bulgarian railway carrier, in accordance with their traffic schedules, service the trains between the two border stations. The traffic schedules and the composition plans of trains are to be coordinated between the railway carriers, NRIC and TCDD together.

In respect of the train movement, NRIC traffic manager on duty controls and manages the locomotives of the Bulgarian railway carrier at Kapikule. It is possible to move the locomotives of the railway carriers at Kapikule only on the orders of TCDD operational manager on duty. During the check-up of a train by the competent Turkish border authorities at Kapikule, no movement of the train shall be allowed.

The staff of the railway carriers at Kapikule realise coupling and decoupling of the locomotives of the railway carriers that cross the border. The railway carriers, using their own locomotives and staff, carry out the shunting operations at Kapikule. The services, which the railway carriers can request from TCDD at Kapikule in exceptional cases, along with their prices, are announced and notified by TCDD to the railway infrastructure and carriers every year together with traffic schedules.

HANDOVER AND TAKEOVER OF FREIGHT TRAINS

A representative of the railway carrier at Svilengrad informs the NRIC traffic manager on duty at Kapikule once every six hours (at 0:00, 06:00, 12:00, 18:00) about which freight trains they are intending to move, and the freight which will be carried by those trains. The NRIC traffic manager on duty informs the TCDD traffic manager on duty and the Turkish railway carriers with regard to this. The TCDD traffic manager on duty at Kapikule informs the NRIC traffic manager on duty and the Bulgarian railway carrier once every six hours about the type of freight trains that will arrive at the station and the freight they will be carrying.

The locomotive and train personnel, as well as the other personnel of the railway carriers needed to execute the takeover procedures of the train, must be ready not later than 15 minutes before the arrival of the train at Kapikule.

The wagons and freight that are handed over by one party to the other shall be compatible with the technical and commercial requirements as well as with the provisions of the international conventions related to loading and securing of freight to which the railway enterprises of both countries are party.

The technical and commercial checks of the wagons of a train coming from Svilengrad and accepted in an electrified track at Kapikule station start once all the railway staff of the railway carriers, NRIC and TCDD and the officers of the competent Turkish border authorities who are going to process the train later, have signed the register for cutting off the power.

Any deficiencies that are detected during the technical and commercial checks performed by the personnel of railway carriers at Kapikule Exchange Border Station shall be tried to be remedied, within the stopping time given in the train itinerary, by the handing-over railway carrier. For the wagons with technical and commercial deficiencies that cannot be remedied within this time, the international railway legislation to which both railway carrier/infrastructure manager are party will be applied.

Once the technical and commercial checks of the wagons are completed and the technical and commercial faults are eliminated, an additional shunting shall be carried out, the rejected wagons shall be removed from the train formation, the buffer levels of the wagons shall be re-arranged and their brakes shall be tested. The wagon inspectors of the Bulgarian railway carrier shall do the full test of the automatic brakes of the trains heading to Svilengrad. The short test of the automatic brakes of trains heading to Svilengrad after the locomotive has been attached shall be executed by the staff of the Bulgarian railway carrier.

The border checks of a train heading to Svilengrad station shall be performed by the competent Turkish Border Authorities simultaneously with the brake tests.

In the peak transport periods, the railway carriers may provide additional staff in order to process the trains in time.

Average stopping times for freight trains at Kapikule station:[12]

- Timetable plan → 315 min
- Actual → 810 min

Freight train transport between Kapikule and the interior of Turkey is carried out only at night, and this could be one of the main reasons for the long stopping times at Kapikule station.

According to information[13] submitted by rail freight operators of the EU, there is a lack of communication and information on train movements from Turkish Railways, the opening hours of Turkish customs offices at the border station at Kapikule are irregular, priority is given to national freight trains, there is a lack of capacity and extremely long stopping times, and a lack of resources (e.g. locomotives) within TCDD, which is the major traction provider.

4.9.4 Dimitrovgrad (IŽS) rail border crossing practice

The source for this content is the study "Rail electronic data interchange in a border crossing point in South East Europe: An assessment of options, The World Bank, May 2015".[14]

An agreement on border control between Serbia and Bulgaria in the Dimitrovgrad Joint Border Station was signed in April, 2005 and has been in force since 2006. It introduced a zone in which the authorities of both states could jointly carry out controls and allowed the customs and border police of both countries to jointly check passengers on moving passenger trains.

The Bulgarian customs and border police are at present not operating in the Joint Border Zone at Dimitrovgrad. Bulgaria is in the process of entering the Schengen Agreement, which does not allow carrying out passport controls on non-Schengen territory. The Bulgarian border police is no longer allowed to work at the Dimitrovgrad BCP, which potentially contributes to increasing border-crossing time.

At Dimitrovgrad, a number of formal activities are conducted, such as export and import clearance, transit procedures, change of locomotives, technical inspection and brake tests, and commercial and technical handovers of the train. These formal activities result in an average stop of many hours for freight trains. Serbian and Bulgarian rail carriers jointly carry out the handing over of trains, IŽS is responsible for the path allocation on the Serbian rail network, while the Bulgarian rail carriers contacts the NRIC for permission to enter into the Bulgarian rail network. Serbian customs and border police carry out clearance of goods and persons. Bulgarian customs and border police are not present at the BCP.

Before train arrival, the parties involved prepare for arrival. Activities such as clearing the track, preparing for activities performed during the train stop such as manoeuvres, commercial and

[12] Source: The CREAM Project, HaCon Ingenieurgesellschaft mbH, Hannover, Germany, July 2012
[13] Source: Study on corridors, OTIF, January 2016
[14] Some of the customs procedures have been changed since February 2016, because Serbia has started applying the joint transit procedure.

technical controls and inspections as well as preparing for dispatching. Compared to the current situation, access to accurate information about the schedule and deviations from scheduled operations would benefit a number of actors preparing for arrival. Access to accurate information about the train would benefit preparation for train arrival. Information such as train composition, passengers and personnel, goods to be exported, transited, and imported among others, would speed up the train stop, enabling work before arrival and a focus on verification during the actual train stop.

During the train stop, a number of actors are involved in shunting, technical and commercial controls and inspections, receiving and managing documentation, validating seals, customs export declarations, and customs import declarations, border police migration controls, among others. Immediate access to all relevant documentation without faxing, copying, delivery, and so on would facilitate working in parallel. At present actors need to wait until paper documents are available, but access to electronic consignment notes would reduce the need for manual verification of train information. Technical solutions for technical controls would reduce the time needed or even eliminate these kind of controls, and would increase the quality of such controls. Lastly, sending pre-arrival information to customs (export, import and transit) would allow the adoption of a risk-based approach, enable faster customs clearance and facilitate identifying when controls are necessary.

Preparing for the departure and final dispatch of the train includes requesting permission to enter a track, ensuring route protection, permissions, and dispatching. Access to permissions and dispatching information for all parties would reduce the number of interactions (via phone, among other methods) necessary at departure and speed up the process.

Information and data exchange between railway actors at Dimitrovgrad is focused on three different data sets:

- Track and trace information. Information about estimated time of arrival as well as deviations from scheduled operations. For some trains the information is available to the Station Master, but it is not used for daily operations;
- Consignment notes. Documents prepared by a consignor and countersigned by the carrier containing information about the movement and goods. Due to the large volume of transit at Dimitrovgrad, this information is received from other countries in paper format. Information in the CIM consignment note is in accordance with the CIT-CIM consignment note and includes information such as: consignor, consignee, goods information (harmonised system and description), destination or delivery point, commercial specification, freight rates and additional services levied by the rail carrier, invoicing and payment instructions, customs movement reference number (MRN), and weights. Information is received from the train driver and shared in sequence, handing over the documentation between different parties at the BCP. Each actor then adds information to the consignment notes, such as additional rates for services at the border,

commercial and customs seals, and K-200, among others.[15] The present process has not yet taken into account the interoperability requirements of TAF/TAP TSI regulations, which have not been implemented in Serbia.

- Wagon lists. Information about the train and wagons is used at train handover to the next infrastructure manager using the K-2[16] document and KOL-65[17] document to hand over the wagons.

Sharing of information using EDI requires access to electronic information and a regulatory framework to share and transfer information. In order to understand EDI options, it is important to first understand the existing systems of each stakeholder. Serbian and Bulgarian parties have central IT systems in operation, some of which are available to Dimitrovgrad personnel. The next table summarises the ICT solutions currently being used by different parties.

Table 4-32: Existing ICT in Dimitrovgrad

Stakeholder/ Actor	**Existing ICT solutions**	
	Serbia	**Bulgaria**
Customs	A national transit, import and export system is in operation. Submission of electronic declarations is not supported. Serbian customs are working to introduce NCTS as required by the EU acquis. Electronic transmission of information is not yet planned.	NCTS is in operation and supports electronic declarations. Electronic information is not exchanged with Serbia or Serbian customs in Dimitrovgrad. National transit needs to be manually started using NCTS for goods arriving from Serbia.
Border Police	Border police have access to national and international systems containing intelligence information and watch lists. Mobile equipment to read and check passports and compare the data with watch lists and intelligence information is being introduced in Serbia, but is not yet available in Dimitrovgrad BCP. Border police have technical inspection equipment, such as cameras, among other items.	There is no need for electronic information from other actors, since Bulgarian border police at the rail BCP are connected electronically with the road BCP and via their HQ in Sofia with Interpol and via Interpol again with the Serbian HQ in Belgrade. Technology such as passport readers, among other items, is used.
RIM	The IT system available in Dimitrovgrad is used to report the arrival of a train and prepare and print an agreed document numbered KOL-65 paper document to hand over to Bulgarian counterparts.	No IT system is in use in Dimitrovgrad BCP.
Rail carrier	The IT system to handle train position and estimated time of arrival is operational and available to the Station Master. The IT system to manage consignment notes is in operation in Serbia, but only used for transport coming from the north (Subotica BCP), once the train	<u>State</u> Consignment notes are exchanged on paper and no IT systems are used in Dimitrovgrad BCP. BDZ is developing a new Cargo Transport Management System and

[15] Wagon List
[16] Bill of Lading
[17] Exit List

<table>
<tr><th rowspan="2">Stakeholder/ Actor</th><th colspan="2">Existing ICT solutions</th></tr>
<tr><th>Serbia</th><th>Bulgaria</th></tr>
<tr><td></td><td>has been handed over to Serbia.[18] Information is sent from the central system of the Hungarian RU arriving at Subotica and further processed by central systems of Serbian railways[19]. User access to this system is available at Dimitrovgrad, but can only be used for trains coming from the north. Only the Station Master has access to the system/information, and paper documents are still necessary if the train goes to other countries.

According to the Serbian rail carrier, the consignment note information and estimated time of arrival information can be made available to all actors in Dimitrovgrad using the rail carrier Extranet/Internet. This would make it possible for customs and other actors to prepare and work in advance of the train stopping.

Serbia is a member of RailData and HitRail, making EDI integration possible with other rail carriers and RIMs. The central systems already exchange information with other actors, and they are prepared to exchange information with new rail carriers and RIMs. TAF/TAP TSI is supported up to the level supported by RailData solutions. Integration with Hungarian and Slovenian rail carriers is already in operation, but not with Bulgarian rail carriers.

Due to RailData, the rail carrier has access to the following EDI systems:
• ORFEUS - Consignment note CIM data exchange
• ISR - Wagon movement and status reporting
• USE-IT (Uniform System for European Intermodal Tracking and tracing)

The new Cargo Transport Management System will replace a number of systems used at present:
• Wagon fleet management system
• Tariffing/pricing system
• Consignment note tariffing and invoice system
• Cargo statistics system
• Received consignment notes system</td><td>the first module is planned to be implemented in the near future. This will only be used for internal management of cargo and transport. A module was already implemented at the end of 2015 to allow data exchange with other rail carriers (Hungary, Czech Republic, Slovakia), but not with Serbia. Electronic exchange of data with NCTS was already implemented in Module 2. Future implementation of the new system in Dimitrovgrad is dependent on funding.

An IT system for the issuance of tickets for international traffic is used for passenger trains. The annual time schedule is published on its website. Train composition and changes to train composition are announced to Serbian counterparts via email.

<u>Private</u>
The Bulgarian Railways Company (BRC) is one of the private companies operating in Bulgaria having a market share in freight of 20%. The Dispatcher at Dimitrovgrad is in full electronic exchange with the main Dispatcher of BRC. Path allocation is made by sending emails to the Bulgarian infrastructure manager (NRIC).</td></tr>
</table>

[18] This started in Subotica because it is a key BCP for the so-called block trains running on the route Sopron – Turkey.
[19] As soon as other rail carriers are prepared to exchange structured information (EDI) solutions (TAF/TAP TSI and RailData compliant) and other TAF/TAP TSI compliant implementations can be used to reduce the amount of manual work.

Stakeholder/ Actor	Existing ICT solutions	
	Serbia	Bulgaria
	• Foreign wagons accounting system • Bulgarian wagons accounting system • Revenue system • Ferry wagon system • Wagon maintenance system (keeping track of maintenance, operations and forecasting) and wagon repair system • Personnel management system • Accounting system Other systems exist and a lack of integration regarding these has been identified as a problem. The purpose of the new system is compliance with EU regulations, to allow exchange of information with customs and other government authorities, as well as to manage a mix of electronic and paper consignment notes.	
Shared/ General	At Dimitrovgrad a network and the internet are available and shared. The IT infrastructure that is used includes a network, computers, printers, and internet (although the latter appears to be slow and at times unreliable).	

Source: KGH Group AB, Rail electronic data interchange in a border crossing point in South East Europe: An assessment of options, The World Bank, May 2015

An assessment of the current situation in Dimitrovgrad reveals that processes are more or less paper-based. Some basic IT exists that supports specific tasks, as described above, but in general electronic information is not available, while central IT systems exist and are being developed. The key observations are as follows:

- **No advance train arrival information and paper-based workflow and processes**. The workflow and processes are manual, and work cannot begin before the actual arrival of the train. The documentation accompanies the train and the locomotive driver hands over paper documents one arrival, and the same papers need to accompany the departing train. Documents received – such as the wagon lists, consignment notes and commercial and customs seals – must be validated and verified on arrival at the train stop, affecting stoppage time. When all procedures are finalised, the documents are signed and stamped to confirm compliance before being handed over to the next party.
  The current approach and lack of pre-arrival information do not allow for any preparations or work to begin before train arrival. Tasks are initiated when documents are available to each party, and tasks are performed in a sequence following the paper documents. When one actor finishes the documents are handed over to the next party in line, limiting parallel work. At train arrival the engine is disconnected before the locomotive changes track to be able to drive close to the station building. After that, the documents are handed over to station personnel the operators start processing. Technical reviews (brake tests, among others) and commercial reviews (checking seals, among others) are carried out in parallel, but without access to documents. Access to pre-arrival

information in case of special treatment, as with transporting hazardous goods, would reduce lead times.

Only the Station Master has access to an IT application with information about train arrivals from the Serbian network. For certain trains, information about the number of wagons, weight and consignment notes is also available. Other parties like customs, border police, and Bulgarian rail actors would benefit from accessing access this information. Information about trains arriving from Bulgaria is not available in electronic form at the BCP.

- **Customs IT system available at the BCP.** Serbian National Transit, Import and Export systems are in use at the BCP. Electronic submission of documents is not possible at present, though systems for this are in development. Since the consignment note information often originates from a rail carrier further away than Serbia or Bulgaria, consignment note information is generally not available in electronic structured form, making electronic transfer of data to customs a challenge. Transport originating from north of Serbia (Subotica) already uses electronic consignment notes, and this information could be used to transfer relevant documentation to customs. The customs IT system presently accepts electronic information only for some types of declarations.
- **IT equipment and internet connection available at the BCP.** The internet and a few computers are available at the BCP. The number of computers is limited, and the capacity of the internet connection is reportedly low and unreliable.
- **Focus on freight movements to have maximum benefits.** The number of passenger trains passing Dimitrovgrad is relatively few compared to the number of cargo trains. Border police do not express any interest in access to passenger lists, among other forms of information, prior to arrival. The ICT hardware and ICT infrastructure requirements are covered by solutions proposed for freight. Taking all this into account the focus should be on freight, where the impact is greatest.
- **Train inspection reporting.** Train inspections are performed without access to train documentation, and reporting is paper-based.
- **Seal verification.** Rail yard personnel perform seal verification without access to train documents, and reporting is paper-based. When station personnel verify compliance, there are risks of mistakes and redundant work stemming from the need to verify seals again.
- **Level of trust among actors.** The level of trust among the parties is low. This is reflected in the controls being made by different authorities a number of times during a run. Communication and cooperation supported by legislation and mutual agreements need to be actively promoted to increase understanding and the level of trust among the actors along the rail corridor.
- **Other government authorities.** Interaction with other government authorities usually involved in import and export procedures is rare in Dimitrovgrad, since the main freight flow is transit. Transit does not require the involvement of agricultural and phytosanitary administrations to the same extent as import and export, and EDI with these parties must be seen as out of the scope of a local pilot.

4.9.5 Conclusions

Physical and non-physical barriers at rail border crossings cause excessive and often inordinate delays, high costs and uncertainties in the entire transport process. Border crossings are major bottlenecks for seamless international railway transport. Inefficient border crossing processes and procedures are one of the main causes for significant delays and increased transport costs, and they reduce the comparative advantages of the railway transport.

At border crossing points several critical processes and procedures take place, such as transfer of wagons and goods between neighbouring railways, change of locomotive and crews, technical inspections and control of compliance with railway transport standards. Neighbouring railways often operate under different legal regimes and different standards.

Lack of railway interoperability, deficits in the operational coordination of border crossings and priority rules to the detriment of rail freight on a multi-purpose rail network are among the main reasons for non-competitive timetables and unreliable rail freight services.

These conclusions are based on aggregate data for all cross-border stations and sections along the AWB RFC, regarding authorities, border stopping times and reasons for delays in rail freight transport. The next table presents the border stations with the related authorities. Handover stations are marked in red cells

Table 4-33: Border stations with authorities

Border	RIM	Station	Handover station	Police	Customs	Veterinarian phytopathological inspection
A/SLO	ÖBB-I	Rosenbach	✗	✗	✗	✗
	SŽ-I	**Jesenice**	✓	✗	✗	✗
A/SLO	**ÖBB-I**	**Spielfeld-Straß**	✓	✗	✗	✗
	SŽ-I	Šentilj	✗	✗	✗	✗
SLO/HR	**SŽ-I**	**Dobova**	✓	✓	✗	✓*
	HŽ-I	Savski Marof	✗	✗	✗	✗
HR/SRB	HŽ-I	Tovarnik	✗	✓	✓	✓*
	IŽS	**Šid**	✓	✓	✓	✓*
SRB/BG	**IŽS**	**Dimitrovgrad**	✓	✓	✓	✓*
	NRIC	Kalotina zapad	✗	✓	✗	✗
	NRIC	Dragoman	✗	✗	✓	✗
BG/TR	NRIC	Svilengrad	✗	✓	✓	✗
	TCDD	**Kapikule**	✓	✓	✓	✓

*located at road border crossing, arrival while needed
Source: RIMs – ÖBB-I, SŽ-I, HŽ-I, IŽS, NRIC

The border stations between Austria and Slovenia do not have police, customs, veterinarian and phytopathological inspections. The border stations from Croatia to Serbia, Bulgaria and Turkey do have police and customs. veterinarian and phytopathological inspections, but these are not located at the railway stations, but usually at road border crossings with the staff arriving at the railway stations when needed.

The next table presents the border stations average stopping times (planned and actual) for freight trains. The average stopping times (for both directions) are determined for every border station from Austria to Turkey. Handover stations are marked in red cells.

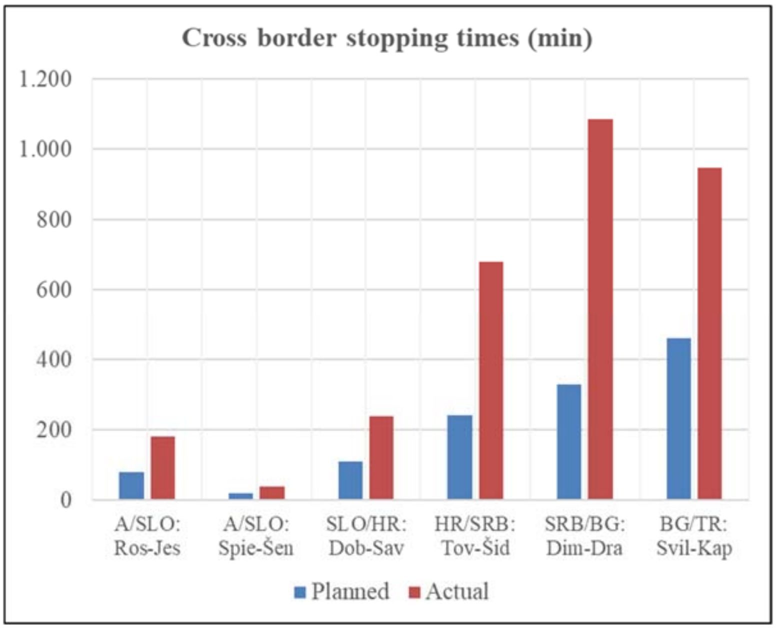
Table 4-34: Planned and actual border stopping times for freight trains

Cross border states	RIM	Station	Border stopping times (min)	
			Planned	Actual
Austria-Slovenia	ÖBB-I	Rosenbach	0	0
	SŽ-I	**Jesenice**	80	180
Austria-Slovenia	**ÖBB-I**	**Spielfeld-Straß**	20	40
	SŽ-I	Šentilj	0	0
Slovenia-Croatia	**SŽ-I**	**Dobova**	110	240
	HŽ-I	Savski Marof	0	0
Croatia-Serbia	HŽ-I	Tovarnik	115	141
	IŽS	**Šid**	131	537
Serbia-Bulgaria	**IŽS**	**Dimitrovgrad**	215	922
	NRIC	Kalotina zapad	25	25
	NRIC	Dragoman	90	139
Bulgaria-Turkey	NRIC	Svilengrad	145	140
	TCDD	**Kapikule**	315	810
Total cross border time (minutes)			**1.246**	**3.174**
Total cross border time (hours)			**20,77**	**52,90**

Source: RIMs – ÖBB-I, SŽ-I, HŽ-I, IŽS, NRIC

The total planned cross border time is 20,77 hours (almost one day!) **and the actual is almost 53 hours** (over two days!). The shortest stopping times are between Austria and Slovenia, the longest between Serbia, Bulgaria and Turkey. The next figure presents summarised stopping times for each cross-border section.

Figure 4-50: Summarised stopping times



Source: RIMs – ÖBB-I, SŽ-I, HŽ-I, IŽS, NRIC

The reasons for long stops and delays (over planned stops) at the border stations are similar for all cross-border sections:

Table 4-35: General reasons for long stops and delays at the border stations

Reason	Responsibility	Comments
Migrants	External	Detailed police inspections.
Customs inspection	Authority	Duplicate procedure at both border states.
Veterinarian and phytopathological inspection	Authority	Not located at rail border stations.
Lack of information systems	State, authority, RIM	A lot of paper documents for all participants at the rail border crossing.
Maintenance works, closures	RIM, State	Maintenance and line upgrading with delays.
Lack of mutual trust agreements	Rail carrier	Agreements between different rail carriers along the transport route.
Lack of locomotives	Rail carrier	While changing the locomotive at the handover station.
Lack of engine drivers	Rail carrier	Engine drivers are not always available.
Broken wagon and load refused	Rail carrier	The following carrier refused inadequate wagons at the handover station.
Lack of capacity on lines and at railway stations	RIM, State	Bottlenecks on the railway infrastructure.

An analysis of conditions and procedures for rail freight at border crossings showed that huge improvements could be made *inter alia* by streamlining procedures at border crossings. The study revealed that average stopping times of freight trains at the AWB RFC border crossings are generally in the range of several hours. Many of the border crossings along the AWB RFC lag behind in this regard compared to the north or central EU RFCs. There is significant potential to implement specific improvements to facilitate cross-border train operations, including measures such as mutual trust agreements or a closer cooperation in border and customs controls at border stations.

Many border procedures are duplicated at both border stations, the handover station and the station on the other side of the border. For example: at both stations customs and police procedures are carried out, thus doubling the time needed.

4.10 AWB RFC CONNECTING LINES

The AWB RFC designated lines consist of three different categories of lines:

- Principal routes: on which Pre-arranged Paths are offered, and the focus of the current study regarding railway infrastructure is the principal routes;
- Diversionary routes: on which Pre-arranged Paths may be considered temporarily in the case of disturbances, e.g. long-term, major construction works on the principal lines;
- Connecting lines: lines connecting the corridor lines to a terminal. These are routing bypassing places (where alternative options exist) on the principle route – related routes and destinations and Pre-arranged Paths apply.

According to the AWB RFC CID Book 5 Implementation plan 2020/2021, the following connecting lines are defined:

- Slovenia, SŽ-I: Ljubljana-Novo mesto (only on the map) and
- Croatia, HŽ-I: Vinkovci-Spačva (on the map and in the table).

Table 4-36: AWB RFC connecting lines – main infrastructure parameters

Infra manager	**Section**	Length (km)	Single/Double-track	Max train length (m)	Intermodal Loading gauge (P/C)	Axle load (t/axle)	Load per metre (t/m)	Max line speed freight trains (km/h)	Traction systems (3, 15, 25 kV; D-Diesel)	ETCS (L1, L2; No)	Communication devices ERTMS/GSM-R (Yes, No, Other)
SŽ-I	**Ljubljana-Novo mesto**	75	1	460	60/380	20,0	6,4	70	D	No	GSM-R
HŽ-I	**Vinkovci-Spačva**	31	1	640	80/410	20,0	8,0	60	D	No	No

Source: SŽ-Infrastruktura, d.o.o. and HŽ-Infrastruktura, d.o.o.

4.11 INTERMODAL TERMINALS

Intermodal terminals are the interface between the different transport modes – road, rail, and water – and are necessary to meet the needs of large cities. Besides the pure transhipment of loading units from one transport mode to the other, intermodal terminals have to perform several basic functions such as transhipment, customs clearance, storage activities, etc. Such terminals are equipped with different forms of infrastructure (rail tracks, docks, storage areas, parking spaces…) and superstructures (trains, wagons, cranes, trucks, forklifts…).

Table 4-37: Terminals per AWB RFC member state

State	No. of intermodal terminals
Austria	8 (1 river port included)
Slovenia	3
Croatia	5 (2 river ports included)
Serbia	3 (1 river port included)
Bulgaria	2
TOTAL	**21**

Source: RIMs – ÖBB-I, SŽ-I, HŽ-I, IŽS, NRIC

The following tables present a list of intermodal terminals along with their basic attributes: railway hub, terminal name, type of mode (rail, road, river), area, storage capacity in TEU, number of tracks, track length in metres, gantry cranes and reach stackers.

Table 4-38: List of intermodal terminals on the AWB RFC

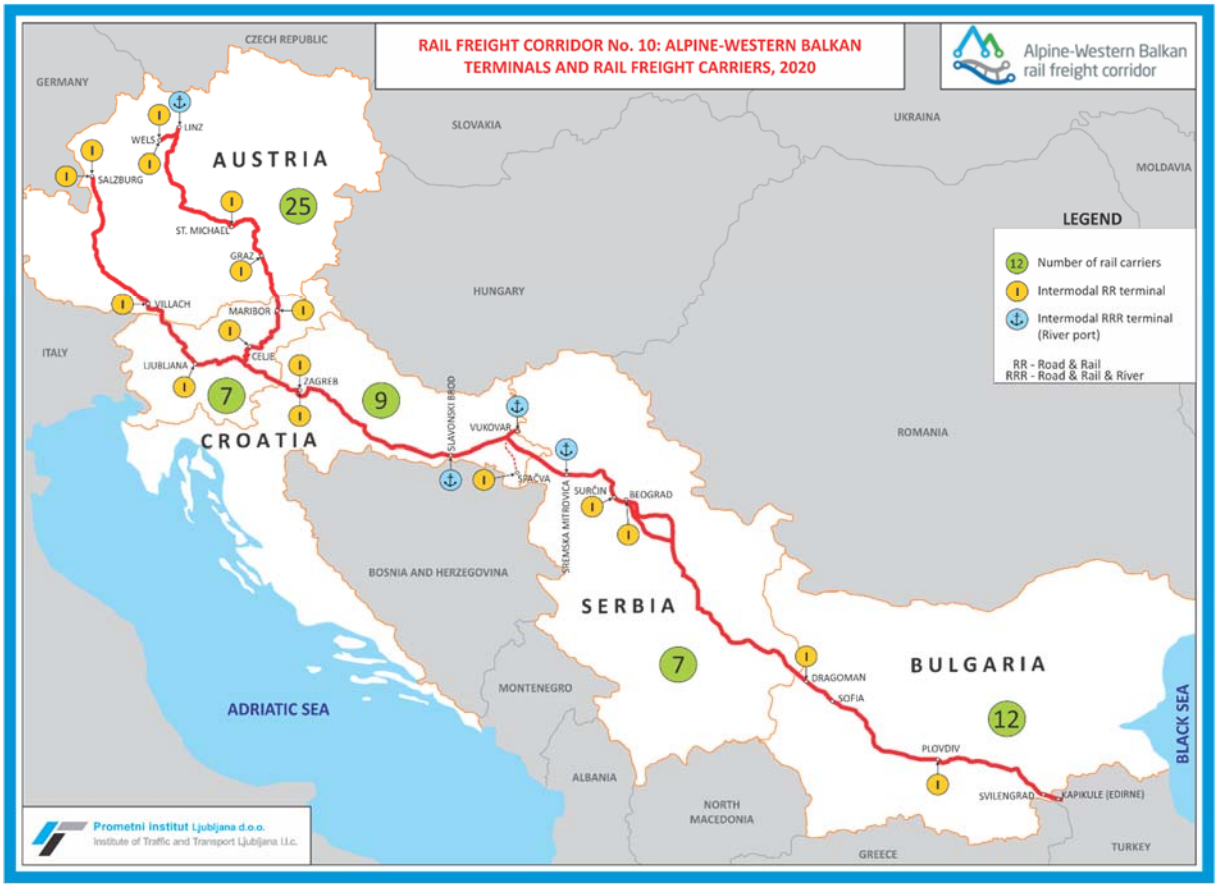
State	Railway Hub	Terminal Name	Rail	Road	River
Austria	Salzburg	Salzburg CTS	✓	✓	×
Austria	Salzburg	Salzburg Frachtenbahnhof - ROLA	✓	✓	×
Austria	Villach	Villach Süd CCT (Fürnitz)	✓	✓	×
Austria	Wels	Wels Vbf. CCT	✓	✓	×
Austria	Wels	Lambach	✓	✓	×
Austria	Linz	Linz Stadthafen CCT	✓	✓	✓
Austria	St.Michael	St.Michael	✓	✓	×
Austria	Graz	Werndorf	✓	✓	×
Slovenia	Maribor	Maribor Tezno	✓	✓	×
Slovenia	Celje	Celje tovorna	✓	✓	×
Slovenia	Ljubljana	Ljubljana Moste KT	✓	✓	×
Croatia	Zagreb	CT Vrapče	✓	✓	×
Croatia	Zagreb	Robni Terminali Zagreb	✓	✓	×
Croatia	Slavonski Brod	Luka Slavonski Brod	✓	✓	✓
Croatia	Vukovar	Luka Vukovar	✓	✓	✓
Croatia	Vinkovci	RO-LA terminal Spačva	✓	✓	×
Serbia	Sremska Mitrovica	Leget Sremska Mitrovica	✓	✓	✓
Serbia	Beograd	Surčin Nelt Dobanovci	✓	✓	×
Serbia	Beograd	ŽIT Beograd	✓	✓	×
Bulgaria	Dragoman	RO-LA Dragoman	✓	✓	×
Bulgaria	Plovdiv	Todor Kableshkov - Zlatitrap RO-LA	✓	✓	×

Table 4-39: Intermodal terminals with basic information

Terminal Name	Area (m2)	Storage Capacity (TEU)	Gantry cranes	Reach stacker
Salzburg CTS	100.000	5.000	2	6
Salzburg Frachtenbahnhof - ROLA	5.000	/	/	/
Villach Süd CCT (Fürnitz)	70.000	1.000	1	2
Wels Vbf. CCT	120.000	1.700	2	4
Lambach	180.000	3.000	/	3
Linz Stadthafen CCT	90.000	8.000	2	6
St.Michael	15.000	800	/	3
Werndorf	25.000	3.700	2	2
Maribor Tezno	3.500	50	/	2
Celje tovorna	6.500	80	/	1
Ljubljana Moste KT	99.250	1.270	1	2
CT Vrapče	25.000	1.021	/	2
Robni Terminali Zagreb	199.000	N/A	/	/
Luka Slavonski Brod	750	N/A	N/A	1
Luka Vukovar	13.000	30	4 (port)	/
RO-LA terminal Spačva	N/A	/	/	/
Leget Sremska Mitrovica	45.000	8.500	/	1
Surčin Nelt Dobanovci	105.000	400	/	1
ŽIT Beograd	12.000	850	1	3
RO-LA Dragoman	N/A	/	/	/
Todor Kableshkov - Zlatitrap RO-LA	77.000	2.000	/	2

Source: Different sources (railway infrastructure managers, terminal operators, WEB,…)

Figure 4-51: Terminals and rail freight carriers along the AWB RFC



Some relevant data regarding the current railway infrastructure at terminals was given by the terminal operators through survey (for detailed information's see ANNEX I: Survey analysis – transport demands).

Transhipment machinery, gantry cranes and reach stackers:

- 60% of terminals lack a gantry crane,
- 40% of terminals have one or two gantry cranes,
- 30% of terminals lack a reach stacker,
- 70% of terminals have at least one or more reach stackers.

Figure 4-52: Gantry crane (Wels terminal) and reach stacker (Ljubljana terminal)

Source: https://infrastruktur.oebb.at/en/partners/terminals/locations/terminal-wels; Miško Kranjec

Number of sidings (rail tracks) in the terminals:

- 44% of terminals have up to two sidings,
- 32% of terminals have between three and five sidings,
- 24% of terminals have over six sidings.

Current (today) maximum available train length in the terminals:

- 36% of terminals have between 401-500 m,
- 24% of terminals have between 601-700 m,
- 16% of terminals have up to 300 m,
- 16% of terminals have between 501-600 m,
- 8% of terminals have over 741 m.

Current (today) maximum weights of freight trains:

- 44% of terminals have between 1.001-1.500 gross tonnes,
- 24% of terminals have between 501-1.000 gross tonnes,
- 16% of terminals have between 1.501-2.000 gross tonnes,
- 16% of terminals have up to 500 gross tonnes.

Types of shunting movements at terminals (more options):

- 100% of terminals operate with shunting locomotives,
- 16% of terminals could operate with a “last mile” locomotive,
- 16% of terminals have road-rail vehicles (dual-mode, tractors….),
- 8% of terminals have electrification of sidings.

Rail, road and river terminals are connected to public railway stations. The railway infrastructure at some terminals is not defined as a public railway infrastructure, because the terminal infrastructure could be in private ownership or state owned. The next table presents relevant infrastructure parameters for the terminal tracks.

Table 4-40: Relevant infrastructure parameters at terminal tracks

Infrastructure parameter	**Relevant**	**Remarks**
Track gauge 1435 mm	✓	Base standard is necessary for undisturbed railway transport. All examined terminals have adequate track gauge.
Train length 740 m	✓	Relevant length for long (container) trains. 700 m wagons length - without locomotives.
Axle load 22,5 t	✓	Capacity efficiency for heavy consignments, which exceed 20,0 t/axle.
Freight train speed 100 km/h	✘	100 km/h speed in terminal is not relevant – only shunting movements with speeds around (below) 50 km/h.
Line electrification	✘ ⦿	Usually tracks are not electrified, such as the tracks under portal cranes for container handling. Shunting movement is provided by diesel locomotives, “last mile” locomotives are one solution.
ERTMS	✘ ⦿	Not relevant for terminal loading/unloading tracks, but if the terminal arrival/departure tracks are included in the operation centre then ERTMS is also required.

✓ - yes; ✘ - no; ⦿ - depends

The focus of the terminal railway infrastructure is on the track gauge, train length, axle load, and load per metre.

The next table presents a summary of the following terminal railway infrastructure: track gauge, train length and axle load category.

Table 4-41: Railway infrastructure at intermodal terminals

Terminal Name	Track gauge 1435 mm	Tracks & lengths (m)	Axle load (t)	Load per meter (t/m)
Salzburg CTS	✓	5x530, 1x350	22,5	8,0
Salzburg Frachtenbahnhof - ROLA	✓	1x420, 1x380	22,5	8,0
Villach Süd CCT (Fürnitz)	✓	1x600, 6x350	22,5	8,0
Wels Vbf. CCT	✓	6x580, 4x420/520	22,5	8,0
Lambach	✓	5x325	22,5	8,0
Linz Stadthafen CCT	✓	1x450, 2x480, 1x650	22,5	8,0
St.Michael	✓	2x360	22,5	8,0
Werndorf	✓	4x700, 2x350	22,5	8,0
Maribor Tezno	✓	2x285	20,0	7,2
Celje tovorna	✓	1x300	20,0	7,2
Ljubljana Moste KT	✓	4x500	22,5	7,2
CT Vrapče	✓	1x575, 1x565, 1x572	22,5	8,0
Robni Terminali Zagreb	✓	N/A	20,0	8,0
Luka Slavonski Brod	✓	1x200	N/A	N/A
Luka Vukovar	✓	1x780, 1x567, 1x595	20,0	8,0
RO-LA terminal Spačva	✓	2x500	20,0	8,0
Leget Sremska Mitrovica	✓	2x270	22,5	7,2
Surčin Nelt Dobanovci	✓	2x300	22,5	8,0
ŽIT Beograd	✓	2x220	22,5	8,0
RO-LA Dragoman	✓	2x500	22,5	8,0
Todor Kableshkov - Zlatitrap RO-LA	✓	1x468	22,5	8,0

Source: Different sources (railway infrastructure managers, terminal operators, WEB,…)

Track gauge: all terminals reach the gauge 1435 mm.

Track length: at most terminals the track length is shorter than 400 metres. At short tracks the container or RO-LA train must be split in two or three sets of wagons.

Axle load: some terminals in Slovenia and Croatia have terminal tracks for only 20,0 t/axle and a load per metre of 7,2 t/m.

5 TRANSPORT VOLUME

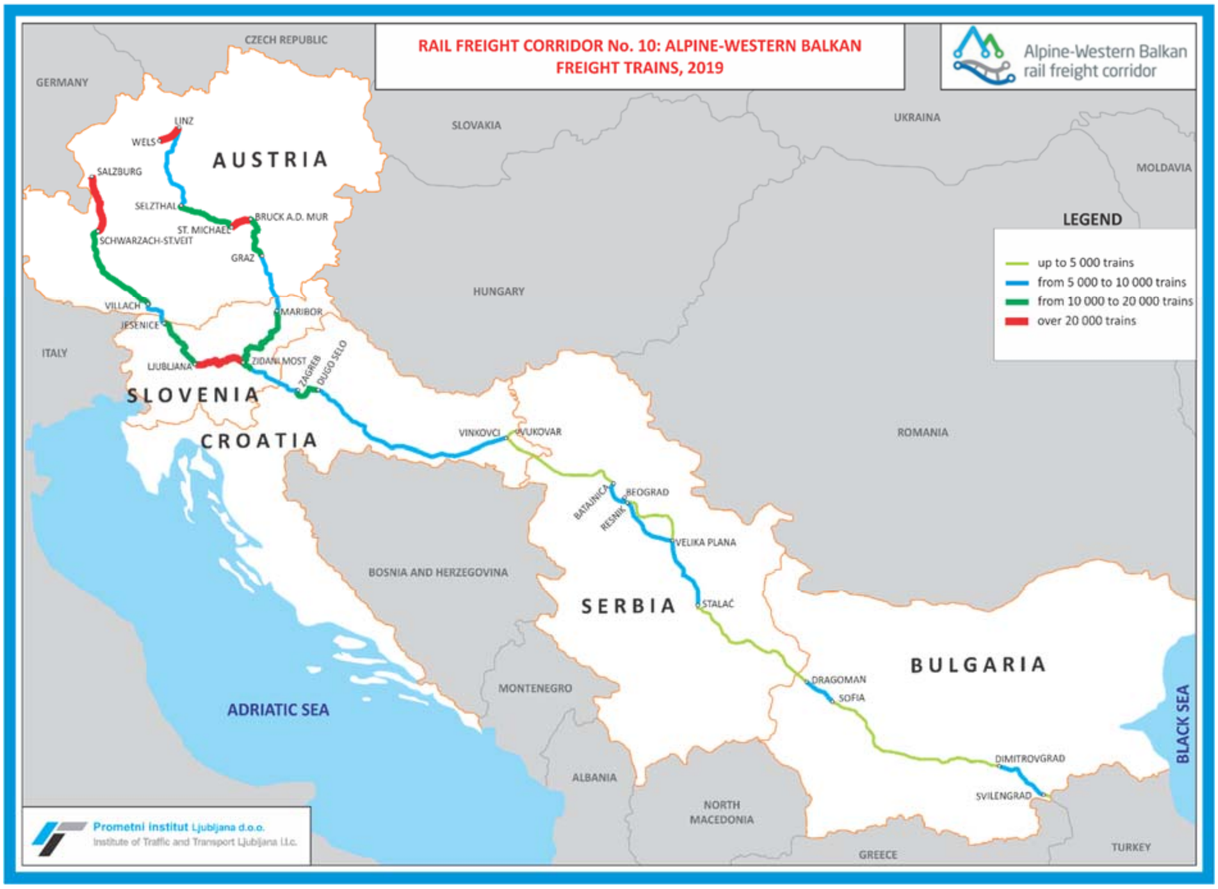
5.1 CURRENT VOLUME

This subchapter is aimed at the analysis of the most important railway transport data that is necessary to determine the AWB RFC routing and drafting of its strategic direction. The data also serves as a basis for drafting the measures to promote rail freight transport. The data has been provided by RIMs along the AWB RFC, in ÖBB-I (Austria), SŽ-I (Slovenia), HŽ-I (Croatia), IŽS (Serbia) and NRIC (Bulgaria).

5.1.1 Freight volume

A freight train (goods train) is a group of freight wagons (cars) hauled by one or more locomotives on a railway, transporting cargo on a complete route or a part of it between the shipper and intended destination as part of a logistics chain. The locomotives on the freight trains may haul bulk material, intermodal containers, general freight or specialised freight in purpose-designed cars.

Figure 5-1: Volume of freight trains along the AWB RFC in 2019



The AWB RFC sections with over 20.000 freight trains in 2019:

- Austria (ÖBB-I):
  - Salzburg-Schwarzach-St. Veit
  - Wels-Marchtrenk-Traun
  - Linz-Traun
  - St. Michael-Bruck a.d. Mur
- Slovenia (SŽ-I):
  - Ljubljana-Zidani Most

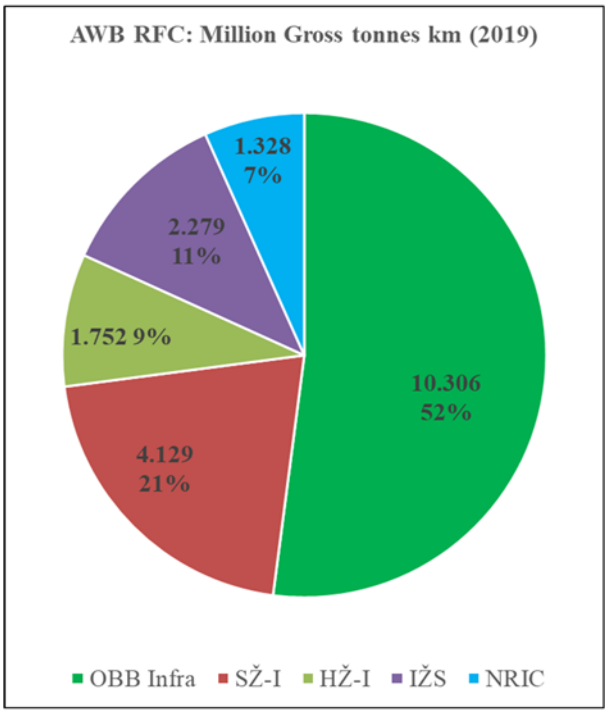
A gross tonne kilometre (GTkm) is a unit of measure of freight transport which represents the transport of one tonne of goods (including tare) by a given transport mode (road, rail…) over a distance of one kilometre. The volume of GTkm for the AWB RFC is presented in the following table and graph.

Table 5-1: Volume of GTkm along the AWB RFC in the period 2014-2019

RIM	AWB RFC: Million Gross tonnes km					
	2014	**2015**	**2016**	**2017**	**2018**	**2019**
OBB-Infra	9.972	9.525	9.356	10.157	9.973	10.306
SŽ-I	3.631	3.552	3.839	4.205	4.041	4.129
HŽ-I	1.511	1.430	1.512	1.720	1.568	1.752
IŽS	3.661	3.811	3.345	4.204	2.613	2.279
NRIC	1.264	1.329	1.374	1.344	1.397	1.328
Total	**20.039**	**19.647**	**19.426**	**21.630**	**19.592**	**19.794**

Source: RIMs – ÖBB-I, SŽ-I, HŽ-I, IŽS, NRIC

Figure 5-2: Volume of GTkm along the AWB RFC in 2019

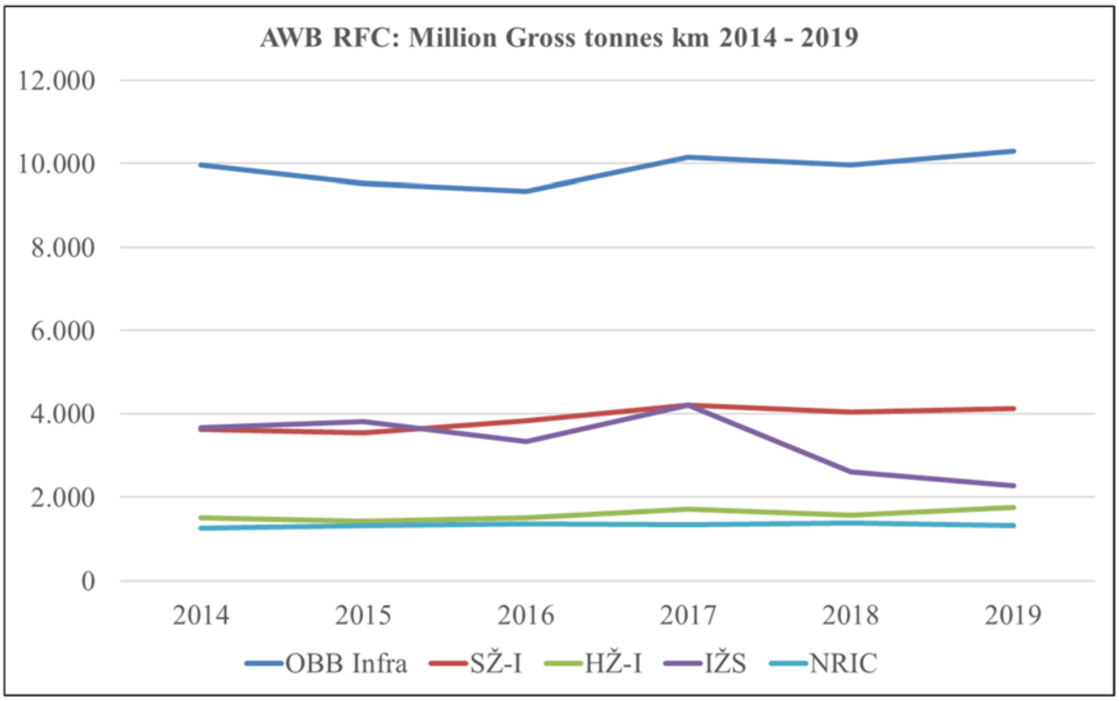


Source: RIMs – ÖBB-I, SŽ-I, HŽ-I, IŽS, NRIC

A total of 52% of the GTkm on the AWB RFC in 2019 was produced in ÖBB-I, 21% in SŽ-I, 11% in IŽS and less than 10% in HŽ-I and NRIC.

Gross tonnes km for the AWB RFC states in the time period 2014-2019 are presented in the following graph.

Figure 5-3: Volume of GTkm along the AWB RFC in period 2014-2019



ÖBB-I has the highest share of GTkm in the period 2014-2019 with about 10.000. SŽ-I and IŽS are quite closed with approximately 4.000 million GTkm, but with traffic decrease in the last two years at IŽS. HŽ-I and NRIC are closed with less than 2.000 million GT km.

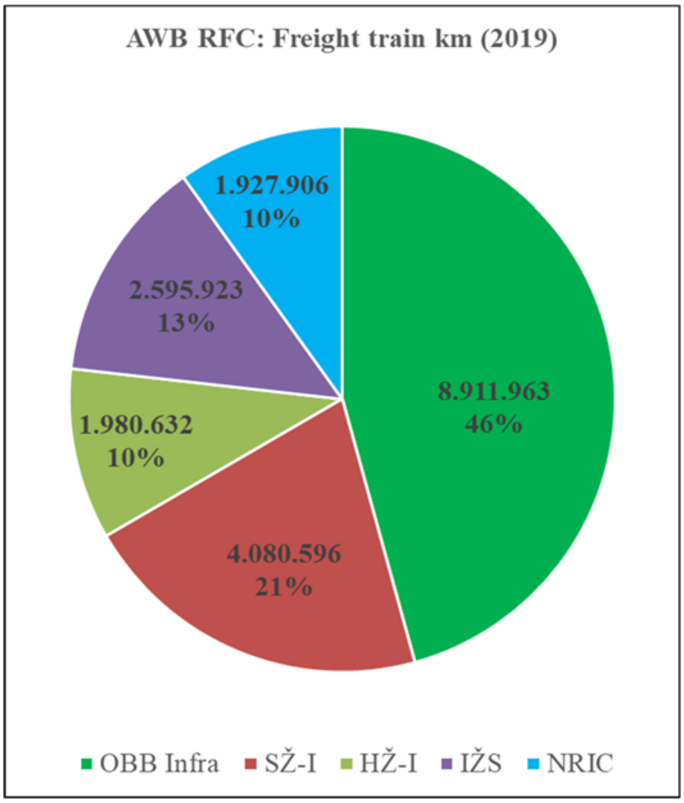
The following table and figure present the freight train kilometres along the AWB RFC.

Table 5-2: Volume of freight train km along the AWB RFC in the period 2014 – 2019

RIM	AWB RFC: Freight train km					
	2014	**2015**	**2016**	**2017**	**2018**	**2019**
OBB Infra	8.038.148	7.725.358	7.556.102	8.922.094	8.557.060	8.911.963
SŽ-I	3.940.631	3.789.766	4.103.074	4.328.424	4.040.670	4.080.596
HŽ-I	1.478.695	1.391.359	1.552.706	2.215.423	1.822.461	1.980.632
IŽS	4.338.150	4.471.073	3.866.123	4.906.976	2.980.964	2.595.923
NRIC	1.891.443	1.971.021	2.065.301	1.905.808	1.950.530	1.927.906
Total	**19.687.067**	**19.348.578**	**19.143.306**	**22.278.726**	**19.351.685**	**19.497.021**

Source: RIMs – ÖBB-I, SŽ-I, HŽ-I, IŽS, NRIC

Figure 5-4: Volume of freight train km along the AWB RFC in 2019



Source: RIMs – ÖBB-I, SŽ-I, HŽ-I, IŽS, NRIC

A total of 46% of freight train km from the AWB RFC in 2019 was in ÖBB-I, 21% in SŽ-I, 13% in IŽS and 10% in HŽ-I and NRIC.

Figure 5-5: Freight gross tonnes along the AWB RFC in 2019

5.1.2 Freight volume in terminals

The terminal operators responded to a survey and gave some relevant data regarding the current annual freight volume (throughput in tonnes and TEUs) at terminals (for detailed information see ANNEX I: Survey analysis – transport demands).

Types transhipment cargo at terminals (more options).

- 80% of terminals tranship containers,
- 48% of terminals tranship swap bodies,
- 44% of terminals tranship vehicles,
- 24% of terminals tranship general cargo,
- 16% of terminals tranship liquid bulk cargo,
- 8% of terminals tranship semi-trailers.

Estimated annual throughput at terminals.

- 28% of terminal throughput is from 0 to 50.000 tonnes,
- 24% of terminal throughput is from 100.001 to 200.000 tonnes,
- 24% of terminal throughput is from 200.001 to 500.000 tonnes,
- 16% of terminal throughput is from 50.001 to 100.000 tonnes,
- 8% of terminal throughput is over 500.000 tonnes.

The terminals that participated in the survey reported a total load/unload of approximately **2,6 million tonnes/per year.**

Estimated annual number of containers, swap bodies and semi-trailers.

- 44% of terminal throughput in TEUs is from 0 to 10.000 TEUs,
- 24% of terminal throughput in TEUs is from 50.001 to 100.000 TEUs,
- 16% of terminal throughput in TEUs is from 25.001 to 50.000 TEUs,
- 8% of terminal throughput in TEUs is from 10.001 to 25.000 TEUs,
- 8% of terminal throughput in TEUs is over 100.000 TEUs.

The terminals that participated in the survey reported a total load/unload of approximately **520.000 TEUs/per year.**

5.1.3 Passenger volume

Passenger train kilometres refers to the number of train kilometres travelled by revenue-earning passenger trains (international, regional, commuter). The following table and figure presents the volumes in period 2016-2019.

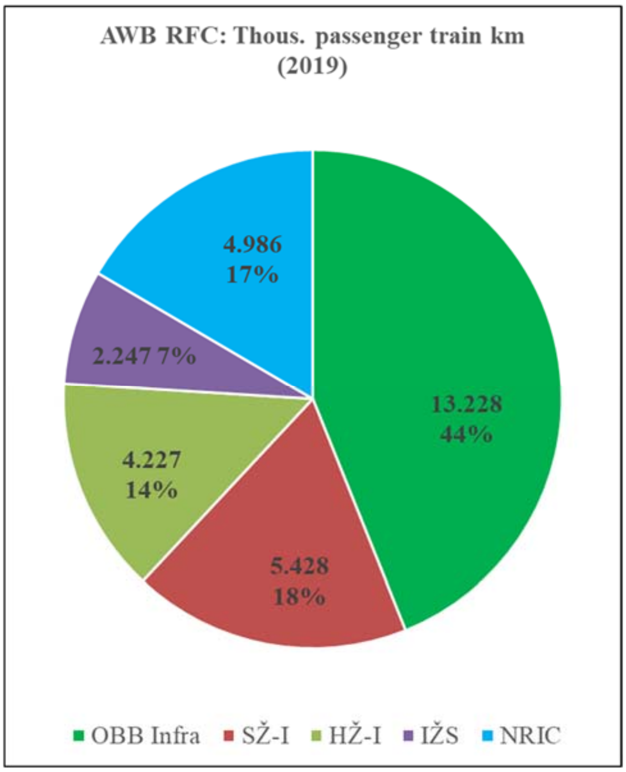
Table 5-3: Passenger train kilometres along the AWB RFC in 2016-2019

RIM	AWB RFC: Thous. Pas. train km			
	2016	2017	2018	2019
OBB Infra	11.630	12.069	13.040	13.228
SŽ-I	5.999	5.840	5.518	5.428
HŽ-I	5.021	6.579	4.256	4.227
IŽS	3.739	4.030	2.447	2.247
NRIC	5.331	5.605	5.367	4.986
Total	31.721	34.123	30.628	30.116

Source: RIMs – ÖBB-I, SŽ-I, HŽ-I, IŽS, NRIC

The volume of passenger train km on the AWB RFC decreased by 5% between 2016 and 2019.

Figure 5-6: Passenger train kilometres along the AWB RFC in 2019



Source: RIMs – ÖBB-I, SŽ-I, HŽ-I, IŽS, NRIC

A total of 44% of all passenger train km on the AWB RFC is accounted for by ÖBB-I. SŽ-I, HŽ-I and NRIC have almost equal shares between 14-18%. IŽS has a share of 7%.

5.1.4 Cross-border sections

From Austria to Turkey, freight trains cross five state borders. The transport volume depends on the different border crossings. The following table and figure present the volume of gross tonnes and freight trains in 2019 on cross-border sections.

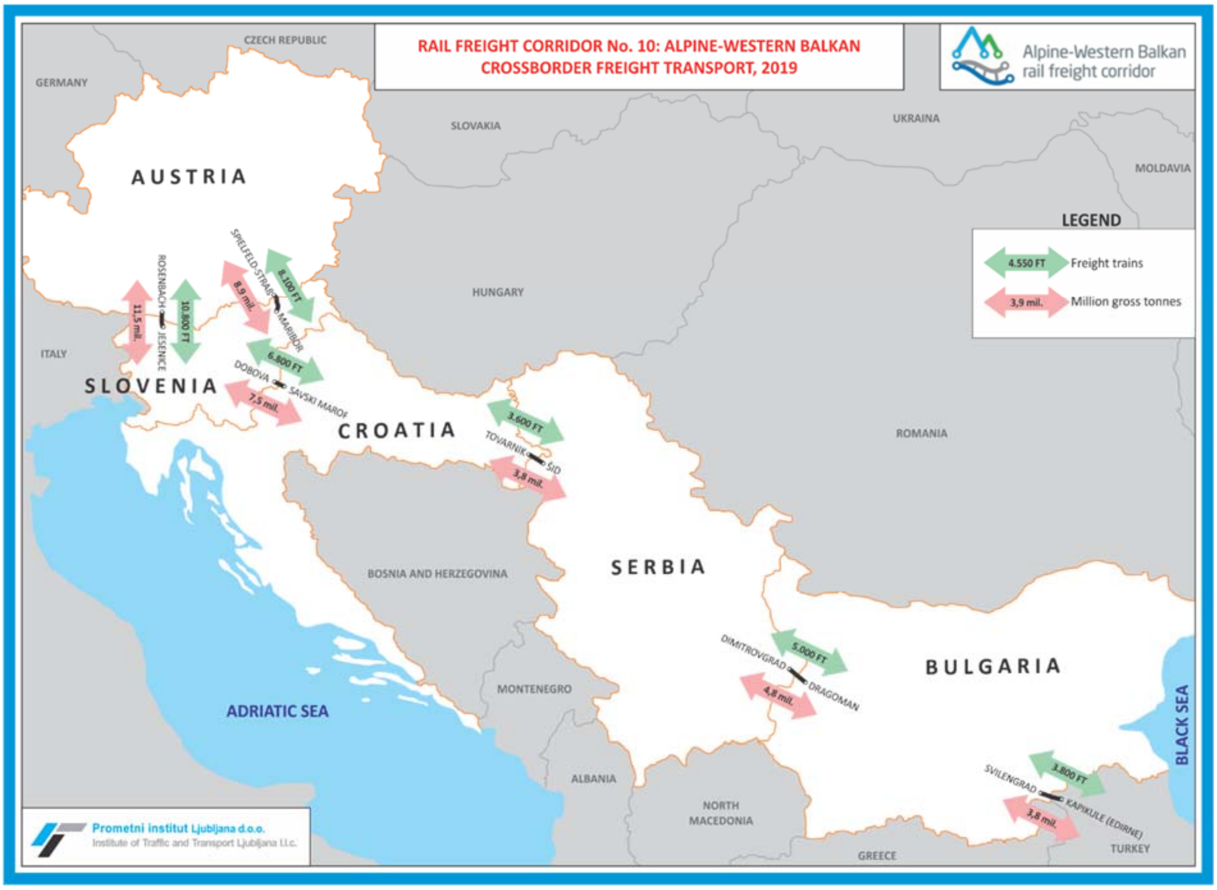
Table 5-4: Freight volume on cross-border sections along the AWB RFC in 2019

From Station	To Station	Freight trains	Mill. gross tons
Rosenbach (A)	Jesenice (SLO)	10.800	11,5
Spielfeld-Straß (A)	(Šentilj) Maribor (SLO)	8.100	8,9
Dobova (SLO)	Savski Marof (HR)	6.800	7,5
Tovarnik (HR)	Šid (SRB)	3.600	3,8
Dimitrovgrad (SRB)	Dragoman (BG)	5.000	4,8
Svilengrad (BG)	Kapikule-Edirne (TR)	3.800	3,8

Source: RIMs – ÖBB-I, SŽ-I, HŽ-I, IŽS, NRIC

The cross-border section between Rosenbach (Austria) and Jesenice (Slovenia) has the highest freight transport volume for trains and gross tonnes. The lowest volume is between Croatia/Serbia and Bulgaria/Turkey.

Figure 5-7: Cross-border freight transport in 2019



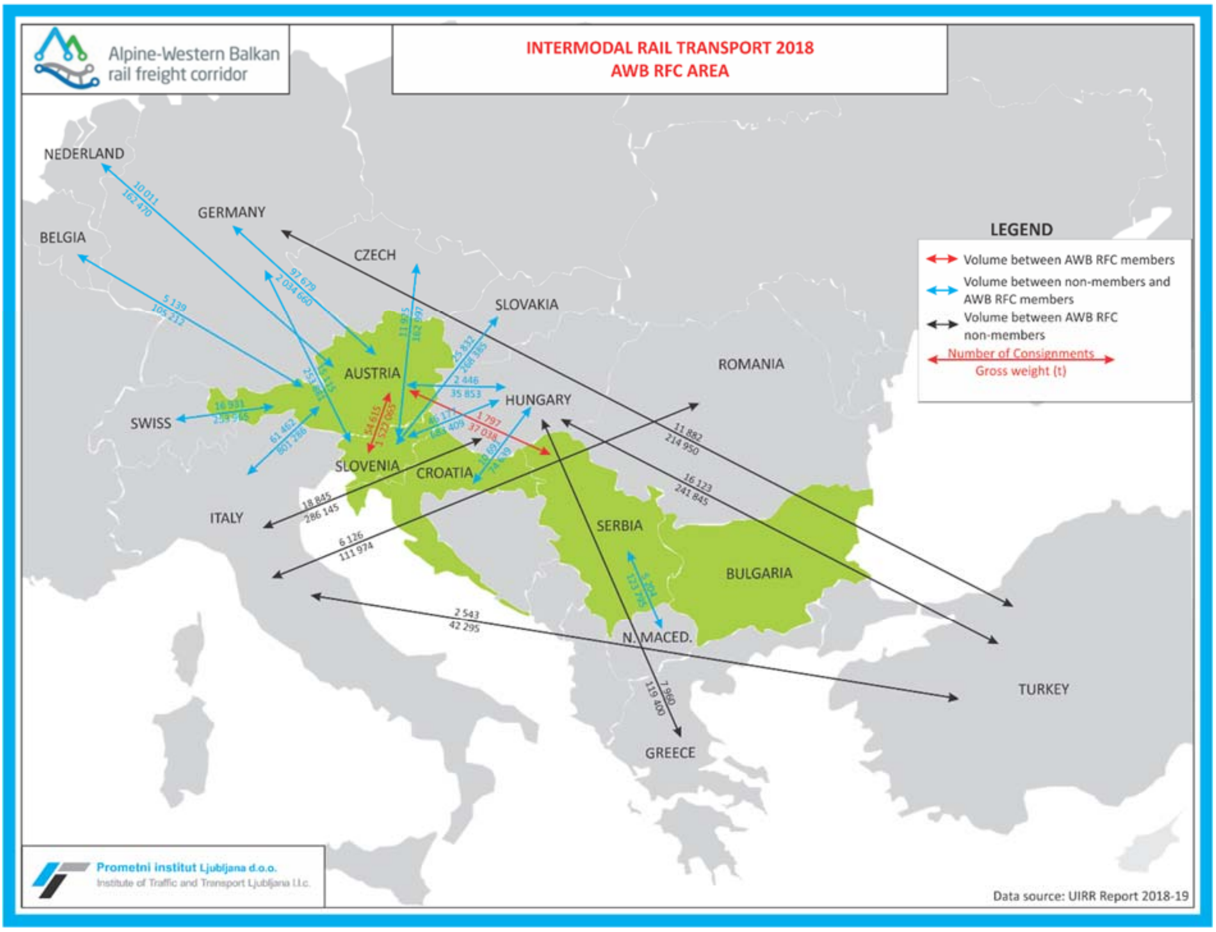
5.1.5 Combined transport

The UIRR[20] member container transport operators realised a traffic increase on both cross-border (+5,3%) and domestic routes (+4,3%). Unaccompanied Combined Transport based on containers and swap bodies increased its share in 2018 (+5,4%) on both cross-border and domestic routes, with +5,2% and +5,9%, respectively, while the use of semi-trailers grew by 10,4% over the year. The carriage of complete trucks (RO-LA or accompanied CT) closed the year with an overall negative result of 7,4%.

The most important routes for unaccompanied Combined Transport are the ones connecting Northwest Europe with South Europe (transalpine corridors with more than 50% of the total volume). RO-LA is focused on transalpine routes. Dynamic traffic development continues on East-West relations, and even more within the eastern countries and along the intercontinental routes towards China, Russia and Turkey.

In the wide area of the AWB RFC, based on the results of a survey of rail carriers and terminal operators, there is the potential (demand) for P/C 70/400 profile trains, as presented in next figure and table.

Figure 5-8: Intermodal rail transport in 2018 for the AWB RFC area



[20] Source: UIRR Report: European road-rail combined transport 2018-19, Brussels, Belgium, 2019

Table 5-5: Intermodal rail transport in 2018 for the AWB RFC area

From	To	Consignments	Gross Weight (t)	ST	SB/CT <8,3 m	SB/CT >8,3 m	RoMo
Austria	Belgia	2.247	33.153		20%	80%	
Belgia	Austria	2.892	72.059		28%	72%	
Austria	Swiss	8.475	127.125		50%	50%	
Swiss	Austria	8.456	126.840		50%	50%	
Austria	Germany	52.351	1.084.598	11%	33%	56%	
Germany	Austria	45.328	950.062	12%	37%	51%	
Austria	Hungary	2.384	35.760		50%	50%	
Hungary	Austria	62	93		50%	50%	
Austria	Italy	26.916	721.715	10%	12%	16%	62%
Italy	Austria	34.546	79.571	7%	20%	24%	49%
Austria	Nederland	3.307	54.741	1%	47%	52%	
Nederland	Austria	6.704	107.729	1%	49%	50%	
Austria	Serbia	1.628	31.461		6%	94%	
Serbia	Austria	169	5.577		13%	87%	
Austria	Slovenia	33.126	883.813		55%	10%	35%
Slovenia	Austria	21.489	638.252		36%	10%	54%
Czech	Slovenia	6.003	83.220		100%		
Slovenia	Czech	5.922	79.757		100%		
Germany	Slovenia	7.924	158.749		58%	42%	
Slovenia	Germany	7.191	95.132		63%	37%	
Germany	Turkey	6.761	150.392		70%	30%	
Turkey	Germany	5.121	64.558		67%	33%	
Greece	Hungary	4.174	62.610		50%	50%	
Hungary	Greece	3.786	56.790		50%	50%	
Croatia	Hungary	5.034	37.854		63%	37%	
Hungary	Croatia	5.657	36.785		48%	52%	
Hungary	Italy	1.963	28.782		50%	50%	
Italy	Hungary	16.882	257.363		50%	50%	
Hungary	Slovenia	11.893	170.196		96%	4%	
Slovenia	Hungary	34.284	513.213		81%	19%	
Hungary	Turkey	7.979	119.685		50%	50%	
Turkey	Hungary	8.144	122.160		50%	50%	
Italy	Romania	3.009	78.762			100%	
Romania	Italy	3.117	33.212			100%	
Italy	Turkey	1.257	35.821		17%	83%	
Turkey	Italy	1.286	6.474		4%	96%	
Macedonia	Serbia	2.462	64.677		4%	96%	
Serbia	Macedonia	2.742	59.118		2%	98%	
Slovenia	Slovakia	14.748	186.031		100%		
Slovakia	Slovenia	11.084	82.354		100%		

ST semi-trailer, SB swap body, CT Combined Transport, RO-MO rolling motorway

Source: UIRR Report 2018-19

5.2 TRANSPORT FORECAST

5.2.1 EU White Paper 2011

The 2011 EU White Paper defines a long-term vision until 2050 for a transport sector that continues to serve the needs of the economy and citizens while meeting future constraints: oil scarcity, growing congestion and the need to cut CO_2 and pollutant emissions in order to improve air quality, particularly in cities. According to this vision, transport will have to cut emissions by 60% by 2050 to contribute to the overall target of 80% to 95% reduction for the entire economy. The strategy set out in the White Paper is to a substantial degree based on low CO_2 emission fuels, energy efficiency, better multimodality of transport and new technologies that should lead to optimised journeys.

To achieve this, more than 30% of road freight over 300 km should shift to other modes such as rail or waterborne transport by 2030, and more than 50% by 2050, facilitated by efficient and green freight corridors. The implementation of the RFCs should be consistent with the development of the Core Network Corridors introduced in 2013 to facilitate the coordinated implementation of the (core) network outlined by the TEN-T. Namely, the new Core Network Corridors are multimodal (rail, road, aviation, inland waterways and ports) corridors covering passengers and freight, their main role being to remove bottlenecks, build missing cross-border connections and promote modal integration and interoperability.

Ten Goals for a competitive and resource efficient transport system: benchmarks for achieving the 60% GHG emission reduction target.[21]

Developing and deploying new and sustainable fuels and propulsion systems

1) Halve the use of 'conventionally-fuelled' cars in urban transport by 2030; phase them out in cities by 2050; achieve essentially CO_2-free city logistics in major urban centres by 2030.
2) Low-carbon sustainable fuels in aviation to reach 40% by 2050; also by 2050 reduce EU CO_2 emissions from maritime bunker fuels by 40% (if feasible 50%).

Optimising the performance of multimodal logistic chains, including by making greater use of more energy-efficient modes

3) 30% of road freight over 300 km should shift to other modes such as rail or waterborne transport by 2030, and more than 50% by 2050, facilitated by efficient and green freight corridors. To meet this goal will also require appropriate infrastructure to be developed.
4) By 2050, complete a European high-speed rail network. Triple the length of the existing high-speed rail network by 2030 and maintain a dense railway network in all Member States. By 2050 the majority of medium-distance passenger transport should go by rail.

[21] Source: White Paper: Roadmap to a Single European Transport Area – Towards a competitive and resource efficient transport system, European Commission, Brussels, March 2011

5) A fully functional and EU-wide multimodal TEN-T 'core network' by 2030, with a high quality and capacity network by 2050 and a corresponding set of information services.
6) By 2050, connect all core network airports to the rail network, preferably high-speed; ensure that all core seaports are sufficiently connected to the rail freight and, where possible, inland waterway system.

Increasing the efficiency of transport and infrastructure use with information systems and market-based incentives

7) Deployment of the modernised air traffic management infrastructure in Europe by 2020 and completion of the European Common Aviation Area. Deployment of equivalent land and waterborne transport management systems. Deployment of the European Global Navigation Satellite System (Galileo).
8) By 2020, establish the framework for a European multimodal transport information, management and payment system.
9) By 2050, move close to zero fatalities in road transport. In line with this goal, the EU aims at halving road casualties by 2020. Make sure that the EU is a world leader in safety and security of transport in all modes of transport.
10) Move towards full application of "user pays" and "polluter pays" principles and private sector engagement to eliminate distortions, including harmful subsidies, generate revenues and ensure financing for future transport investments.

5.2.2 European Green Deal

The European Union published, at the end of 2019, a European Green Deal, which covers policy guidance on climate and pollution. Climate change and environmental degradation are an existential threat to Europe and the world. To overcome these challenges, Europe needs a new growth strategy that will transform the EU into a modern, resource-efficient and competitive economy, where:

- there are no net emissions of greenhouse gases by 2050,
- economic growth is decoupled from resource use,
- no person and no place is left behind.

The European Green Deal is a plan to make the EU's economy sustainable. It can be done by turning climate and environmental challenges into opportunities, and making the transition just and inclusive for all. The European Green Deal provides an action plan to:

- boost the efficient use of resources by moving to a clean, circular economy,
- restore biodiversity and cut pollution.

The EU aims to be climate neutral in 2050, and a European Climate Law has been proposed to turn this political commitment into a legal obligation. Reaching this target will require action by all sectors of economy, including:

- investing in environmentally friendly technologies,
- supporting industry to innovate,
- rolling out cleaner, cheaper and healthier forms of private and public transport,
- decarbonising the energy sector,
- ensuring buildings are more energy efficient,
- working with international partners to improve global environmental standards.

The EU will also provide financial support and technical assistance to help those that are most affected by the move towards the green economy. This is called the Just Transition Mechanism. It will help mobilise at least 100 billion EUR over the period 2021-2027 in the most affected regions.

5.2.3 Base input data

According to the results of the survey of rail carriers (see ANNEX I: SURVEY ANALYSIS – TRANSPORT DEMANDS) about the future annual growth of transport volume/services:

- 35% rail carriers predicted growth between 1,01-2,0%,
- 20% rail carriers predicted growth up to 1,0%,
- 18% rail carriers predicted growth over 5,01%,
- 12% rail carriers predicted growth between 2,01-3,0%,
- 10% rail carriers predicted growth between 4,01-5,0% and
- 5% rail carriers predicted growth between 3,01-4,0%.

55% of rail carriers predicted future annual growth of up to 2%.

According to the results of the survey of terminal operators (see ANNEX I: SURVEY ANALYSIS – TRANSPORT DEMANDS) about the future annual growth of transport volume/services:

- 48% terminal operators predicted growth between 2,01-3,0%,
- 28% terminal operators predicted growth up to 1,0%,
- 16% terminal operators predicted growth between 1,01-2,0% and
- 8% terminal operators predicted growth over 5,01%.

48% of terminal operators predicted future annual growth of between 2-3%.

Average annual future growth of transport for rail carriers is 2,55%.

Average annual future growth of transport for terminal operators is 2,12%.

Other additional data about the future annual growth of transport and services was obtained from:

- GDP growth,
- Planned investments in the railways,
- The EU White paper on transport guidelines.

5.2.4 Fields of action for modal shift

A better modal shift in rail freight transport could be reached by decisive action in three fields:[22]

1) **The rail freight operating sector** works by speeding up journeys and offering superior, innovative products for the benefit of the customer;
2) **Infrastructure** enables and regulators support the view that driving a train is "as simple as running a truck";
3) **Transport policy** initiatives must be directed towards multimodality with an important market share for the railways by creating fair intermodal conditions (e.g. equal treatment of internal and external costs).

5.2.4.1 Rail carriers

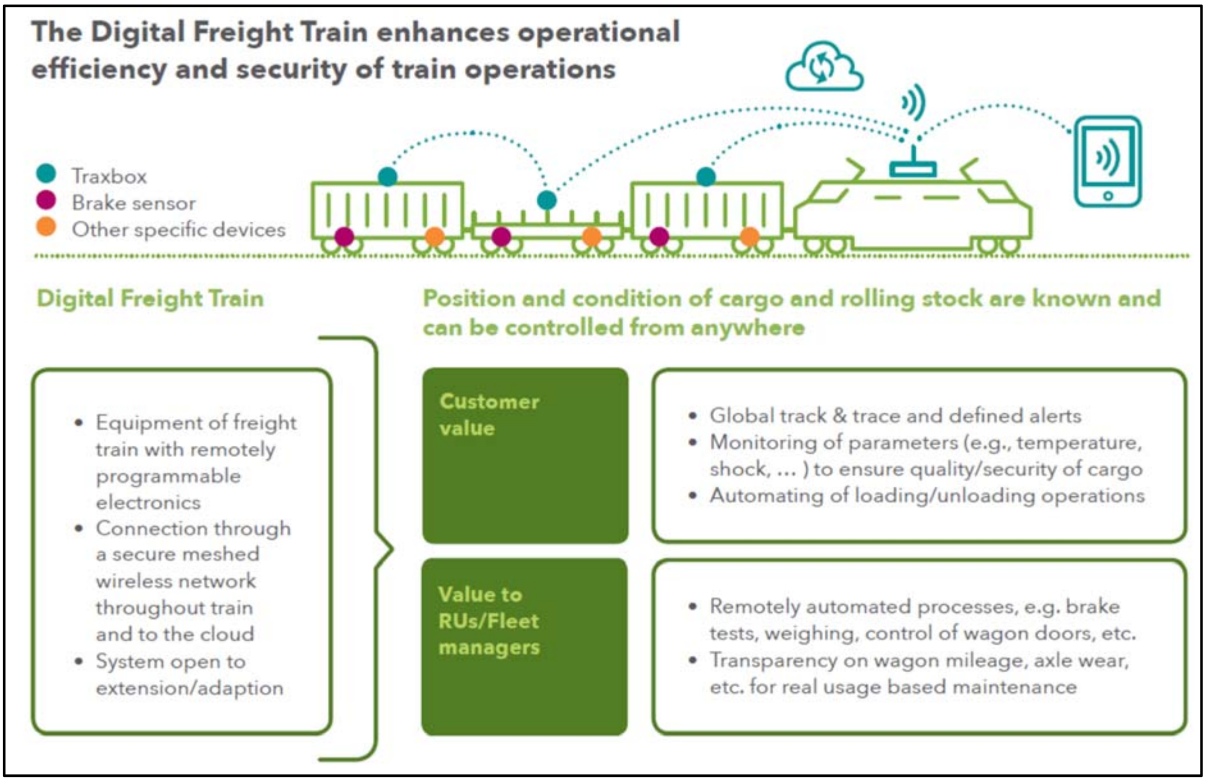
Productivity improvements and financial performance. Rail carriers need to be perform economically to attract customers. The sector has already gone through major efficiency programmes, but is still not able to reach sufficient profitability to allow a buffer for replacement investments. It remains an absolute necessity to continue the journey of restructuring and modernisation to achieve a competitive cost base and high resource productivity.

Development of attractive rail and multimodal solutions. Rail carriers need to intensify their work on quality, flexibility and ease of use to convince more customers to use their services. Only by offering rail products that are superior to trucks will they be able to attract customers towards rail.

Digitisation/technical innovation in rail freight. In the area of product and asset innovation, partnerships with technology suppliers have produced the first results on intelligent wagons and digital trains. This will be more efficient, more economical and even more environmentally friendly.

[22] Source: 30 by 2030, Rail Freight strategy to boost modal shift

Figure 5-9: Example digital freight train



Source: 30 by 2030, Rail Freight strategy to boost modal shift

Contingency Management plans for rail carriers. The European Commission gathered together the railway sector's stakeholders in order to develop an International Contingency Management Handbook, which was adopted mid-2018 and defines the roles and responsibilities of RIMs and rail carriers in case of a major international crisis.

5.2.4.2 Railway infrastructure

Infrastructure managers' efforts must continue in four main areas[23]:

- Easy access to the entire European rail network;
- Easy, reliable and fast planning of train paths throughout Europe;
- Easy train operations with real-time ETA and dynamic traffic management in case of congestion
- Standardised, highly available and high-capacity infrastructure for freight without bottlenecks.

Easy access to the entire European rail network. Twenty-five years of European rail liberalisation has not yet created a single economic area in terms of rail transport. Today, EU legislation provides for a fully liberalised rail freight market. Considerable progress has been made in fostering the technical and operational harmonisation of the rail markets of all Member States. However, in practice all railway companies, private and public, passenger and freight

[23] Source: 30 by 2030, Rail Freight strategy to boost modal shift

transport, are heavily penalised due to the lack of interoperability and persistence of national rules.

Easy, reliable and fast planning of train paths throughout Europe. Improvements in planning rail capacity are necessary. Infrastructure managers should take into account that rail freight transport does not fit into the rigid structure of passenger transport, and therefore has special needs. The customers require available, internationally guaranteed end-to-end and economical rail paths.

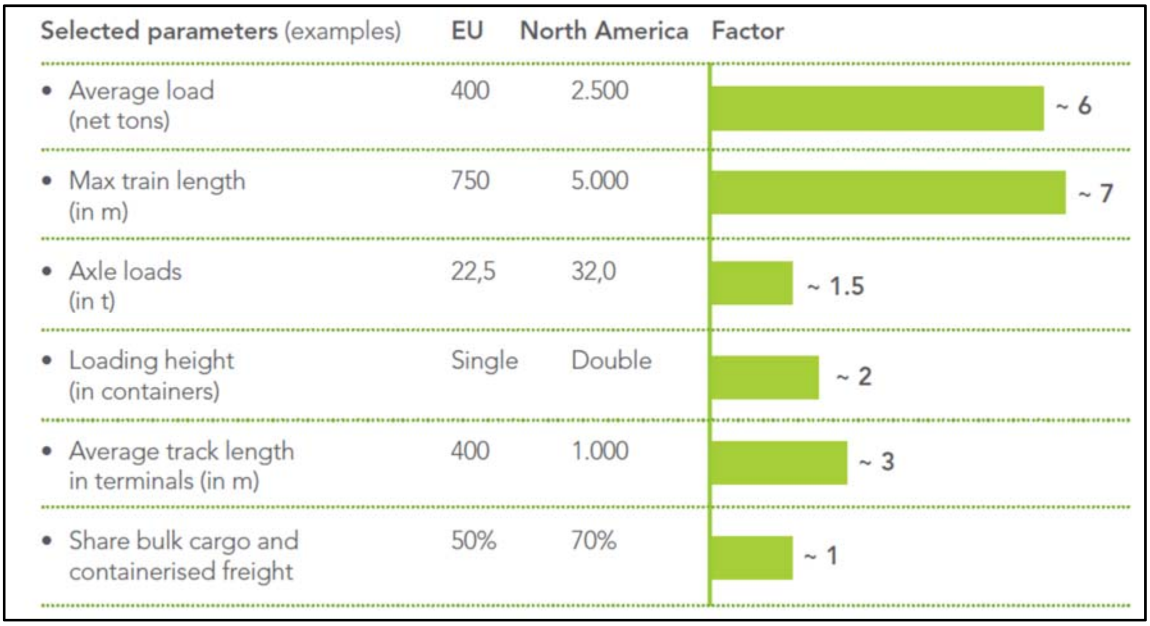
Easy train operations. In addition to planning, there is a need for improvement in daily traffic management. In their daily operations, the rail carriers notice room for further improving the short-term optimisation:

In most countries, there is insufficient pro-active real-time communication between train drivers and infrastructure managers;

- The priority regulation between operators (highspeed line, passenger transport and only then freight transport) does not take into account other operational parameters;
- Rail paths are often not aligned with real-time use of tracks in railway bundles and shunting yards;
- Contingency management and disaster management are equally high on the agenda.

Infrastructure design parameters need to be adjusted in order to accommodate growth. By 2030, rail freight companies want to take a 30% modal market share. In reality, this means transporting more than double the current volume of goods. However, it does not mean that we need to double the physical infrastructure for rail. Additional capacity can be found through optimisation.

Figure 5-10: Comparison of infrastructure parameters between the EU and North America



Source: 30 by 2030, Rail Freight strategy to boost modal shift

5.2.4.3 The policymakers and authorities

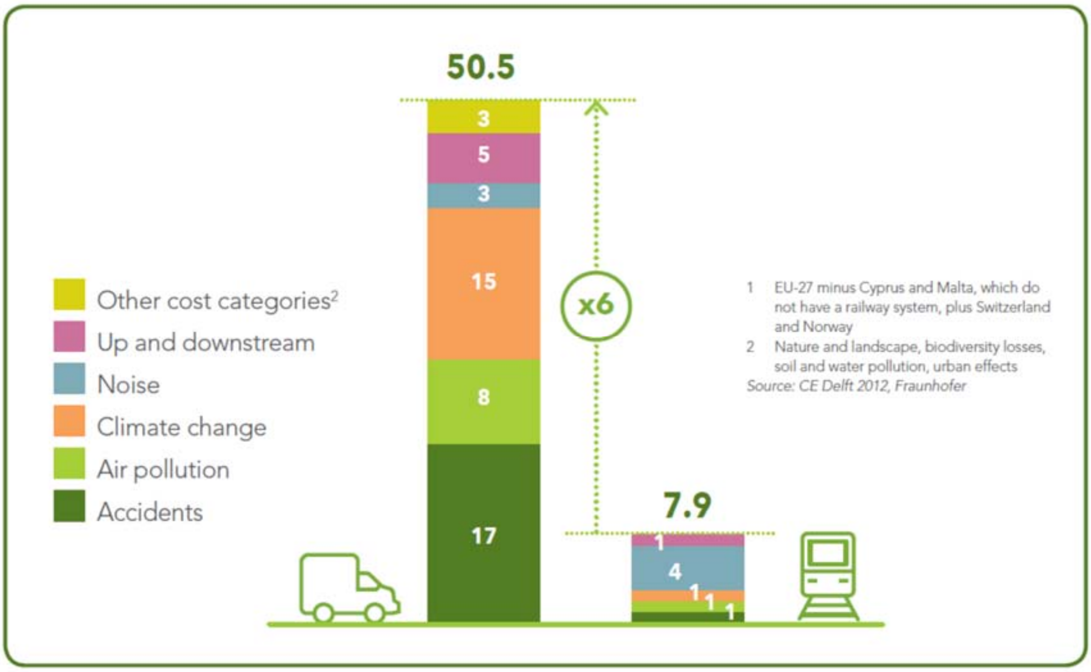
A stable regulatory framework. In order to support a modal shift, the railway sector needs a stable legal framework with fair operating conditions. The completion and implementation of the current regulations takes time and is currently being conducted at a national level. Therefore, shippers and the whole supply chain industry will feel more confident about having a long-term vision thanks to a stable framework and no additional regulation.

A level playing field. Freight transport by rail is economically efficient, but is still confronted with an unequal playing field compared with other modalities. It is a well-known fact that the competitiveness of rail increases the greater the distance, but it has also been shown that the tipping point can be reached on shorter distances. The following measures will considerably lower that tipping point and encourage shippers to shift freight from road to rail:

- Reduce differences in internalisation of external costs
- Reduction of the Track Access Charges
- Reduce administrative costs
- Burden-sharing of safety cost
- Cost-benefit analyses of infrastructure investment taking into account all societal benefits
- Support measures for Last Mile Infrastructure
- Support innovation

Road has 6x higher external costs that rail. Comparison of average external costs in EUR/1,000 ton-km; EU 27, 2008, excluding congestion.

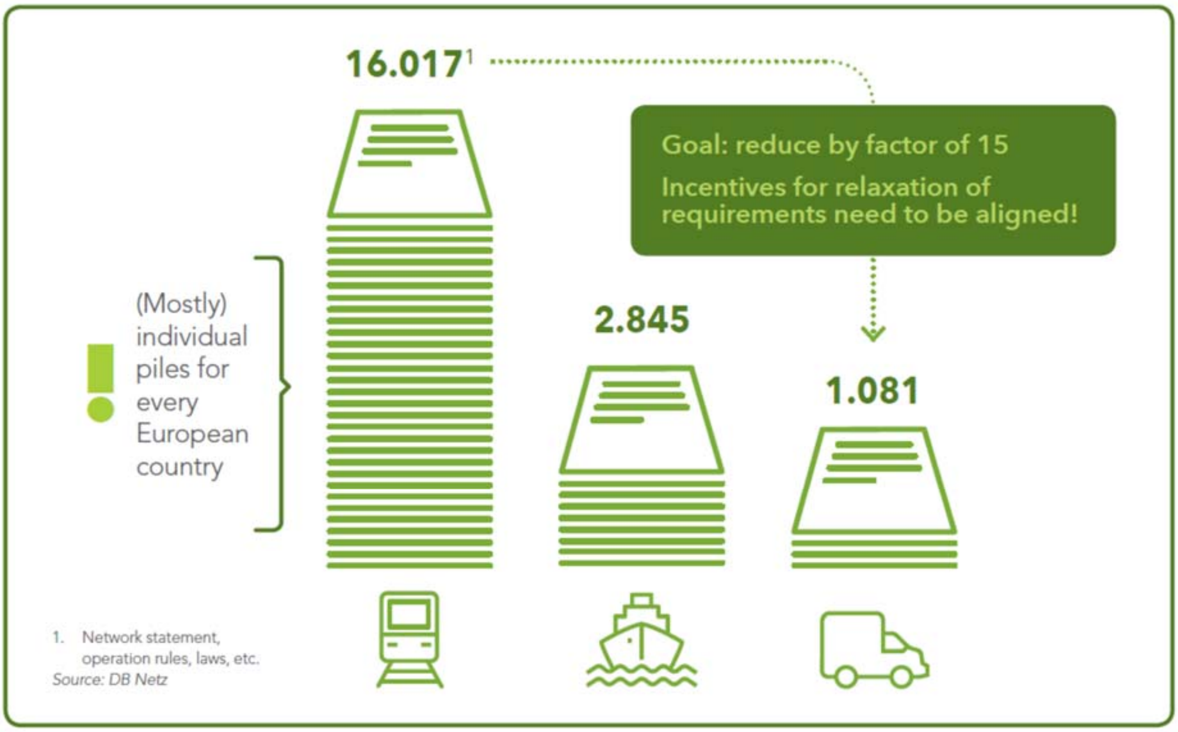
Figure 5-11: Difference in environmental performance leads to difference in external costs



Source: 30 by 2030, Rail Freight strategy to boost modal shift

Requirements/regulations for operating freight trains incur high cost and should be simplified/reduced by a factor of 15. Relevant rules/regulations to operate on transport infrastructure in number of pages.

Figure 5-12: The amount of documents required for a train is 15x greater than for a truck



Source: 30 by 2030, Rail Freight strategy to boost modal shift

5.2.5 Forecast scenarios

This study proposes three forecast scenarios for freight transport:

- **S1 – optimistic scenario:** is provisionally referred to as the "high growth rate" one. With this it is expected that the major transport infrastructure projects that are planned and foreseen will be successfully completed by 2030. The significant competitiveness of the AWB RFC is the primary land route for many types of cargo between Turkey (with West Asia). The corridor fulfils all requirements with regard to the TEN-T infrastructure parameters for core and comprehensive network. The situation at the border crossings, regarding the stopping time and procedures, will see great progress (with stops of only a few minutes). Without major bottlenecks along the corridor.
- **S2 – realistic scenario:** the scenario between S1 and S3 is based on a "stable growth rate" assumption, and represents the "baseline" scenario for transport, according to the growth predictions obtained in the survey. Progress at the border crossing has been made, along with investments to the infrastructure according to the stated plans, but with some exceptions regarding the TEN-T core network parameters (line speed 100 km/h is not achieved for all the corridor, nor is ERTMS, and there are a minimal number of stations for 740 m trains).

- **S3 – pessimistic scenario**: the foreseen investments in the railway infrastructure do not go according to the plans (major delays). Infrastructure TEN-T core network parameters are not achieved for all segments (740 m train length, ERTMS, line speed 100 km/h). The situation at the border crossings, regarding the stopping times and procedures, are more or less without major progress.

Due to Covid-19 (the coronavirus crisis), the volume of rail freight transport in 2020 was very unpredictable and dependent on the related state. Within the coming years, higher growth is foreseen for rail transport.

The next table presents the average growth rates for three scenarios with different time horizons for freight transport.

Table 5-6: Freight forecast average growth

Scenario	Average growth (%)		
	2019-2030	2030-2040	2040-2050
S1 - optimistic	2,54	3,17	3,60
S2 - realistic	1,97	2,30	2,42
S3 - pessimistic	1,00	1,12	1,14

The following three tables show forecast scenarios for the AWB RFC for the period 2019 – 2050, separated by RIMs. The transport forecast for freight transport is available in gross-tonne kilometres, train kilometres, number of trains and gross tonnes. The forecast for passenger transport is available for train-kilometre units and passenger trains.

Table 5-7: Transport forecast AWB RFC, Scenario S1 - optimistic

RIM	Transport	Unit	2019	2030	2040	2050
ÖBB-I	freight	gross tkm (mill.)	10.306	13.199	17.548	24.279
		train-km (thous.)	8.912	11.414	15.174	20.995
		trains	16.959	21.720	28.876	39.953
		gross tonnes (thous.)	19.611	25.117	33.392	46.202
	passenger	train-km (thous.)	13.228	14.205	15.461	16.998
		trains	25.172	27.031	29.422	32.347
SŽ-I	freight	gross tkm (mill.)	4.129	5.710	8.139	12.073
		train-km (thous.)	4.081	5.642	8.043	11.931
		trains	13.861	19.166	27.319	40.526
		gross tonnes (thous.)	14.026	19.394	27.644	41.009
	passenger	train-km (thous.)	5.428	6.666	8.197	10.180
		trains	18.438	22.643	27.842	34.580
HŽ-I	freight	gross tkm (mill.)	1.752	2.151	2.753	3.666
		train-km (thous.)	1.981	2.432	3.112	4.145
		trains	5.736	7.044	9.014	12.004
		gross tonnes (thous.)	5.073	6.230	7.972	10.617
	passenger	train-km (thous.)	4.227	4.604	5.076	5.653
		trains	12.240	13.332	14.700	16.372
IŽS	freight	gross tkm (mill.)	2.279	3.218	4.675	7.067
		train-km (thous.)	2.596	3.665	5.324	8.048
		trains	4.596	6.489	9.426	14.250
		gross tonnes (thous.)	4.036	5.698	8.277	12.513
	passenger	train-km (thous.)	2.247	2.683	3.216	3.894
		trains	3.979	4.751	5.695	6.895
NRIC	freight	gross tkm (mill.)	1.328	1.798	2.514	3.660
		train-km (thous.)	1.928	2.611	3.652	5.315
		trains	5.126	6.942	9.709	14.132
		gross tonnes (thous.)	3.530	4.780	6.685	9.731
	passenger	train-km (thous.)	4.986	6.253	7.838	9.922
		trains	13.257	16.627	20.840	26.382
Total AWB RFC	**freight**	**gross tkm (mill.)**	**19.794**	**26.076**	**35.628**	**50.745**
		train-km (thous.)	**19.497**	**25.765**	**35.305**	**50.434**
		trains	**46.278**	**61.361**	**84.344**	**120.865**
		gross tonnes (thous.)	**46.276**	**61.220**	**83.971**	**120.071**
	passenger	**train-km (thous.)**	**30.116**	**34.411**	**39.788**	**46.648**
		trains	**73.086**	**84.384**	**98.500**	**116.576**

Table 5-8: Transport forecast AWB RFC, Scenario S2 - realistic

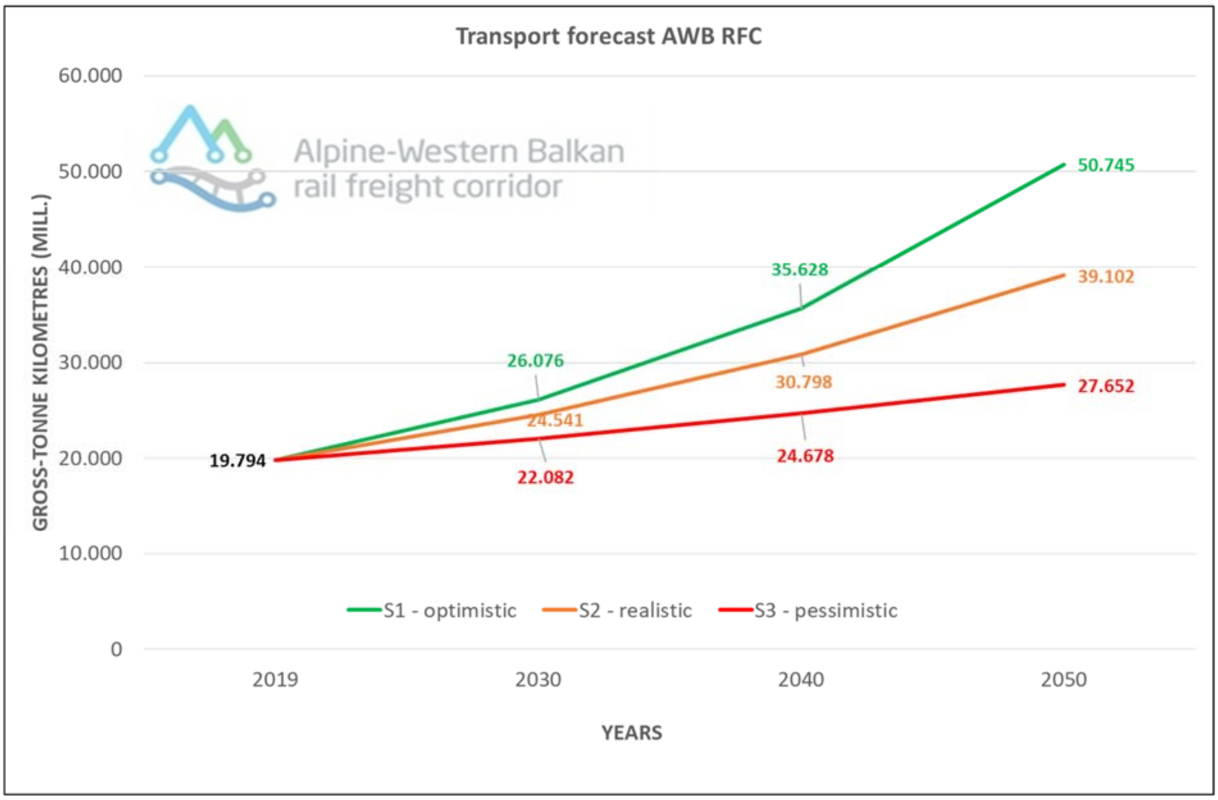
RIM	Transport	Unit	2019	2030	2040	2050
ÖBB-I	freight	gross tkm (mill.)	10.306	12.422	15.169	18.709
		train-km (thous.)	8.912	10.742	13.117	16.178
		trains	16.959	20.442	24.961	30.787
		gross tonnes (thous.)	19.611	23.639	28.865	35.602
	passenger	train-km (thous.)	13.228	13.295	13.490	13.826
		trains	25.172	25.299	25.672	26.311
SŽ-I	freight	gross tkm (mill.)	4.129	5.374	7.035	9.303
		train-km (thous.)	4.081	5.310	6.952	9.193
		trains	13.861	18.038	23.615	31.228
		gross tonnes (thous.)	14.026	18.253	23.897	31.600
	passenger	train-km (thous.)	5.428	6.239	7.152	8.281
		trains	18.438	21.192	24.293	28.127
HŽ-I	freight	gross tkm (mill.)	1.752	2.025	2.380	2.825
		train-km (thous.)	1.981	2.289	2.690	3.194
		trains	5.736	6.629	7.792	9.250
		gross tonnes (thous.)	5.073	5.863	6.891	8.181
	passenger	train-km (thous.)	4.227	4.309	4.429	4.598
		trains	12.240	12.478	12.826	13.317
IŽS	freight	gross tkm (mill.)	2.279	3.029	4.041	5.446
		train-km (thous.)	2.596	3.449	4.602	6.202
		trains	4.596	6.107	8.148	10.980
		gross tonnes (thous.)	4.036	5.363	7.155	9.642
	passenger	train-km (thous.)	2.247	2.512	2.806	3.167
		trains	3.979	4.447	4.969	5.608
NRIC	freight	gross tkm (mill.)	1.328	1.692	2.173	2.820
		train-km (thous.)	1.928	2.457	3.157	4.096
		trains	5.126	6.533	8.393	10.890
		gross tonnes (thous.)	3.530	4.499	5.779	7.498
	passenger	train-km (thous.)	4.986	5.853	6.839	8.071
		trains	13.257	15.562	18.183	21.460
Total AWB RFC	**freight**	**gross tkm (mill.)**	**19.794**	**24.541**	**30.798**	**39.102**
		train-km (thous.)	**19.497**	**24.248**	**30.519**	**38.863**
		trains	**46.278**	**57.749**	**72.909**	**93.134**
		gross tonnes (thous.)	**46.276**	**57.616**	**72.587**	**92.523**
	passenger	**train-km (thous.)**	**30.116**	**32.207**	**34.716**	**37.944**
		trains	**73.086**	**78.979**	**85.943**	**94.823**

Table 5-9: Transport forecast AWB RFC, Scenario S3 - pessimistic

RIM	Transport	Unit	2019	2030	2040	2050
ÖBB-I	freight	gross tkm (mill.)	10.306	11.177	12.155	13.230
		train-km (thous.)	8.912	9.666	10.511	11.441
		trains	16.959	18.393	20.001	21.772
		gross tonnes (thous.)	19.611	21.270	23.130	25.177
	passenger	train-km (thous.)	13.228	13.295	13.490	13.744
		trains	25.172	25.299	25.672	26.154
SŽ-I	freight	gross tkm (mill.)	4.129	4.835	5.637	6.579
		train-km (thous.)	4.081	4.778	5.571	6.501
		trains	13.861	16.230	18.923	22.084
		gross tonnes (thous.)	14.026	16.424	19.148	22.347
	passenger	train-km (thous.)	5.428	6.239	7.152	8.231
		trains	18.438	21.192	24.293	27.959
HŽ-I	freight	gross tkm (mill.)	1.752	1.822	1.907	1.998
		train-km (thous.)	1.981	2.060	2.156	2.259
		trains	5.736	5.965	6.243	6.541
		gross tonnes (thous.)	5.073	5.276	5.522	5.785
	passenger	train-km (thous.)	4.227	4.309	4.429	4.571
		trains	12.240	12.478	12.826	13.237
IŽS	freight	gross tkm (mill.)	2.279	2.725	3.238	3.851
		train-km (thous.)	2.596	3.104	3.688	4.386
		trains	4.596	5.495	6.529	7.765
		gross tonnes (thous.)	4.036	4.825	5.733	6.818
	passenger	train-km (thous.)	2.247	2.512	2.806	3.149
		trains	3.979	4.447	4.969	5.575
NRIC	freight	gross tkm (mill.)	1.328	1.522	1.742	1.994
		train-km (thous.)	1.928	2.211	2.529	2.896
		trains	5.126	5.879	6.725	7.701
		gross tonnes (thous.)	3.530	4.048	4.631	5.303
	passenger	train-km (thous.)	4.986	5.853	6.839	8.023
		trains	13.257	15.562	18.183	21.331
Total AWB RFC	**freight**	**gross tkm (mill.)**	**19.794**	**22.082**	**24.678**	**27.652**
		train-km (thous.)	**19.497**	**21.818**	**24.454**	**27.483**
		trains	**46.278**	**51.963**	**58.422**	**65.863**
		gross tonnes (thous.)	**46.276**	**51.843**	**58.163**	**65.430**
	passenger	**train-km (thous.)**	**30.116**	**32.207**	**34.716**	**37.717**
		trains	**73.086**	**78.979**	**85.943**	**94.256**

The following figure shows the overall prognosis of the development of rail freight transport performances along the AWB RFC for all states together for all scenarios.

Figure 5-13: Transport forecast AWB RFC – Gross tonnes km (mill.)



Scenario S1 is an optimistic scenario with the average yearly growth of 3,1% between the years 2019 – 2050 for freight transport. In passenger transport, the average yearly growth is 1,4%.

Scenario S2 is a realistic scenario with the average yearly growth of 2,3% between the years 2019 – 2050 for freight transport. In passenger transport the average yearly growth is 1,0%.

Scenario S3 is a pessimistic scenario with the average yearly growth of 1,1% between the years 2019 – 2050 for freight transport. In passenger transport the average yearly growth is 0,7%.

6 WP8: RESULTING MEASURES AND COST ESTIMATION

6.1 INVESTMENT PLANS

The investment plans include the investment projects relating to renewal, enhancement and construction of tracks, electrification systems, signalling systems, tunnels, bridges, sidings, passing tracks, extra tracks, or any other railway infrastructure.

The benefits of the infrastructure projects are different. They can relate to the improvement of only one parameter or to multiple improvements. The most common improvements are as follows:

- relief of bottlenecks, in order to make the infrastructure more available;
- increasing the safety/security;
- increasing the speed to increase competitiveness, especially regarding road transportation;
- improvement of punctuality;
- better protection of environment in order to comply with national laws;
- deployment of interoperability to increase competitiveness;
- maintenance of railway infrastructure, especially the renewal of tracks;
- capacity improvement.

The source for the investment plans for the AWB RFC is CID Book 5 Implementation plan 2020/2021 and the RIM and transport market study for the AWB RFC with investment plans (costs and timeframe) for every RIM.

6.1.1 Austria (ÖBB-I)

ÖBB-I together with the Ministry of Transport carried out comprehensive traffic forecasts (passenger and freight traffic) and timetable/capacity calculations. Under the condition of implementing the abovementioned projects, there will be no capacity bottlenecks on the lines of the AWB RFC in Austria by 2030 (>100% according to the UIC method).

Some of the line sections of the AWB RFC already fulfilled the criteria for running 740 m trains in 2019. There are plans to increase the capacity for 740 m trains by implementing additional longer sidings by 2030 on the core corridors.

All lines of the AWB RFC already fulfilled the criteria for 100 km/h line speed in the main parts of the line sections in 2019. There are no further plans to increase the speed in lower sections, with the following exceptions by 2030: Bischofshofen-Salzburg (Golling-Abtenau-Sulzau), Graz-Bruck/Mur, Spielfeld-Straß-Graz and Graz-Weitendorf.

Table 6-1: AWB RFC planned investments in Austria

Section/Station	Description	Period	EUR (mill)
Bischofshofen - Salzburg	Golling-Abtenau - Sulzau; Improvement of alignment Speed increase	2018-2022	32
Spielfed-Straß - Graz	Graz – Weitendorf; Four-track upgrade; Connection to Terminal and Airport link; Connection with Koralm line Capacity improvement (four-track upgrade), Terminal connection. Part of overall "Koralm Line Project"	2000-2025	880
Bruck an der Mur-Graz	Station reconfigurations Bruck a.d. Mur - Graz (Mixnitz-Bärenschützklamm, Frohnleiten, Peggau-Deutschfeistritz, Gratwein-Gratkorn) Capacity improvement; new 740 m sidings	2015-2027	212
Linz-Wels	Four-track expansion; the project includes the construction of two lines that will complement the two existing lines	2028	430
Graz-Werndorf	Upgrade between Graz Station and the Werndorf Station, increase in capacity (partly with construction of third and fourth tracks)	2016-2023	112
Werndorf-Border AT/SL	Upgrade of existing single/double-track line, maximum speed up to 160 km/h, construction of a second track	Not fixed	570
Bruck an der Mur-Border AT/SL	Upgrade to ERTMS level 2	2030	190

Source: AWB RFC CID Book 5 Implementation plan 2020/2021 and ÖBB-I

A new line is being built between Graz and Klagenfurt (not the AWB RFC section) with a maximum speed of 230 km/h and maximum slope of 10‰. The line is going to be operational in 2025, and estimated costs are 5.367 million EUR.

ETCS will be implemented on the AWB RFC according to the National Deployment Plan.

- Linz – Wels: ETCS L2, 2022
- Spielfed-Straß-Graz: ETCS L2, 2030
- Graz-Bruck a.d. Mur: ETCS L2, 2030
- Bruck a.d. Mur-St. Michael: ETCS L2, 2030
- St. Michael-Selzthal: ETCS L2, 2030
- Traun-Linz: ETCS L2, 2030
- Traun-Marchtrenk: ETCS L2, 2030
- Selzthal-Traun: after 2030
- Rosenbach-Villach: after 2030
- Villach-Spittal-Milstättersee: after 2030

- Spittal/Milstättersee-Schwarzach/St. Veit: after 2030
- Schwarzach/St. Veit-Bischofshofen: after 2030
- Bischofshofen-Salzburg: after 2030

Table 6-2: AWB sections with infrastructure characteristics in 2030 for Austria

2030		LINE TYPE: PRINCIPAL ROUTE	LINE TYPE: DIVERSIONARY	LINE TYPE: CONNECTING/FEEDER	TRACK GAUGE: 1435 mm	TRACK GAUGE: 1520	DOUBLE TRACK	MAX. TRAIN LENGHT INCL. TRACTION: 200 m	360 m	450 m	500 m	550 m	575 m	600 m	625 m	650 m	740 m	AXLE LOAD: 18,0 T/axle	20,0 T/axle	21,0 T/axle	22,5 T/axle	LOAD PER METRE: 6,4 T/m	7,2 T/m	8,0 T/m	TRAIN SPEED: v ≤ 75 km/h	75 < v ≤ 90 km/h	90 < v ≤ 100 km/h	v > 100 km/h	INTERMODAL LOADING GAUGE: UIC Guideline	LOADING GAUGE: Lines / Tunnels	POWER SUPPLY: DC 1500 V / DC 3000 V / AC 25000 V	TRAIN PROTECTION SYSTEMS	GRADIENT / (INCLINE): ‰ towards N-S Direction 1	‰ towards S-N Direction 2
ÖBB	Graz - Border next to Spielfeld/Straß	x			x												x				x			x				x	P/C 80/410	GA, G1, G2	15 kV 16,7Hz	PZB	7,00	7,00
	Bruck a.d. Mur - Graz	x			x		x										x				x			x				x	P/C 80/410	GA, G1, G2	15 kV 16,7Hz	PZB	7,00	7,00
	Bruck a.d. Mur - St. Michael	x			x		x										x				x			x				x	P/C 80/410	GA, G1, G2	15 kV 16,7Hz	PZB	13,00	13,00
	St. Michael - Selzthal	x			x		x										x				x			x				x	P/C 80/410	GA, G1, G2	15 kV 16,7Hz	PZB	15,00	15,00
	Traun - Selzthal	x			x												x				x			x				x	P/C 80/410	GA, G1, G2	15 kV 16,7Hz	PZB	21,00	21,00
	Linz - Traun	x			x		x										x				x			x				x	P/C 80/410	GA, G1, G2	15 kV 16,7Hz	PZB	26,00	26,00
	Marchtrenk - Traun	x			x												x				x			x				x	P/C 80/410	GA, G1, G2	15 kV 16,7Hz	PZB	12,00	12,00
	Marchtrenk - Wels	x			x		x										x				x			x				x	P/C 80/410	GA, G1, G2	15 kV 16,7Hz	PZB	13,00	13,00
	Villach - Staatsgrenze next to Rosenbach	x			x												x				x			x			x		P/C 80/410	GA, G1, G2	15 kV 16,7Hz	PZB (ETCS L2 + PZB Villach - Villach Süd)	22,00	22,00
	Spittal-Milstättersee - Villach	x			x		x										x				x			x				x	P/C 80/410	GA, G1, G2	15 kV 16,7Hz	PZB	6,00	6,00
	Schwarzach-St. Veit - Spittal-Milstättersee	x			x												x				x		x	x				x	P/C 80/410	GA, G1, G2	15 kV 16,7Hz	PZB	29,00	29,00
	Bischofshofen - Schwarzach-St. Veit	x			x		x										x				x			x				x	P/C 80/410	GA, G1, G2	15 kV 16,7Hz	PZB	10,00	10,00
	Salzburg - Bischofshofen	x			x		x										x				x			x				x	P/C 80/410	GA, G1, G2	15 kV 16,7Hz	PZB	11,00	11,00

Source: AWB RFC CID Book 5 Implementation plan 2020/2021

6.1.2 Slovenia (SŽ-I)

Slovenia has AWB RFC capacity problems on the line section Kranj – Jesenice. The utilised capacity of trains in 24 hours is 76 -100 trains, while the occupancy rate is 92%. Since this occupancy is high it is necessary to increase the line capacity.

In some stations in Slovenian that are part of the AWB RFC there may be insufficient capacity in the long term, because of short station tracks.

One goal targeted by development projects is to ensure the axle load D4 (8,0 t/m and 22,5 t) on entire AWB RFC sections in Slovenia. Another goal is to increase the train length on all lines of AWB RFC sections in Slovenia to 740 m.

Table 6-3: AWB RFC planned investments in Slovenia

Section/Station	Description	Period	EUR (mill)
Jesenice-border-Rosenbach (AT)	Security-technical upgrading of the Karavanke railway tunnel	2020-2021	115 SI-50
Ljubljana-Jesenice	Upgrade of line, stations and stop points, construction of second track, speed increase, tracks for 740 m trains	N/A	1.140
Maribor-Šentilj, Stations Maribor, Mb. Tezno, Pesnica, Šentilj	Upgrade of axle load category, track extensions, increase speed and capacity, new signal-safety devices, improve electric supply, new platforms and accesses	2018-2022	254

Section/Station	Description	Period	EUR (mill)
Pragersko	Upgrade of axle load category, track extensions, increase speed and capacity, new signal-safety devices, improve electric supply, new platforms and accesses	until 2025	89
Zidani Most-Šentilj	Upgrading signal safety devices, remote traffic control at all stations on the section	2019-2023	71,4
Pragersko-Maribor-Šentilj; Dobova-Zidani Most	ETCS Level 1 implementation	2017-2023	19
Maribor-Šentilj	New double-track line with new tunnel and viaduct between Maribor and Pesnica	2020 2027	101
Ljubljana-Jesenice	ETCS Level 1 implementation	until 2024	10

Source: AWB RFC CID Book 5 Implementation plan 2020/2021 and http://www.krajsamorazdalje.si/

Deployment of ERTMS/ETCS (level 1, baseline 3-set 2_ overlaid existing INDUSI I60), on line section Zidani Most-Dobova-border SLO/HR and on line section Pragersko-Maribor-Šentilj-border SLO/A. The deadline for the end of works is at the end of 2022.

- the section Zidani Most-Dobova-border SLO/HR is in the phase of certification, with completion expected in 2020;
- the section Pragersko-Maribor-Šentilj-border SLO/A is in the phase of designing the ETCS, with completion expected in 2022;
- deployment of ETCS for the section Ljubljana-Jesenice-border SLO/A is expected in 2024.

All sections of the AWB RFC are equipped with GSM-R. The system is in operation from Q4 2017.

The extension of tracks for 740 m freight trains will be made on the sections Dobova-Ljubljana, Pragersko-Zidani Most and Ljubljana-Jesenice until 2030.

Table 6-4: AWB sections with infrastructure characteristics in 2030 for Slovenia

2030		SECTION LENGHT	LINE TYPE			TRACK GAUGE		DOUBLE TRACK	MAX. TRAIN LENGHT INCL. TRACTION									
		km	PRINCIPAL ROUTE	DIVERSIONARY	CONNECTING/FEEDER	1435 mm	1520 mm		200 m	360 m	450 m	500 m	550 m	575 m	600 m	625 m	650 m	740 m
SŽ-I	St. border - Dobova - Zidani Most	51	X			X		X										x
SŽ-I	Zidani Most - Ljubljana	64	X			X		X										x
SŽ-I	Ljubljana - Jesenice - St. border	71	X			X												x
SŽ-I	Zidani Most - Pragersko	73	X			X		X										x
SŽ-I	Pragersko - Maribor	18	X			X		X										x
SŽ-I	Maribor - Šentilj - St. border	17	X			X												x

2030	AXLE LOAD				LOAD PER METRE			TRAIN SPEED				INTERMODAL LOADING GAUGE	LOADING GAUGE					TRAIN PROTECTION SYSTEMS	GRADIENT / (INCLINE)	
	18,0 T/axle	20,0 T/axle	21,0 T/axle	22,5 T/axle	6,4 T/m	7,2 T/m	8,0 T/m	v ≤ 75 km/h	75 < v ≤ 90 km/h	90 < v ≤ 100 km/h	v > 100 km/h	UIC Guideline	Lines	Tunnels	DC 1500 V	DC 3000 V	AC 25000 V		‰ towards NS	‰ towards SN
St. border - Dobova - Zidani Most				x			x				x	P/C 99/429	GC			x		ETCS L1	0_5	0_5
Zidani Most - Ljubljana				x		x			x			P/C 99/429	GC			x		ETCS L1	0_5	0_5
Ljubljana - Jesenice - St. border				x			x			x		P/C 99/429	GC			x		ETCS L1	15_20	5_10
Zidani Most - Pragersko				x			x			x		P/C 90/410	GC			x		ETCS L1	5_10	5_10
Pragersko - Maribor				x			x				x	P/C 80/400	GC			x		ETCS L1	0_5	0_5
Maribor - Šentilj - St. border				x			x		x			P/C 80/400	GC			x		ETCS L1	5_10	5_10

Source: AWB RFC CID Book 5 Implementation plan 2020/2021

6.1.3 Croatia (HŽ-I)

The Croatian rail network on the AWB RFC, faces bottlenecks on the section line Dugo Selo-Novska and at the station Dugo Selo, and to a lesser extent at Sesvete station.

The line section Dugo Selo-Novska is a single-track line with speeds of 60 km/h (2/3 of the section line) and 80 km/h (1/3 of section line), and with a number of stations with low track capacity in terms of track number and length. Due to these infrastructure capacities, the capacity is 79 trains per day, although according to the timetable it is 86, which represents a capacity utilisation of 109%.

Dugo Selo station primarily, and to a lesser extent Sesvete station, both represent bottlenecks, especially in the peak hour of passenger traffic.

The section line Savski Marof-Zagreb ZK, although a double-track railway line, has a reduced capacity utilisation due to the condition of the infrastructure and consequently the lower infrastructural speeds.

Table 6-5: AWB RFC planned investments in Croatia

Section/Station	Description	Period	EUR (mill)
Zagreb GK-Savski Marof	Reconstruction, renewal of tracks, bottleneck relief, reconstruction of the station according to the interoperability requirements	2019-2021	63
Vinkovci-Vukovar	Upgrade and electrification of line and stations, new signal safety devices*	2019-2021	71
Dugo Selo-Novska	Preparation of the design and documentation for the reconstruction and modernisation and second track – phases 1, 2, 3	After 2022	550

Section/Station	Description	Period	EUR (mill)
Okučani-Vinkovci	Reconstruction, modernisation and renewal of tracks, reconstruction of the stations according to the interoperability requirements. Preparation of design documentation for the reconstruction.	After 2022	11 (documentation only)

*EU allows exceptions regarding the usable track length

Source: AWB RFC CID Book 5 Implementation plan 2020/2021 and HŽ-Infrastruktura, http://www.hzinfra.hr

Documentation for the installation of ETCS Level 1 is being drafted for the:

- section Dugo Selo-Novska (ETCS in use until 2030)
- section Vinkovci-Vukovar (ETCS in use until 2030)

The production of documentation within which ETCS Level 2 will be designed starting with

- section Okučani-Vinkovci (ETCS in use until 2030)

GSM-R is not implemented on any railway line section in Croatia. The project is planned to run in the coming period, and there is a plan that the GSM-R will be installed on the AWB RFC by 2030.

Table 6-6: AWB sections with infrastructure characteristics in 2030 for Croatia

2030		SECTION LENGHT km	LINE TYPE PRINCIPAL ROUTE	DIVERSIONARY	CONNECTING/FEEDER	TRACK GAUGE 1435 mm	1520 mm	DOUBLE TRACK	MAX. TRAIN LENGHT INCL. TRACTION 200 m	360 m	450 m	500 m	550 m	575 m	600 m	625 m	650 m	740 m	AXLE LOAD 18,0 T/axle	20,0 T/axle	21,0 T/axle	22,5 T/axle	LOAD PER METRE 6,4 T/m	7,2 T/m	8,0 T/m	TRAIN SPEED v ≤ 75 km/h	75 < v ≤ 90 km/h	90 < v ≤ 100 km/h	v > 100 km/h	INTERMODAL LOADING GAUGE UIC Guideline	LOADING GAUGE Lines	Tunnels	POWER SUPPLY DC 1500 V	DC 3000 V	AC 25000 V	TRAIN PROTECTION SYSTEMS	GRADIENT / (INCLINE) ‰ towards NS	‰ towards SN
HŽI	Savski Marof St. Bor. - Savski Marof	5,092	X			X		X										X				X			X				X	80/410	GC				X	SI	0	3
HŽI	Savski Marof - Zaprešić	6,540	X			X		X										X				X			X				X	80/410	GC				X	PZB	1	1
HŽI	Zaprešić - Zagreb Zap. Kolodvor	13,008	X			X		X										X				X			X				X	80/410	GC				X	PZB	3	3
HŽI	Zagreb Zap. Kolodvor - Zagreb RK	10,685	X			X		X*										X				X			X	X				80/410	GC				X	PZB	3	4
HŽI	Zagreb RK - Sesvete	11,981	X			X		X										X				X			X				X	80/410	GC				X	PZB	6	5
HŽI	Sesvete - Dugo Selo	10,156	X			X		X										X				X			X				X	80/410	GC				X	PZB	1	5
HŽI	Dugo Selo - Banova Jaruga	66,932	X			X		X										X				X			X				X	80/410	GC				X	ETCS L1	5	5
HŽI	Banova Jaruga - Novska	17,279	X			X		X										X				X			X				X	80/410	GC				X	ETCS L1	4	3
HŽI	Novska - Nova Kapela Batrina	56,618	X			X		X						X				X				X			X				X	80/410	GC				X	PZB/ETCS L1**	6	6
HŽI	Nova Kapela Batrina - Strizivojna Vrpolje	62,590	X			X		X						X				X				X			X				X	80/410	GC				X	ETCS L2****	5	6
HŽI	Strizovojna Vrpolje - Vinkovci	31,937	X			X		X							X			X				X			X				X	80/410	GC				X	ETCS L2****	4	3
HŽI	Vinkovci - Tovarnik	32,375	X			X		X										X				X			X				X	80/410	GC				X	PZB/ETCS L1**	4	6
HŽI	Vinkovci - Vukovar	18,542	X			X				X***												X			X				X	80/410	GC					ETCS L1	5	5
HŽI	Tovarnik - Tovarnik St. Bor.	1,547	X			X		X									X					X			X			X		80/410	GC				X	SI	0	1

** ETCS level 1 Novska – Okučani

*Double-track on section Zagreb Klara - Zagreb RK Opposite direction of the section Zagreb Zap. Kolodvor - Zagreb RK OS is 139 m shorter

***on section Vukovar Borovo Naselje - Vukovar, excluded from INF TSI

****Okučani - Vinkovci

Source: AWB RFC CID Book 5 Implementation plan 2020/2021

6.1.4 Serbia (IŽS)

On the Serbian railway network there are two sections representing bottlenecks:

- Batajnica-Surčin (section Batajnica-Beograd Ranžirna) with a capacity of 43 trains/day,
- Čiflik-Staničenje (section Niš Ranžirna-Dimitrovgrad) with a capacity of 46 trains/day.

These two sections have the lowest capacity due to the speed limits and single-track traffic.

On the horizon until 2024, during the reconstruction of a part of the line Niš Ranžirna-Dimitrovgrad, some stations will be reconstructed, which will enable the traffic of longer trains. In addition, the train speed will be increased on this section. On the horizon until 2024 the whole section Niš Ranžirna-Dimitrovgrad will be electrified.

Table 6-7: AWB RFC planned investments in Serbia

Section/Station	**Description**	**Period**	**EUR (mill)**
Border-Šid-Golubinci (81 km)	Reconstruction and modernisation of the existing double-track line for a speed up to 160 km/h	2023-2027	250
Stara Pazova-Beograd Centar (34,5 km)	Reconstruction and modernisation of the existing double-track line for a speed up to 200 km/h	2018-2021	314,8
Beograd (Batajnica)	New intermodal terminal	2020 - 2022	14,5
Ostružnica-Beograd Ranž. (20 km)	Second track on the bypass line Beograd Ranžirna-Ostružnica-Surčin-Batajnica for a speed up to 120 km/h	2023-2025	52
Beograd Ranžirna	Station reconstruction with a container terminal	2019-2021	5,5
Jajinci-Mala Krsna (59 km)	Reconstruction of existing single track line for speed up to 120 km/h	2019-2021	39,3
Belgrade - Niš (240 km)	Reconstruction and modernisation of the Belgrade - Nis railway line with construction of the second track for a speed up to 200 km/h	2024-2030	2.000
Niš-Dimitrovgrad (96 km)	Reconstruction and modernisation with electrification: • Construction of Niš bypass (22 km) for a speed up to 160 km/h • Reconstruction and modernisation of railway section Sicevo-Dimitrovgrad (80 km) for a speed up to 120 km/h • Niš-Dimitrovgrad Railway line electrification (86 km)	2021-2024	268

Source: AWB RFC CID Book 5 Implementation plan 2020/2021, Infrastruktura železnice Srbije, Ministry of Construction, Transport and Infrastructure of Serbia

The ERTMS deployment plan in Serbia for the AWB RFC is as follows:

- section border with Croatia - Stara Pazova in the timeframe 2023-2027,
- section Stara Pazova - Batajnica in the timeframe 2019-2021,
- section Niš - Dimitrovgrad - border with Bulgaria in the timeframe 2025-2030,
- section Belgrade - Niš in the timeframe 2024-2030.

Table 6-8: AWB sections with infrastructure characteristics in 2030 for Serbia

2030		SECTION LENGHT	LINE TYPE			TRACK GAUGE		DOUBLE TRACK	MAX. TRAIN LENGHT INCL. TRACTION										AXLE LOAD				LOAD PER METRE			TRAIN SPEED				INTERMODAL LOADING GAUGE	LOADING GAUGE		POWER SUPPLY			TRAIN PROTECTION SYSTEMS	GRADIENT /(INCLINE)	
		km	PRINCIPAL ROUTE	DIVERSIONARY	CONNECTING/FEEDER	1435 mm	1520 mm		200 m	360 m	450 m	500 m	550 m	575 m	600 m	625 m	650 m	740 m	18,0 T/axle	20,0 T/axle	21,0 T/axle	22,5 T/axle	6,4 T/m	7,2 T/m	8,0 T/m	v ≤ 75 km/h	75 < v ≤ 90 km/h	90 < v ≤ 100 km/h	v > 100 km/h	UIC Guideline	Lines	Tunnels	DC 1500 V	DC 3000 V	AC 25000 V		‰ towards NS	‰ towards SN
IŽS	St. Border - Šid	6	X			X		☑									☑					X		X			X	X			GB	GB			X	ID	4	1
IŽS	Šid- Ruma	52	X			X		☑						☑								X		X		X		X			GB	GB			X	PZB+CTC	3	4
IŽS	Ruma- Golubinci	20	X			X		☑									☑					X		X				X	X		GB	GB			X	PZB+CTC	6	6
IŽS	Golubinci- Stara Pazova	9	X			X		☑									☑					X		X			X		X		GB	GB			X	PZB+CTC	3	9
IŽS	Stara Pazova- Batajnica	14	X			X		☑									☑					X		X		X					GB	GB			X	PZB+CTC	1	3
IŽS	Batajnica- Beograd Ranžirna	26	X			X											☑					X			X	X					GB	GB			X	PZB+CTC	7	8
IŽS	Beograd Ranžirna- Resnik	10	X			X											☑					X			X	X					GB	GB			X	PZB+CTC	17	11
IŽS	Beograd Ranžirna- Rakovica- Mala Krsna- Velika Plana	99	X			X							☑									X			X	X		X			GB	GB			X	PZB+CTC	13	10
IŽS	Resnik- Velika Plana	76	X			X											☑					X			X	X		X			GB	GB			X	PZB+CTC	15	15
IŽS	Velika Plana- Lapovo	19	X			X		☑					☑									X			X	X		X			GB	GB			X	PZB+CTC	5	6
IŽS	Lapovo- Stalać	64	X			X		☑					☑									X			X	X	X	X	X		GB	GB			X	PZB+CTC	5	4
IŽS	Stalać-Niš Ranžirna	62	X			X		☑				☑										X			X	X	X	X			GB	GB			X	PZB+CTC	7	6
IŽS	Niš Ranžirna-Dimitrovgrad	101	X			X									☑							X		X				X			GB	GB			X	ID	10	6
IŽS	Dimitrovgrad- St. Border Serbia/Bulgaria	7	X			X											☑					X			X		X				GB	GB			X	ID	12	-

*Double-track Đunis - Trupale; single tracks Stalać - Đunis and Trupale - Niš ranžirna

*The lines where technical parameters are expected to improve are marked yellow. The whole section Niš Ranžirna - Dimitrovgrad will be electrified

Source: AWB RFC CID Book 5 Implementation plan 2020/2021

6.1.5 Bulgaria (NRIC)

The removal of the bottlenecks regarding the capacity along the AWB RFC on the territory of Bulgaria is planned as follows:

- Sofia-Septemvri until 2025
- Voluyak-Sofia until 2025
- Kalotina Zapad-Voluyak until 2030

Table 6-9: AWB RFC plan investments in Bulgaria

Section/Station	**Description**	**Period**	**EUR (mill)**
Voluyak-Dragoman-Serbian border	Modernisation of the 49,5 km Voluyak Dragoman-Serbian border line, identified by the EU Council as a priority cross-border section	N/A	132
Sofia-Voluyak	Modernisation and upgrade of the existing double-track railway section, in line with requirements for Core Network Corridors as set by Regulation 1315/2013 and repealing Decision 661/2010/EU. Development of Sofia Railway Junction: Sofia-Voluyak Railway Section	2016-2024	104
Sofia-Elin Pelin	Modernisation of the railway section Sofia-Elin Pelin	2021	64
Elin Pelin-Kostenets	Modernisation of railway infrastructure in accordance with the requirements for the railway infrastructure of the core TEN-T network as specified in Regulation 1315/2013	2019-2026	476
Kostenets-Septemvri	Modernisation of railway infrastructure in accordance with the requirements for the railway infrastructure of the core TEN-T network as specified in Regulation 1315/2013	2019-2023	168
Plovdiv	Development of Plovdiv railway node	ongoing -2020	103

Source: AWB RFC CID Book 5 Implementation plan 2020/2021,Connecting Europe Facility (CEF) – Transport grants 2014-2018

The ERTMS deployment plan in Bulgaria is as follows:

- Kalotina Zapad-Dragoman: The ERTMS (ETCS-1 and GSM-R) deployment project is set for implementation in the period 2021-2027;
- Dragoman-Voluyak: The ERTMS (ETCS-1 and GSM-R) project is being explored in the scope of the current programming period to 2021, and the realisation will be completed in the period 2021-2027;
- Voluyak-Sofia: With regard to the construction of ERTMS (ETCS-1 and GSM-R), it is expected that it will be built by 2023;
- Sofia-Septemvri: The GSM-R system is built. The ETCS-1 deployment project is set for implementation until the end of 2023.

Table 6-10: AWB sections with infrastructure characteristics in 2030 for Bulgaria

2030		SECTION LENGHT	LINE TYPE			TRACK GAUGE		DOUBLE TRACK	MAX. TRAIN LENGHT INCL. TRACTION										AXLE LOAD				LOAD PER METRE			TRAIN SPEED				INTERMODAL LOADING GAUGE	LOADING GAUGE		POWER SUPPLY			TRAIN PROTECTION SYSTEMS [3]	GRADIENT / (INCLINE) [2]	
		km	PRINCIPAL ROUTE	DIVERSIONARY	CONNECTING/FEEDER	1435 mm	1520		≤ 200 m	≤ 350 m	≤ 450 m	≤ 500 m	≤ 550 m	≤ 575 m	≤ 600 m	≤ 625 m	≤ 650 m	≤ 740 m	18,0 T/axle	20,0 T/axle	21,0 T/axle	22,5 T/axle	6,4 T/m	7,2 T/m	8,0 T/m	v ≤ 75 km/h	75 < v ≤ 90 km/h	90 < v ≤ 100 km/h	v > 100 km/h	UIC Guideline	Lines	Tunnels	DC 1500 V	DC 3000 V	AC 25000 V		‰ towards NS	‰ towards SN
NRIC	St. Border Serbia/Bulgaria - Kalotina Zapad	0,800	X			X												X				X			X		X			59/389	GC				X	RSABS	-7,2	
	Kalotina Zapad - Kalotina	2,000	X			X												X				X			X				X	59/389	GC				X	ABS-AC + ECTS-L1	-20,5	
	Kalotina - Dragoman	11,720	X			X		X										X				X			X				X	50/380	GC	GC			X	ABS-AC + ECTS-L1	-21,0	-15,0
	Dragoman - Aldomirovtsi	7,052	X			X		X										X				X			X				X	59/389	GC				X	ABS-AC + ECTS-L1	18,5	18,5
	Aldomirovtsi - Voluyak	27,435	X			X		X										X				X			X				X	59/389	GC				X	ABS-AC + ECTS-L1	15,0	15,0
	Voluyak - Sofia	7,793	X			X		X										X				X			X				X	59/389	GC				X	ABS-AC + ECTS-L1	9,7	9,2
	Sofia - Kazichene	14,353	X			X		X										X				X			X				X	50/380	GC				X	ABS-AC + ECTS-L1	-9,6	-9,6
	Kazichene -Vakarel	24,919	X			X		X										X				X			X				X	59/389	GC	GC			X	ABS-AC + ECTS-L1	19,5	19,5
	Vakarel - Septemvri	63,526	X			X		X										X				X			X				X	59/389	GC	GC			X	ABS-AC + ECTS-L1	-20,0	-20,0
	Septemvri - Stamboliyski	35,361	X			X		X										X				X			X				X	59/389	GC				X	ABS-AC + ECTS-L1	-7,6	-6,5
	Stamboliyski - Plovdiv	17,155	X			X		X										X				X			X				X	59/389	GC				X	ABS-AC + ECTS-L1	-7,1	-7,1
	Plovdiv - Krumovo	11,698	X			X		X										X				X			X		X			59/389	GC				X	ABS + ECTS-L1	2,5	2,5
	Krumovo - Katunitsa	4,887	x			x												x				x			x				x	59/389	GC				x	ABS-AC + ECTS-L1	1,6	
	Katunitsa - Popovitsa	16,913	x			x		x										x				x			x				x	59/389	GC				x	ABS-AC + ECTS-L1	-7,5	7,5
	Popovitsa - Dimitrovgrad	46,799	x			x											x					x			x				x	59/389	GC				x	ABS-AC + ECTS-L1	10,0	
	Dimitrovgrad - Simeonovgrad	27,031	X			X											X					X			X				X	59/389	GC				X	ABS-AC + ECTS-L1	12,0	
	Simeonovgrad - Svilengrad	40,522	X			X											X					X			X				X	59/389	GC				X	ABS-AC + ECTS-L1	10,0	
	Svilengrad - St. Border Bulgaria/Turkey	18,862	X			X																X			X				X	59/389	GC				X	RSABS	8,8	
	Svilengrad - St. Border Bulgaria/Greece	3,890	X			X																X			X		X			59/389	GC				X	RSABS	8,0	

[1] - maximum longitudinal gradient of track N1 in the direction of travel of the route from the second column; the "+" sign means climb, the "-"descent

[2] - in case of double-track - maximum longitudinal slope of track N2 opposite to the direction of movement of the route from the second column; the "+" sign means climb, the "-"descent

[3] - systems for providing and controlling the movement of trains: automatic blocking systems with axle counters without through signals -ABS-AC; automatic blocking systems with through signals - ABS; relay semi-automatic blocking system - RSABS; automatic cab system - ACS; European train control system level 1 - ETCS-L1.

Source: AWB RFC CID Book 5 Implementation plan 2020/2021

6.2 COSTS

Many investment plans of the states along the AWB RFC have already been estimated with regard to the investment costs needed to fulfil the TENT criteria for the following infrastructure parameters: line electrification, axle load, line speed, trains with a length of 740 m and ERTMS.

According to the RIMs' investment plans and cost estimations (see chapter 6.1 INVESTMENT PLANS), the next table presents summarised investment values in EUR for the time period until the 2030.

Table 6-11: Investment costs for AWB sections until 2030

RIM	mill. EUR
ÖBB-I	2.426
SŽ-I	1.799
HŽ-I	695
IŽS	2.944
NRIC	1.047
Total	**8.912**

Source: different sources

Total value of planned investment costs for AWB sections until 2030 is 8.912 mill. EUR.

For cost estimation for upgrading of the lines along the AWB RFC that are not included in the state plans, the next table was used for different types of investment (upgrade) and the costs (in million EUR) per unit.

Table 6-12: Estimated costs per unit for line upgrading

Investment	Unit	Mill. EUR
Construction of new conventional line (up to 160 km/h) with small share of tunnels and viaducts	km/double-track	25,0
Line and stations upgrading (line category …)	km/double-track	12,0
Tracks extension - small station (up to 2 tracks)	station	7,0
Tracks extension - medium station (up to 4 tracks)	station	14,0
Tracks extension - large station (up to 6 tracks)	station	25,0
ERTMS - ETCS Level 1	km/double-track	0,15
ERTMS - ETCS Level 2	km/double-track	0,75
ERTMS - GSM-R (Infrastructure module)	km/line	0,2
Line electrification (substations, catenary…)	km/single track	1,0

Sources: http://www.krajsamorazdalje.si/, UIC, Transport Development Challenges in the Twenty-First Century, Proceedings of the 2015 TranSopot Conference and other sources

6.3 WP1: TRAIN LENGTH

According to the rail carrier survey (see ANNEX I: SURVEY ANALYSIS – TRANSPORT DEMANDS) about future demand for maximum train length, the results are as follows:

- 35% rail carriers predicted "up to 600 m,"
- 30% rail carriers predicted "701-740 m,"
- 20% rail carriers predicted "601-700 m" and
- 15% rail carriers predicted "over 741 m."

35% of rail carriers predicted a future demand for train length up to 600 m and 65% of carriers over 600 m. According to the investment plans until 2030, most of the lines of the AWB RFC will fulfil the criteria for operating 740 m freight trains, with the following exception:

- Croatia (HŽ-I): Vinkovci-Vukovar, because it is excluded from INF TSI

Operation of 740 m trains in 2030 will be available along 99% of the length of the AWB RFC.

	ÖBB-I	SŽ-I	HŽ-I	IŽS	NRIC
740 m (%)	100	100	94*	100	100

*Vinkovci-Vukovar excluded from INF TSI

Figure 6-1: Map of maximal train length in 2030

Investments for extension of station tracks should take into consideration the additional (reserve) length, while operating 740 m long trains. For a 740 m long freight train the usable track length should be over 750 m.

Figure 6-2: Additional track length

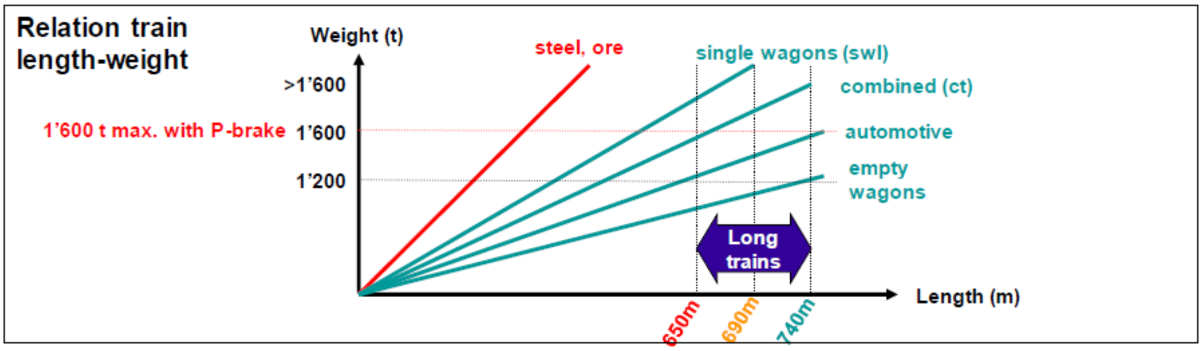
Source: Prometni institut Ljubljana, d.o.o.

Why is operating longer freight trains worth it?[24]

- **Increased capacity utilisation of the network.** This will make better use of the existing infrastructure and boost rail freight transport's economic performance. In addition, increasing train utilisation is also less expensive than constructing new lines.
- **Increased productivity will cut operating costs.** With additional wagons, more freight can be transported on the same trip, lowering the cost per tonne-kilometre and strengthening rail freight in its competition with HGVs.
- **Reduced energy consumption.** The increased volume of freight capacity means fewer trains are required, saving traction current.
- **Increased demand for rail freight transport.** As a result, more freight can be transport by rail. This will reduce the volume of traffic on motorways and national roads, leading to a cut in CO_2 emissions, thus making a major contribution to climate protection.

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

Figure 6-3: Relation between train length and train weight



Source: Study of Long Trains (740 m) on the Corridor Rotterdam-Genoa, May 2014

[24] Source: https://www.allianz-pro-schiene.de/en/press-releases/740-metre-freight-train/

Figure 6-4: Potential trains for extension (car train, container train)

Source: https://farm4.static.flickr.com/3840/14675095722_52df590e81_b.jpg , https://farm7.static.flickr.com/6164/6188752362_4e6231c6d4_b.jpg in

The next table presents the increase of train capacity with additional wagons.

Table 6-13: Example of extended trains

Train type	Length (m) no Loco	Wagons	Gross mass (t)	Cargo		Remarks
⇩⇩ EXISTING SITUATION ⇩⇩						
car train	496	16	1.000	192	cars	+ 1 x Loco; Laas
container	502	19	1.150	80	TEU	+ 1 x Loco; Sgs
empty	459	24	637	/	/	+ 1 x Loco; Tads; cereal
⇩⇩ TRAIN EXTENTION ⇩⇩						
car train	682	22	1.375	264	cars	+ 1 x Loco; Laas
container	679	26	1.574	104	TEU	+ 1 x Loco; Sgs
empty	689	36	956	/	/	+ 1 x Loco; Tads; cereal
⇩⇩ DIFFERENCE ⇩⇩						
car train	186	6	375	72	cars	
container	177	7	424	24	TEU	
empty	230	12	319	/	/	
⇩⇩ CAPACITY IMPROVEMENT (%) ⇩⇩						
car train	**37,5**					
container	**35,2**					
empty	**50,0**					

Source: Prometni institut Ljubljana, d.o.o.

The lengths are without locomotives. For every locomotive, the train is longer by an additional 20 metres. The increase in capacity for car trains is 37%, for container trains 35% and empty trains 50%.

6.3.1 COSTS

Not all railway stations should have tracks for 740 m trains, but only defined one. At double-track lines the overtaking tracks for 740 m trains should be every 35-40 km. At single track lines the crossing tracks for 740 m trains should be every 20-25 km (every second railway station). Other critical stations for 740 m trains are freight stations, marshalling yards and border handover stations.

The next table presents the estimated minimal number of railway stations with tracks for 740 m trains. As mentioned before, the tracks should have a usable length over 750 m.

Table 6-14: Estimated minimal number of stations for 740 m trains

RIM	Section	Stations	Total
ÖBB-I	Salzburg-Bischofshofen-Villach-border A/SLO (Jesenice)	6	16
	Linz-Selzthal	5	
	Selzthal-St. Michael-Bruck a.d. Mur Graz-border A/SLO	5	
SŽ-I	border A/SLO-Jesenice-Ljubljana	3	9
	border A/SLO-Maribor-Zidani Most	3*	
	Ljubljana-Zidani Most-Dobova-border A/SLO	3	
HŽ-I	border SLO/HR-Savski Marof-Zagreb RK-Dugo Selo	2	11
	Dugo Selo-Novska	4	
	Novska-Vinkovci-Tovarnik-border HR/SRB	5	
IŽS	border HR/SRB-Šid-Stara Pazova-Batajnica	2	20
	Batajnica-Beograd Ranžirna-Resnik (-Rakovica)-Mala Krsna-Velika Plana	9	
	Velika Plana-Lapovo-Stalać-Niš	4	
	Niš-Dimitrovgrad-border SRB/BG	5	
NRIC	border SRB/BG-Dragoman-Voluyak	2	13
	Voluyak-Sofia-Septemvri-Plovdiv-Popovitsa	5	
	Popovitsa-Dimitrovgrad-Svilengrad-border BG/TR (Kapikule)	6	

*Section Pragersko-Zidani Most

The estimated number of railway stations with tracks with a usable length over 750 m for 740 m trains along the AWB RFC is 69.

The next table presents the estimated investment costs (in EUR) for extension of railway tracks for 740 m trains at 69 railway stations along the AWB RFC.

Table 6-15: Estimated costs (in EUR) for track extension for 740 m trains

RIM	Costs (mill. EUR)	Remarks
ÖBB-I	224	Focus on the TENT comprehensive network section: Salzburg-Villach and Linz-Bruck a.d. Mur.
SŽ-I	126	Focus on the TENT core network section Ljubljana-Dobova-border SLO/HR and comprehensive section border A/SLO-Jesenice-Ljubljana.
HŽ-I	154	Focus on all the TENT core network AWB RFC sections in Croatia.
IŽS	280	Focus on all the indicative TENT core network[25] AWB RFC sections in Serbia.
NRIC	182	Focus on the TENT core network section: border SRB/BG-Dragoman-Sofia-Plovdiv.
Total	**966**	

The estimated investment costs for extension of station tracks for 740 m trains are 966 million EUR. Some of these costs are already included in investment plans for upgrading the rail sections and stations up to 2030.

6.3.2 VOLUME OF 740 M TRAINS

To determine the number of 740 m trains on AWB RFC, the following assumptions must be taken into consideration:

- According to the types of cargo and its potential, the 740 m trains could present about one third of all freight trains in the future. All these 740 m trains could operate under the S1 – optimistic scenario.
- Information from the rail carriers that participated in the survey shows that 740 m trains could account for about 18% of all freight trains. These 740 m trains could operate under the S2 – realistic scenario.
- The S3 – pessimistic (minimal) scenario could have a market share of 9%.for 740 m trains
- Worst-case scenario: if the infrastructure is not ready for 740 m trains – these trains could not operate.
- From five freight trains (empty, container, car) with a current length of 550 m could be formed four new 740 m trains. From four freight trains with a current length of 500 m could be formed three new 740 m trains. From six freight trains with a current length 450 m could be formed four new 740 m trains.

[25] According to Annex III of 1315/2013 and TENtec

Figure 6-5: Number of 740 m trains in 2030

Figure 6-6: Number of 740 m trains in 2050

6.4 WP2: LOADING GAUGE

According to the results of the rail carrier survey (see ANNEX I: SURVEY ANALYSIS – TRANSPORT DEMANDS) the future demand for line loading gauge P/C 70/400 is as follows:

- 39% rail carriers predicted "High demand,"
- 39% rail carriers predicted "It could be available" and
- 22% rail carriers predicted "Low demand."

The investment to rectify insufficient intermodal loading gauge P/C along the AWB RFC should be focused on Serbia and Bulgaria, where the current loading gauge is below P/C 70/400 or not defined.

- Serbia (IŽS):
  - No necessary P/C codification has been performed (565 km AWB lines).
- Bulgaria (NRIC):
  - SRB/BG border Dragoman-Kazichene and Plovdiv-Krumovo (79 km AWB lines)

In Serbia the IŽS should organise (i.e. provide) railway line measures that meet the defined P/C profile along all the IŽS network. The measures must be done on existing and already upgraded railway lines. The relevant P/C profile could be provided with the complete upgrading of the lines until 2030 that are already planned at some sections of the AWB RFC in Serbia.

In Bulgaria the NRIC has also planned to upgrade the railway lines with an insufficient P/C profile on the section SRB/BG border Dragoman-Sofia-Kazichene until 2030. After upgrading of lines new measures should be provided to meet the defined new P/C profile.

The RIMs along the AWB RFC have already planned the complete upgrade of the lines to meet the criteria for sufficient loading gauge P/C, especially in Bulgaria and at some sections in Serbia. The investment costs regarding loading gauge are already included in the investments plans up to 2030 for both corridor member states.

6.5 WP3: AXLE LOAD AND LOAD PER METRE

6.5.1 Axle load

According to the investments plans until 2030, all lines of the AWB RFC fulfil the criteria for 22,5 t per axle. The last upgraded section is:

- Croatia (HŽ-I):
    - Vinkovci-Vukovar, 2021

After 2021 the entire AWB RFC will be available for 22,5 t per axle.

	ÖBB-I	SŽ-I	HŽ-I	IŽS	NRIC
22,5 t/axle (%)	100	100	100	100	100

Figure 6-7: Map of axle load in 2030

The investment costs for upgrading the HŽ-I section Vinkovci-Vukovar are already included in the investments plans up to 2030. Other principal routes along the AWB RFC do not need any upgrading projects (only maintenance) regarding axle load category, because they already meet the criteria for 22,5 t/axle.

6.5.2 Load per metre

According to the rail carrier survey (see ANNEX I: SURVEY ANALYSIS – TRANSPORT DEMANDS), the future demand for axle load per metre is as follows:

- 80% rail carriers predicted 8,0 tonnes / metre (category D4),
- 15% rail carriers predicted 7,2 tonnes / metre (category D3), and
- 5% rail carriers predicted 8,8 tonnes / metre (category E5).

Rail carriers predicted high demand for parameter 8,0 tonnes / metre. However, , according to the investment plans upgrading of the load per metre from 7,2 to 8,0 t/m will not be achieved by for the following sections of the AWB RFC :

- Austria (ÖBB-I):
  - some sections on line Schwarzach-St. Veit - Spittal-Milstättersee
- Slovenia (SŽ-I):
  - Ljubljana-Zidani Most

In 2030 a load of 8,0 t/m will be available for 96% of the length of the AWB RFC.

	ÖBB-I	SŽ-I	HŽ-I	IŽS	NRIC
8,0 t/m (%)	98	78	100	100	100

Figure 6-8: Map of load per metre in 2030

The sufficient load per metre of 8,0 tonnes/metre in Austria, Slovenia and Serbia could be achieved through the complete upgrading of the lines. The investment costs for upgrading of the infrastructure parameter load per metre from 7,2 to 8,0 tonnes/metre in Serbia (IŽS) are already included in the investment plans up to 2030 for the sections border HR/SRB-Šid-Batajnica and Niš-Dimitrovgrad-border SRB/BG.

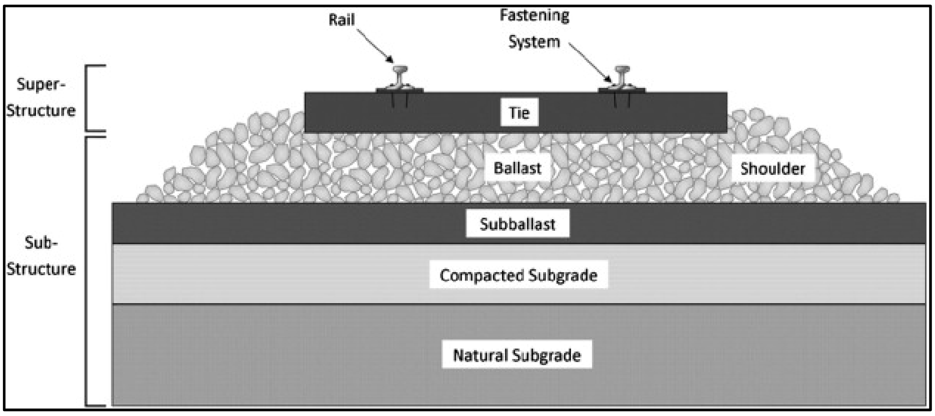
The investment costs for upgrading of the load per metre in Slovenia (SŽ-I) are included in plans for the line section Ljubljana-Jesenice-border SLO/A. Upgrading of the section Ljubljana-Zidani Most is not included to the plans. The investment costs for upgrading of some sections on line Schwarzach-St. Veit - Spittal-Milstättersee in Austria (ÖBB-I) are not included in the national plans. The next table presents the estimated investment costs (in EUR) for load per metre after 2030, which are not included in the investment plans.

Table 6-16: Estimated investment costs (in EUR) for load per metre after 2030

RIM	**Costs (mill. EUR)**	**Remarks**
ÖBB-I	132	Some sections between Schwarzach-St. Veit - Spittal-Milstättersee (11 km).
SŽ-I	1.380	Costs for section Ljubljana-Dobova border SLO/HR (114,7 km). Section Ljubljana-Jesenice already in plans.
HŽ-I	/	All sections with 8,0 tonnes/metre.
IŽS	*	Investment costs included in investment plans up to 2030.
NRIC	/	All sections with 8,0 tonnes/metre.
Total	**1.512**	

The estimated investment costs for upgrading the load per metre from 7,2 to 8,0 tonnes/metre are 1.512 million EUR. The upgrading of the load per metre from 7,2 to 8,0 t/m needs complete renewal of super- and sub-structures.

Figure 6-9: Rail sub- and super-structures



Source: https://ars.els-cdn.com/content/image/1-s2.0-S221439121400018X-gr2.jpg

6.6 WP4: SPEEDS

According to the rail carrier survey (see ANNEX I: SURVEY ANALYSIS – TRANSPORT DEMANDS) about future demand line speeds (km/h), the results are as follows:

- 45% rail carriers predicted a line speed of 91-100 km/h,
- 20% rail carriers predicted a line speed of 111-120 km/h,
- 15% rail carriers predicted a line speed of 101-110 km/h,
- 10% rail carriers predicted a line speed of 81-90 km/h and
- 10% rail carriers predicted a line speed of 70-80 km/h.

Upgrading of the railway lines according to the investment plans until 2030 will increase the line speeds in some sections, but will not meet the criteria for 100 km/h along all the AWB RFC for freight trains until 2030.

In 2030, an average line speed of 91-100 km/h for freight transport will be available at 71% of the length of the AWB RFC.

	ÖBB-I	SŽ-I	HŽ-I	IŽS	NRIC
91-100 km/h (%)	58	48	91	100	42

Figure 6-10: Map of average line speeds in 2030 (freight transport)

Only Serbia will achieve all lines along the corridor having an average line speed of 91-100 km/h for the year 2030. The highest share fir this speed class will thus be for Serbia (100%), then Croatia (HŽ-I) at over 90%, and finally Bulgaria (NRIC) with the lowest share at 42%. The basis for this data is the investment plans of every state and its RIM, with the assumption being that all upgraded lines will have the speed class of 91-100 km/h.

At many corridor sections, the line speed of 91-100 km/h could be achieved through the complete upgrade of the lines and related railway stations. The investment costs to increase the speed according to the plans are already included in the investment plans for every corridor member state.

Complete upgrading of the railway line or its section could include more or less all infrastructure parameters, such as electrification, axle load category, load per metre, train length 740 m, ERTMS and also line speeds, which depends to the line radius in the curves.

The focus in the future regarding the line speed should be the elimination of the permanent (and temporary) speed restrictions. According to the data from RIMs, 11% (about 235 km) of the AWB RFC has speed restrictions.

6.7 WP5: LINE ELECTRIFICATION

According to the investment plans until 2030, all lines of the AWB RFC will be electrified. The last electrified sections will be:

- Croatia (HŽ-I):
  - Vinkovci-Vukovar, 2021
- Serbia (IŽS):
  - Niš ranžirna-Dimitrovgrad, 2024

According to the plans, after 2024 the entire AWB RFC will be electrified.

	ÖBB-I	SŽ-I	HŽ-I	IŽS	NRIC
Electrif. (%)	100	100	100	100	100

Figure 6-11: Map of line electrification in 2030

HŽ-I and IŽS have already planned through the upgrade of the lines to meet the criteria for the complete electrification of the lines. The investment costs are already included in the investment plans for both corridor member states.

6.8 WP6: ERTMS

6.8.1 ETCS

According to the investment plans until 2030, installation of ETCS will not fulfil the criteria for ERTMS interoperable lines until 2030. The AWB RFC sections without ETCS in 2030 will be as follows:

- Austria (ÖBB-I):
  - Selzthal-Traun (installation after 2030)
  - Rosenbach-Salzburg (installation after 2030)
- Croatia (HŽ-I):
  - SLO/HR border Savski Marof-Zagreb RK-Dugo Selo

In 2030 ETCS will be installed at 83% of the length of the AWB RFC.

	ÖBB-I	SŽ-I	HŽ-I	IŽS	NRIC
ETCS (%)	42	100	72	100	100

Figure 6-12: Map of ETCS installation in 2030

The next table presents the summarised estimated investment costs (in mill. EUR) for installation of ETCS, according to the investment plans, before and after 2030.

Table 6-17: Estimated investment costs (in EUR) for ETCS

RIM	Costs (mill. EUR)	Remarks
ÖBB-I	353	Only ETCS L2, before 2030 and after 2030
SŽ-I	7	Only ETCS L1, before 2030
HŽ-I	122	ETCS L1 and L2
IŽS	295	Probably ETCS L2
NRIC	20	ETCS L1, before 2030
Total	**797**	

The estimated investment costs for installation of ETCS (L1 and L2) are 797 million EUR.

6.8.2 GSM-R

Installation of GSM-R according to the investments plans until 2030 will fulfil the criteria for ERTMS interoperable lines by 2030.

In 2030 GSM-R will be installed at 100% of the length of the AWB RFC.

	ÖBB-I	SŽ-I	HŽ-I	IŽS	NRIC
GSM-R (%)	100	100	100	100	100

The next table presents the estimated investment costs (in EUR) for installation of GSM-R.

Table 6-18: Estimated investment costs (in EUR) for GSM-R installation

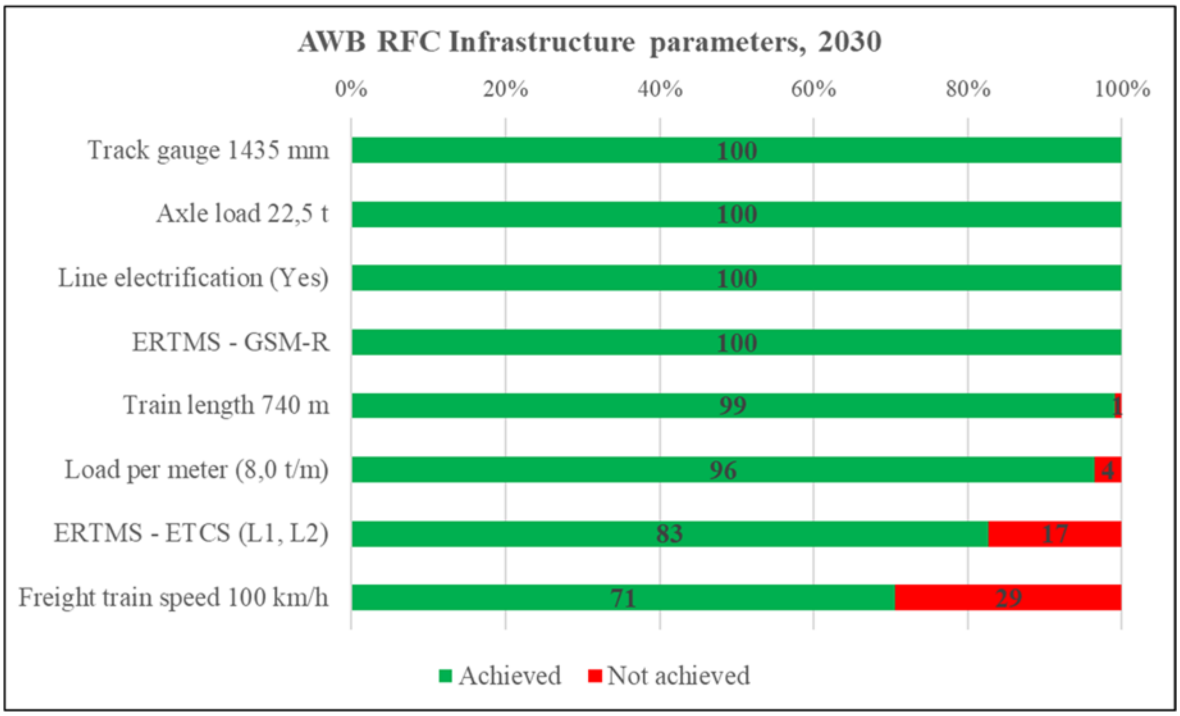
RIM	Costs (mill. EUR)	Remarks
ÖBB-I	/	Already installed at all rail sections of the AWB RFC
SŽ-I	/	Already installed at all rail sections of the AWB RFC
HŽ-I	69	Planned for all AWB RFC rail sections by 2030
IŽS	113	ERTMS deployment plan: Šid-Stara Pazova (2023-2027), Stara Pazova-Batajnica (2019-2021), Niš-Dimitrovgrad (2025-2030), Belgrade-Niš (2024-2030)
NRIC	11	Costs included in investment plans for the line section border SRB/BG-Dragoman-Sofia (56,8 km)
Total	**193**	

Figure 6-13: Map of GSM-R installation in 2030

6.9 INFRASTRUCTURE ACHIEVEMENT IN 2030

The next figure presents the infrastructure parameter achievements in 2030 according to the investment plans for all AWB RFC member states. Track gauge, axle load 22,5 t, line electrification, GSM-R will all be 100% parameter achieved. Train length will be achieved 99% and load per metre 96%. ETCS will achieved along 83% of the AWB RFC lines, and train speed along 71%.

Figure 6-14: Infrastructure parameter achievements in 2030



6.10 WP7: BORDER STATION OPERATIONS

Simplification, standardisation and harmonisation of the legal, technical and operational requirements relevant for processes and procedures at railway border crossings is a very demanding and challenging endeavour that requires mandates given by the related governments for actions and cooperation at both national and cross-border levels.

The relevant standards[26] and recommendations address wide range of issues, including:

- formalities at common border crossings, such as: correlation of business hours/competence; joint customs controls; juxtaposed customs offices;
- coordinated and simultaneous controls of customs and other competent authorities;
- lodging of the goods declaration/supporting documents by electronic means using recommended international standards;
- limited requirements (only that deemed necessary) for data on the goods declaration/supporting documents;
- limited requirements for translation of particulars in supporting documents;
- pre-arrival lodgement/checking of goods declaration;
- use of commercial/transport documents as a descriptive part of customs declarations or as customs declarations for transit;
- providing simplified procedures for authorised operators;
- simplified temporary admission formalities for means of transport.

6.10.1 General proposals

The proposals[27] for improvement of border-crossing practices in international railway transport are as follows:

- electronic information systems for sharing information,
- railway-to-railway electronic data interchange (EDI),
- information exchange between railways and control authorities,
- reduced data and document requirements,
- standardisation and harmonisation of data requirements,
- Rail Transport Single Window Facility/System,
- government-to-government electronic information exchange,
- pre-arrival information, risk assessment and selective controls,
- use of new technologies and non-intrusive inspections,
- simplification for customs transit procedures at railway border crossings, and
- joint controls by border authorities at the railway border crossings.

[26] Source: Study on border crossing practices in international railway transport, United Nations, Bangkok, 2018
[27] Ibidem.

6.10.1.1 Information systems for sharing information

Electronic information systems support:

- optimisation of railway processes at border crossings,
- electronic information exchange between railways,
- electronic information exchange between railways and control authorities.

The railway electronic information systems automate the organisation of cargo traffic and provide a communication interface between railways undertakings and their clients, business partners, and control authorities at border-crossing checkpoints. Information system applications could support the electronic processing of documents, such as electronic consignment notes.

At busy border crossings it is very important for the railway station administration to optimise the railway processes and avoid unnecessary delays. The optimisation may include following railway processes: train schedules; the routes and stops of the trains on entering and exiting a railway border station; shunting and sorting the wagons and marshalling the trains should be abandoned or minimised at handover stations; the railway staff and equipment should be used for technical controls and railway related operations. The electronic information systems can support optimisation of the railway processes.

6.10.1.2 Electronic data interchange (EDI)

EDI allows efficient exchange of information among railways to complete border-crossing formalities. Railways in the region are encouraged to implement such systems with appropriate arrangements, such as bilateral/sub-regional or regional agreements. As far as possible the EDI systems and messages thereon should be harmonised across the railways in the region. Phased implementation of electronic systems is recommended, with appropriate training for officials implementing it.

6.10.1.3 Information exchange between railways and control authorities

The efficiency of information exchange between different infrastructure managers, rail carriers and control authorities on international railway freight transport data can be further enhanced with the electronic exchange of information. Customs authorities have a major regulatory role with respect to goods entering their jurisdiction, and consequently advance electronic information can support them in completing the related formalities expeditiously. The railways of the region would be able to increase the reliability of freight train services through the electronic exchange of information between different infrastructure managers, rail carriers and control authorities. Therefore, implementation of such systems is recommended. It is further suggested to set standards for the exchange of such information at the regional level.

6.10.1.4 Reduced data and document requirements

Data and document requirements are reduced only to those necessary for efficient control of customs and other control authorities. Supporting documents are not translated on a regular basis, even though translation may be required when it is necessary for processing of declaration and for control of the goods. When documents and data are submitted in electronic form, the paper-based version does not have to be presented to the control authorities. When it is necessary in selected and duly justified cases the control authorities may check the paper-based documents (including supporting documents identified in the customs declaration and stored by the railways/forwarders) during regular or post-clearance audit.

6.10.1.5 Standardisation and harmonisation of data requirements

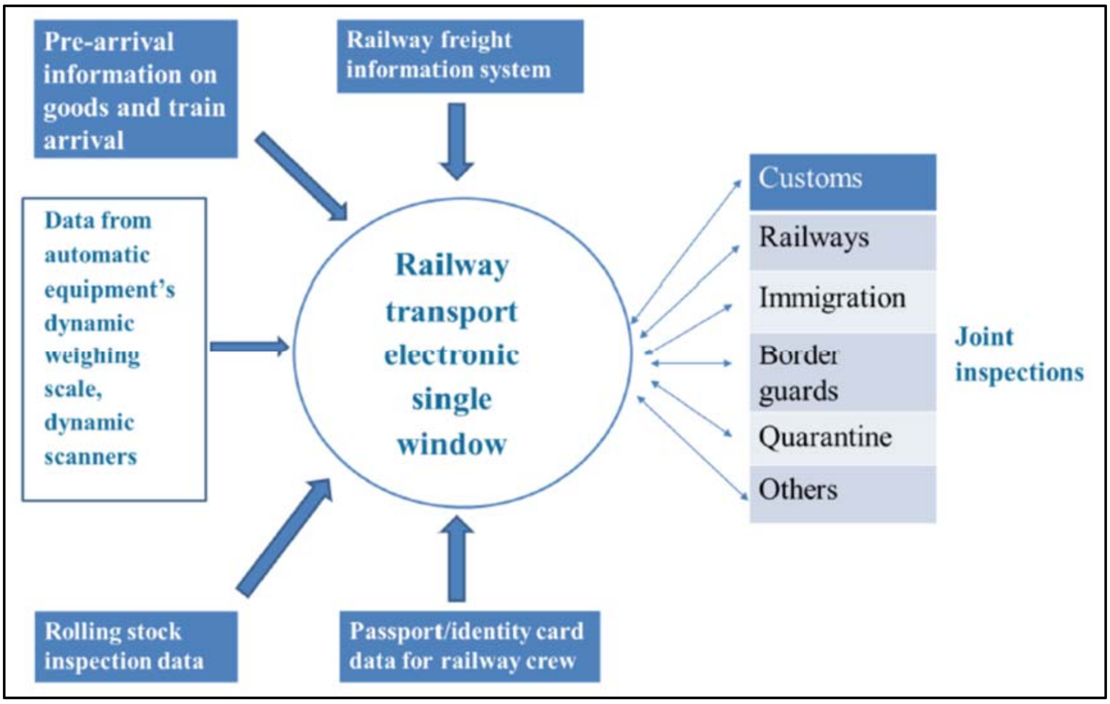
Formal standardisation and harmonisation of data requirements of the infrastructure managers, rail carriers and control authorities responsible for border and customs control, medico-sanitary, veterinary and phytosanitary inspections, enables seamless electronic data exchange and the introduction of a single window facility.

6.10.1.6 Rail Transport Single Window Facility

An electronic single window for railway transport could be contemplated at railway border crossings using current technologies. The railways and government authorities require a lot of the same information, documents and certificates to complete their designated formalities. For example, information on description of goods and loading and unloading places is usually required by railways, customs and quarantine and health inspections. The data collected from multiple sources, such as electronic systems of railways, customs and immigration, automatic control equipment and dynamic scanners, could be stored in a neutral platform or the single window for railway transport. It can then be accessed by control authorities at railway border crossings for completion of regulatory formalities. [28]

[28] Source: United Nations, Economic and Social Council, Economic and Social Commission for Asia and the Pacific, Committee on Transport, Bangkok, November 2018

Figure 6-15: Railway transport single window



Source: www.unescap.org/resources/model-integrated-controls-border-crossings

Linking railway information systems with the systems of other government authorities, national single window facilities and the information systems of the carriers would lead to more efficient information exchange. In particular, it would alleviate the need for resubmission of similar information. The introduction of cross-border electronic information exchange among related government authorities could contribute to smooth cross-border operations and a reduction in delays at railway border crossings. It would also aid risk management and, accordingly, enhance the efficiency of the controls conducted by customs and other government authorities. All in all, electronic information exchange among government authorities at railway border crossings would contribute towards making completion of controls more efficient.

6.10.1.7 Government-to-government electronic information exchange

Government authorities exchange electronic information with other government authorities present at the railway border-crossing checkpoint. The data exchanged electronically may include: information on transport means and goods; licenses, certificates, authorisations, declarations and other information on border control clearance; information relevant for joint/coordinated risk analysis and/or joint/coordinated control. The government control authorities exchange relevant electronic information at a national level, and at a cross border level with their counterparts in neighbouring countries.

6.10.1.8 Pre-arrival information, risk assessment and selective controls

Pre-arrival information is submitted to the customs and/or other control authorities at the railway border crossing, preferably in the electronic format. Customs and other control authorities jointly apply risk analysis and selective controls at the railway border crossing.

Inspection for targeted goods and transport means (wagons/containers) is done in coordination with all the relevant authorities – the authorities may designate customs to do the inspections and share the results. The inspections should as far as possible use non-intrusive technologies, such as scanners. As these facilities are usually costly, they should be shared among the control authorities through appropriate arrangements.

6.10.1.9 Use of new technologies and non-intrusive inspections

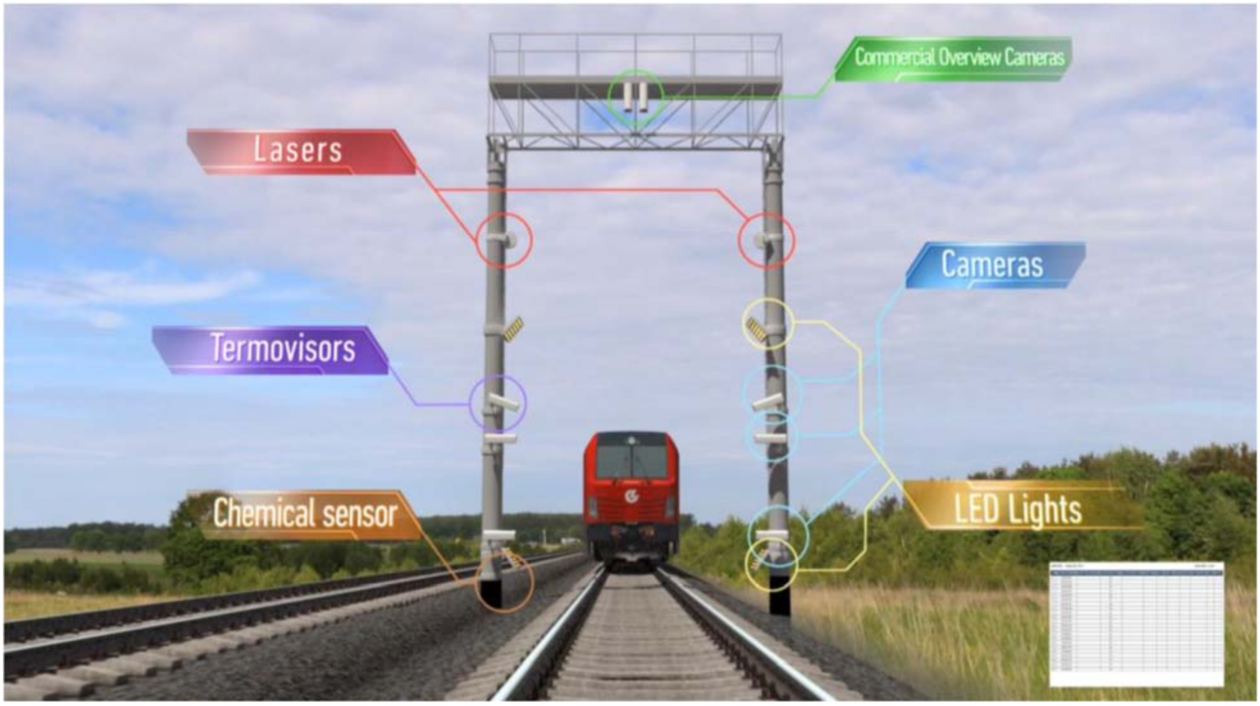
Using new technologies and non-intrusive inspections could support the efficient completion of border crossing formalities. The application of new technologies, such as the use of mobile scanners, would allow expeditious completion of the required controls, reducing delays. Where possible the use of non-intrusive inspection of the cargo and transport means is suggested. Joint use of inspection facilities among the railways and control authorities and sharing of control results is encouraged.

The use of modern and non-intrusive control technologies can contribute significantly to improvement of the organisation of railway technical inspections, customs controls and controls of other authorities and inspections at railway border crossings. The relevant technologies include:

- train signalling systems
- electronic dynamic weighing scales
- automated wagon and container number readers
- automated sensor (e.g. heat, impact, chemical leaking, noise etc.) readers
- RFID systems composed of tags installed on wagons and readers
- laser or optical dimension control systems
- video and electronic surveillance systems
- radiation scanners
- x-ray scanner
- thermal imaging system

Various control systems may be combined, interconnected and linked with railway electronic information systems, as well as with the information systems of customs and other control authorities.

Figure 6-16: Multifunctional automated technical control system



Source: Lithuanian Railways, the train inspection system at Lithuanian railway border stations

The control systems should be installed in the proximity of railway border crossings, and ideally they should record the data as the train approaches the railway border station and is still in motion.

Figure 6-17: Thermal imaging for liquid level measurement

Source: Lithuanian Railways, the train inspection system at Lithuanian railway border stations

The data collected from the control system needs to be transmitted to the control centres at the border crossing (e.g. railways and customs), so when the train arrives at the station the railway administration, customs and other control authorities will have advance information provided from control systems already available in their own electronic information systems.

6.10.1.10 Simplification of customs transit procedures at railway border crossings

The customs transit procedures at railway border crossings can be simplified by instituting such measures as: use of consignment notes as customs transit declarations; reduced document requirements; transit guarantee waiver; electronic exchange of transit information; acceptance of railway seals or mutual recognition of customs of country of departure; minimal inspection for transit goods at railway border crossing; and grant of authorised economic operator status to railways.

At border crossings with significant international traffic, it is suggested that export/import procedures may be shifted to inland locations, such as dry ports. This will reduce the time needed for freight trains in transit.

The majority of control formalities associated with export and import customs procedures do not have to be performed at the border crossing. Such controls can be more efficiently organised at the departure and destination customs offices that are usually located inland at major railway stations and marshalling yards, where the goods are loaded/unloaded, and the trains are configured and reconfigured.

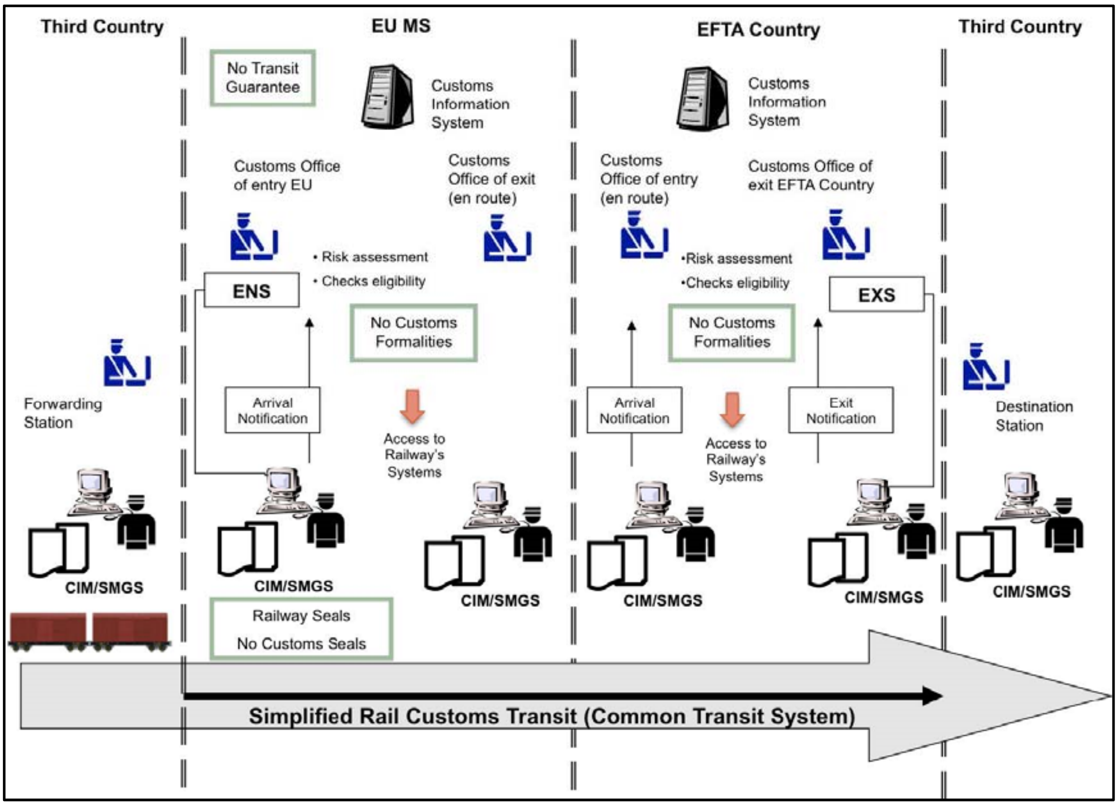
With such a shift, the transit formalities and controls at railway border crossing checkpoints could be significantly simplified. The simplification of customs transit procedures can be achieved through a variety of measures, including many of the good practices presented above, such as:

- recognition of railway consignment notes as customs transit declarations;
- electronic exchange of consignment note data (or electronic consignment note) between railways and re-submission of those data to customs authorities as advance information and/or customs transit declaration in electronic form;
- documentary and physical control based on risk analysis adapted for transit. Risk analysis is done on data provided from advance information before arrival of a train at the railway border checkpoint. The data already available from an electronic consignment note should be sufficient for advance information purposes and additional data should not be requested;
- x-ray scanning control is done only on selected wagons and only if necessary based on risk management. Systematic x-ray scanning of all transport means in transit is not recommended;
- for the goods in transit systematic translation and control of all accompanying documents to the customs transit declaration (e.g. invoices, packing list, contracts, etc.). Such documents should be identified in the customs transit declaration, and controlled only if necessary based on risk management. The railways should be obliged to keep copies of accompanying documents to the customs declaration and make them available

to the customs authorities if necessary (e.g. if the customs transit procedure is not properly terminated and discharged.);

- detailed customs control for goods in transit should be occasional, only if it is duly justified in accordance with risk analysis or if reliable intelligence information on suspected fraudulent activity is provided;
- veterinary, phytosanitary, quarantine and other control requirements for goods and transport means in transit are substantially reduced in accordance with international standards and conventions;
- the rail carriers has been granted authorised economic operator status in accordance with national customs legislation that may include: approval of custom transit guarantee waiver; use of railways seals; and other simplifications with respect to customs transit procedure;
- specific simplified customs transit procedures for goods transported by rail in accordance with bilateral/ multilateral agreements;
- simplified customs transit procedures where the railways is entitled to register customs transit in their own records. Access to the railways records is provided to the customs authorities, and the customs could control the transit by auditing the entries recorded by railways undertakings.

Figure 6-18: Example of Simplified Common Transit Procedure by rail



Source: Study on border crossing practices in international railway transport, United Nations, Bangkok, 2018

6.10.1.11 Joint controls by border authorities at the railway border crossings

Joint controls should be introduced at the railway border crossings. The customs and other control authorities institute control formalities at the railway border-crossings jointly either through transfer of responsibilities to a single authority, or through the institution of joint controls. It is suggested to extend the principle of joint controls across the border by:

- coordination of customs and border-crossing control formalities for streamlined movement across both border-crossing checkpoints,
- designation of joint a border-crossing checkpoint where the procedures and controls are organised at one location,
- organisation of common procedures in major inland stations, in parallel with the operational procedures for traffic management, without stopping at the border station.

6.10.1.12 European Agreement (AGTC)

The European Agreement on important international combined transport lines and related installations (AGTC) regarding the border-crossing points: trains of combined transport shall run as far as possible all the way across borders to a station where the exchange of wagon groups is necessary in any case, or to their final point of destination, without having to stop on route. There shall be, if possible, no stops at the border or, if unavoidable, only very short stops (of no more than 30 minutes). This shall be achieved:

- by not carrying out work normally done at the frontier or, if this is not possible, by shifting this work to inland places where the trains have to stop in any case for technical and/or administrative reasons;
- by stopping only once, if at all, at joint border stations.

6.10.2 TAF TSI

The TAF TSI aims to define the data exchange between individual RIMs, and also between RIMs and rail carriers. In addition to data exchange, the TAF TSI describes business processes involving RIMs and rail carriers. For this reason, the TAF TSI deeply impacts existing international rail infrastructure business processes. The TAF, or at least the IT interfaces with other partners, must be implemented in a similar way by all TAF TSI partners, including the RIMs.

In the early stages of development of the TAF TSI it has been acknowledged that in the freight transport sector railways need to improve service and efficiency to increase revenues and market share, and to play their part in delivering sustainable transport. The critical attributes of a successful freight service are the ability to keep track of consignments, determine when deliveries to customers will be made, and maximise the productivity of the transport chain.

What are the expected benefits for railways implementing and operating the TAF TSI?[29]

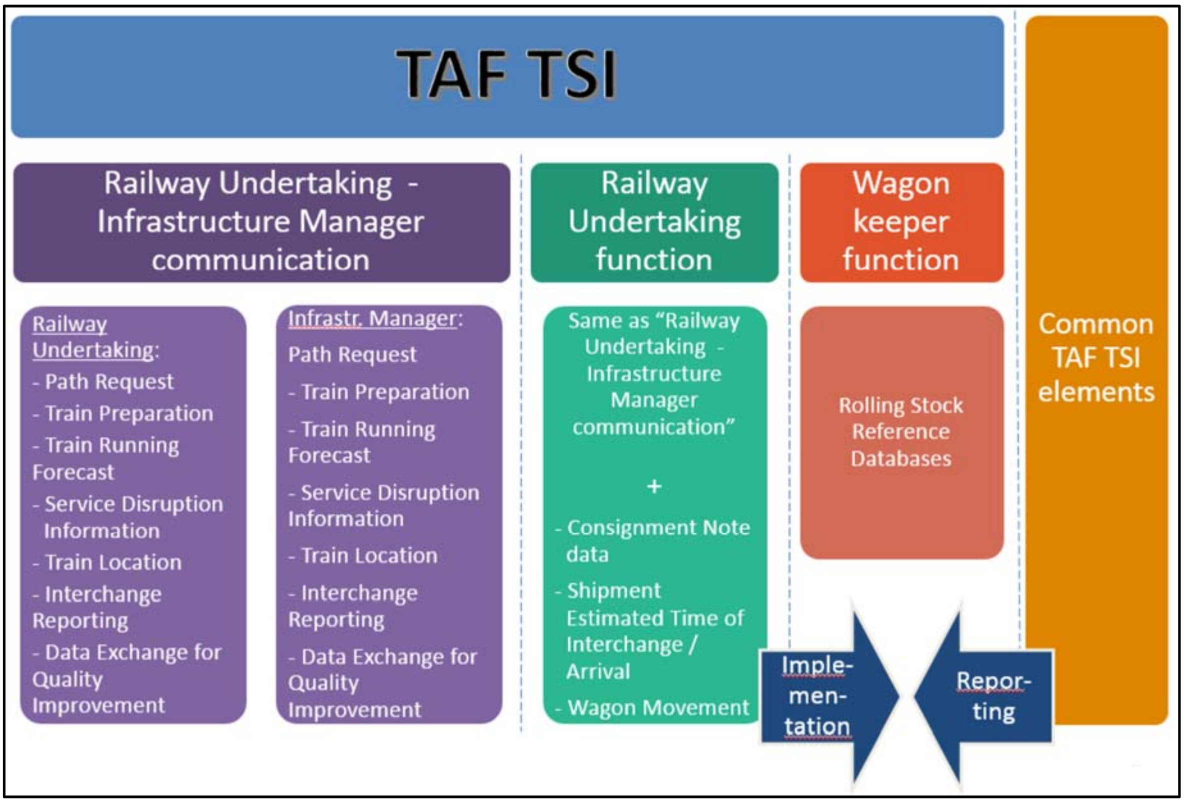
- Single communication system for all business cases an operator can find.
- Improved communication and process coordination between railway operators and infrastructure managers (in terms of quality and speed).
- Single standardised way of working, providing cost savings through a better management quality system; establishment of homogeneous procedures; reduction in system maintenance costs.
- Standardised and interoperable communication interfaces.
- Participants possess a strong and committed TAF User Community.

Consequently, the following benefits emerge regarding the value chain passengers / freight customers:

- Access to more transparent railway products, meaning more efficient and thus competitive products
- Monitoring becomes more transparent
- Quicker and better information delivery to freight customers and business partners

The TAF TSI's functions can be summarised in the next figure.

Figure 6-19: Overview of TAF TSI functions

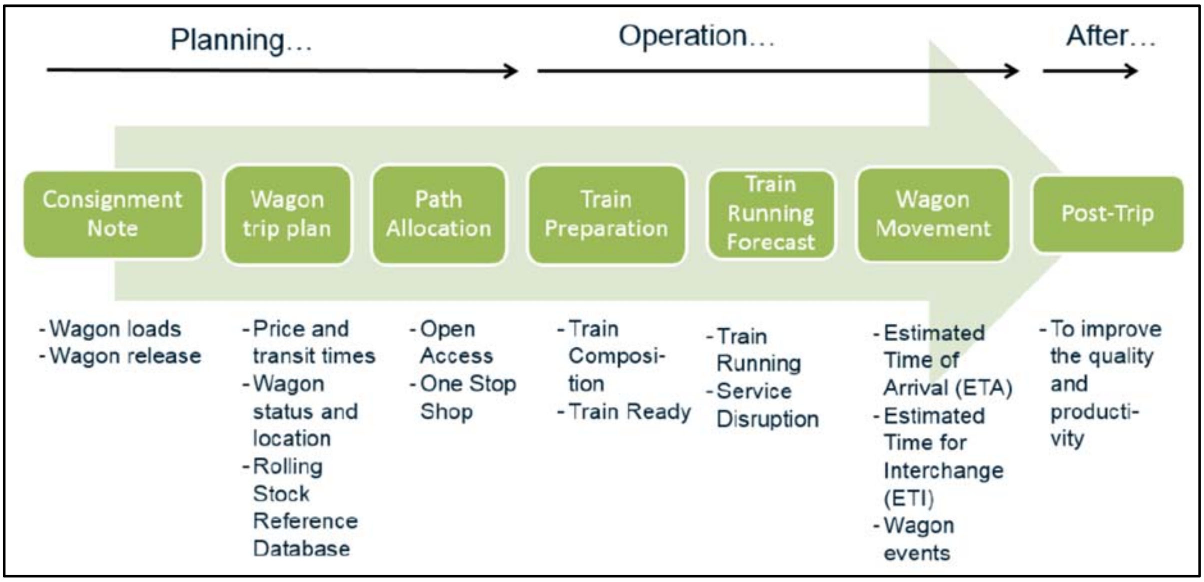


Source: 6th TAF TSI Regional Workshop, 12-13 September, 2017

[29] Source. Electronic information exchange systems in rail freight transport, United Nations, Transport Division ESCAP, 2018

The functions shown in the TAF TSI are described in the legal text in dedicated chapters as a set of procedures (who sends what type of electronic message to whom and when) and of corresponding technical interfaces to such messages (XML definitions in so-called Technical Documents). The TAF TSI describes business-to-business processes between the railway operators, railway infrastructure managers and wagon keepers with a clear link for the freight customers to show how they can get transport-related electronic messages from the contracted railway operator. The same functions from the next figure can be also represented as parts of the rail freight transport process.

Figure 6-20: TAF TSI functions as part of the transport process



Source: 6th TAF TSI Regional Workshop, 12-13 September, 2017

Currently, the TAF TSI is at an advanced stage of implementation within the European Union. It is leading to harmonisation of electronic information exchange in Europe, and has attracted a huge and committed user community (railway companies, control authorities, infrastructure managers, wagon keepers and customers) covering 85% of the EU rail freight market. The TAF TSI implementation has also triggered positive effects on the harmonisation of rail operation processes.

IT Tools for implementation of TAF TSI functions[30]

The implementation and operation of the TAF TSI functions in the form of the IT tools mentioned in this section are successful because they

- have been developed on a voluntary and commercially oriented basis by the European rail sector for several years, and
- have been (co)funded by the European Union in the form of Connecting Europe Facility (CEF) calls.

[30] Source. Electronic information exchange systems in rail freight transport, United Nations, Transport Division ESCAP, 2018

In Europe the following IT Tools are needed for the implementation and operation of TAF TSI:

- ORFEUS,
- HEROS,
- Path Coordination System (PCS),
- Common Components System (CCS),
- Train Information System (TIS) and
- Improved Service Reliability (ISR).

Figure 6-21: Integration of products into TAF TSI

Source: 6th TAF TSI Regional Workshop, 12-13 September, 2017

6.10.3 Good practice

6.10.3.1 “Bosphorus Europe Express” container train

On 16 March 2009 the container train named “Bosphorus Europe Express” set out on its journey from Ljubljana to Istanbul, more precisely for the Halkali Container Terminal. This was a product of the transport operators Adria Kombi and Kombiverkehr, offering their services to end-users from Slovenia, Germany and Turkey. The transport performance included the activities of railway undertakings as well as infrastructure managers of Slovenian, Croatian, Serbian, Bulgarian, and Turkish Railways.

According to the current timetable, the train covered a distance of 1.577 km in approximately 60 hours. On its way it crossed five states; due to different power supply systems and closed national railway systems, it changed its locomotives many times; the train also stopped at national borders for the purpose of completing railway administrative and technical formalities (brake test performance, repeated drawing-up of documents), as well as for the purpose of carrying out the formalities required by state authorities (customs, phytopathological and veterinary inspections, etc.).

A months before the first journey started the related railways convened a meeting and started to analyse the possibilities for reducing the travel time. They focused their efforts on the increase of open line speeds under the present infrastructure conditions, and on the optimisation of activities at border stations. A contribution to the travel time reduction of this train was also made by introducing an interoperable multi-system locomotive and diesel locomotive. Under these specific conditions the promotional train reached its destination within 38 hours.

Table 6-19: Timetable of “Bosphorus Europe Express”

State	Station	Arrival	Depart.	Day	Remarks
SLO	Ljubljana	/	8:30	1	Operator Adria Kombi previously informed all services involved at the border crossings (wagon list, transport documents). SLO/HR handover station Dobova.
	Dobova	10:10	10:45	1	
HR	Zagreb RK	11:30	12:00	1	Customs procedures HR - 30 minutes.
	Tovarnik	16:32	17:02	1	Customs procedures HR.
SRB	Šid	17:12	17:57	1	HR/SRB handover station, customs procedures.
	Niš/Crven Kr	0:48	1:08	2	Change of traction electric to diesel.
	Dimitrovgrad	4:40	5:40	2	Customs procedures SRB and BG. (UTC + 1 h)
BG	Dragoman	7:55	8:05	2	SRB/BG handover station. (UTC + 2 h)
	Svilengrad	15:10	16:10	2	Customs procedures BG. (UTC + 2 h)
TR	Kapikule	16:30	17:15	2	Customs procedures TR. (UTC + 2 h)
	Halkali	22:28	/	2	Intermodal terminal Halkali (UTC + 2 h)

Source: https://uic.org/com/uic-e-news/137/article/bosphorus-europe-express-container

The promotional run of the train, which was given priority along the entire route (as a non-regular train), should prove that creative cooperation and the joint will of various entities can lead to success, while on the other side, certain issues will become evident in practice which will then require common solutions, in particular to realise the goals of different agreements. This means the development of joint border stations, at which border formalities are performed simultaneously by the railway and state authorities. In particular, this includes the acceptance of trains on trust, development of an electronic consignment note and electronic data transfer (announcement of consignments) between the railways and customs authorities (at present this is carried out by means of a fax or email), and introducing the interoperability of locomotives. Reductions in travel time will also be achieved in the long-term by the realisation of the envisaged restructuring projects on the railway infrastructure from Ljubljana to Halkali.

Figure 6-22: "Bosphorus Europe Express" container train

Source: https://uic.org/com/IMG/jpg/bosphorus_Express.jpg

6.10.3.2 Electronic consignment note

Handover of complete trains and groups of wagons is also possible with a single electronic consignment note. For consignments which concern the EU Customs Union or the area where the Community transit procedure applies and contains both the wagon/container under customs control and those exempt from all customs formalities, the customs status of the goods must be indicated for each wagon/container.

The provisions on the list of wagons shall be used for the printing of the electronic consignment note. In order to design processes as rationally as possible, the partners agree on the necessary rules in advance.

The consignment note and its duplicate may take the form of electronic data records that may be formatted in legible form. The procedures used for recording and processing data must be functionally equivalent, in particular with regard to the probative value of the consignment note.

The carrier and customer agree on a contractual agreement between the messages exchanged and the type and method of data exchange of the electronic consignment note. A mixed system may be agreed in order to allow the electronic consignment note to be used on one part of the train route, due to its use throughout the area. This mixed system allows different media to be used for the same consignment (paper consignment note, electronic consignment note, printout which can be used as a paper consignment note).

6.10.3.3 RNE IT tools

AWB RFC uses the following common IT tools[31] provided by RNE in order to facilitate fast and easy access to the corridor infrastructure/capacity and corridor-related information for the applicants.

Path Coordination System (PCS)

PCS is the only tool for publishing the binding Pre-arranged Paths and Reserve Capacity offer and for managing international path requests on the corridor. The advantage of this solution is that the displayed data for Pre-arranged Paths and Reserve Capacity may be used for creating a path request dossier – without any manual copying. Furthermore, this method simplifies the presentation and management of the paths, which remain in the catalogue for allocation as ad-hoc paths during the running timetable period.

Train Information System (TIS)

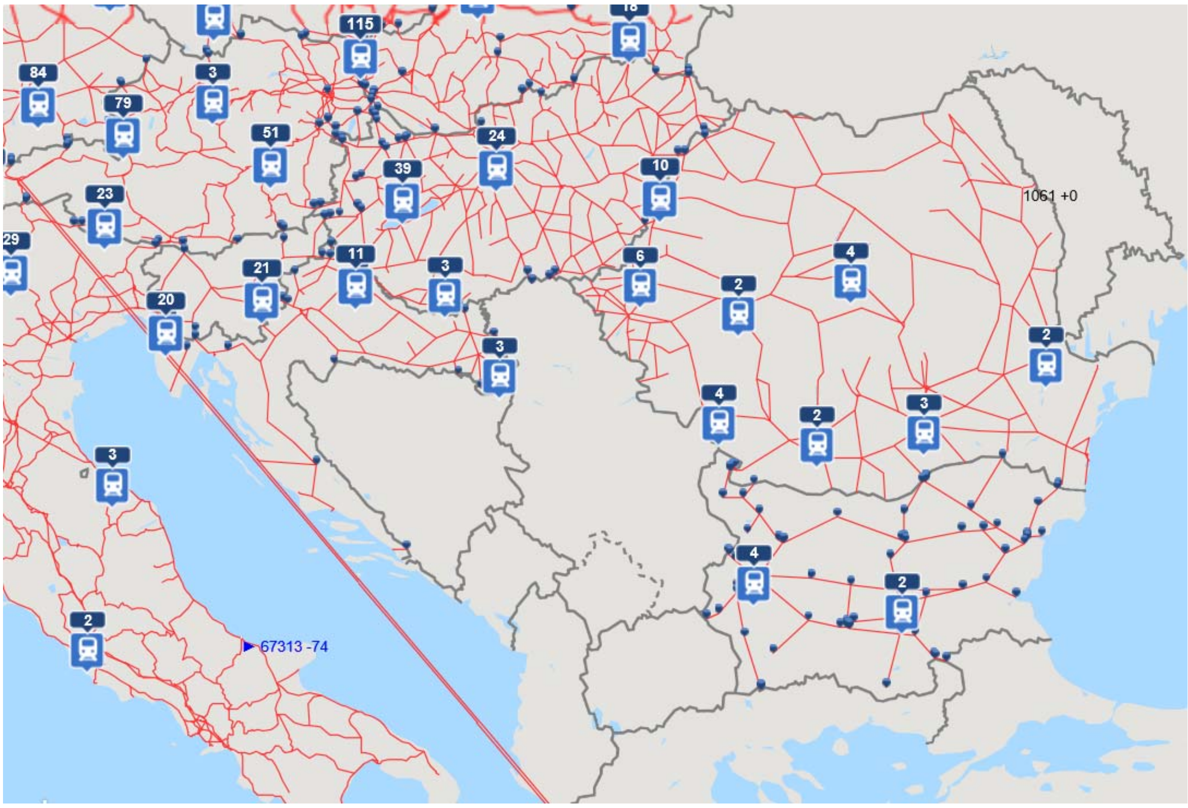
TIS is a web-based application that supports international train management by delivering real-time train data concerning international trains. The relevant data are obtained directly from the RIMs systems. The RIMs send data to TIS, where all the information from the different RIMs is combined into one train run from departure or origin to final destination. In this manner, a train can be monitored from start to end across borders. TIS also provides support to the Corridor Train Performance Management by providing information on punctuality, delay and quality analysis. The following RIMs on AWB RFC participate in TIS: ÖBB-I, SŽ-I, HŽ-I and NRIC.

Rail carriers and terminal operators may also be granted access to TIS. They are invited to join the RNE TIS Advisory Board, as all members of this board grant all other members full access to TIS data if they are involved in the same train run. However, if the rail carriers and terminal operators concerned are not members of the RNE TIS Advisory Board, mutual agreements have to be signed between individual carriers and between carriers and terminal operators.

[31] Source: AWB RFC CID Book 1 Generalities 2020/2021

The system is already fully TAF/TAP TSI-compliant and was, in addition, a frontrunner in terms of implementing this sophisticated framework. The system supports mostly internationally active Railway Undertakings in steering their logistical chains and it also provides support to Rail Freight Corridors by providing proper reports for Train Performance Management. Currently TIS handles over 4,7 Million single train runs per year.

Figure 6-23: RNE TIS map



Source: https://tis-online.rne.eu/im_pt/viewing/networkOverview.seam?cid=12521445#

Common Components System (CCS)

The Common Components System comprises three elements to ensure the interoperability of European railway traffic:

- Common Interface (CI): a technical tool that supports the interoperable exchange of messages.
- Central Reference File Database (CRD): a centralised database that stores Location Codes and Company Codes required under TAF TSI regulation.
- Certification Authority (CA): ensures secure communication between parties using the Common Interface.

The services of the CCS can be used by multiple stakeholders within the industry. The CI provides a platform for the standardised exchange of data. Country and Location Codes are available in the CRD. Furthermore, Rolling Stock Reference Databases (RSRD) are also accessible via the CI. This means the CCS can create user value for RIMs, rail carriers and wagon keepers.

6.10.3.4 EU Border Crossing Practice

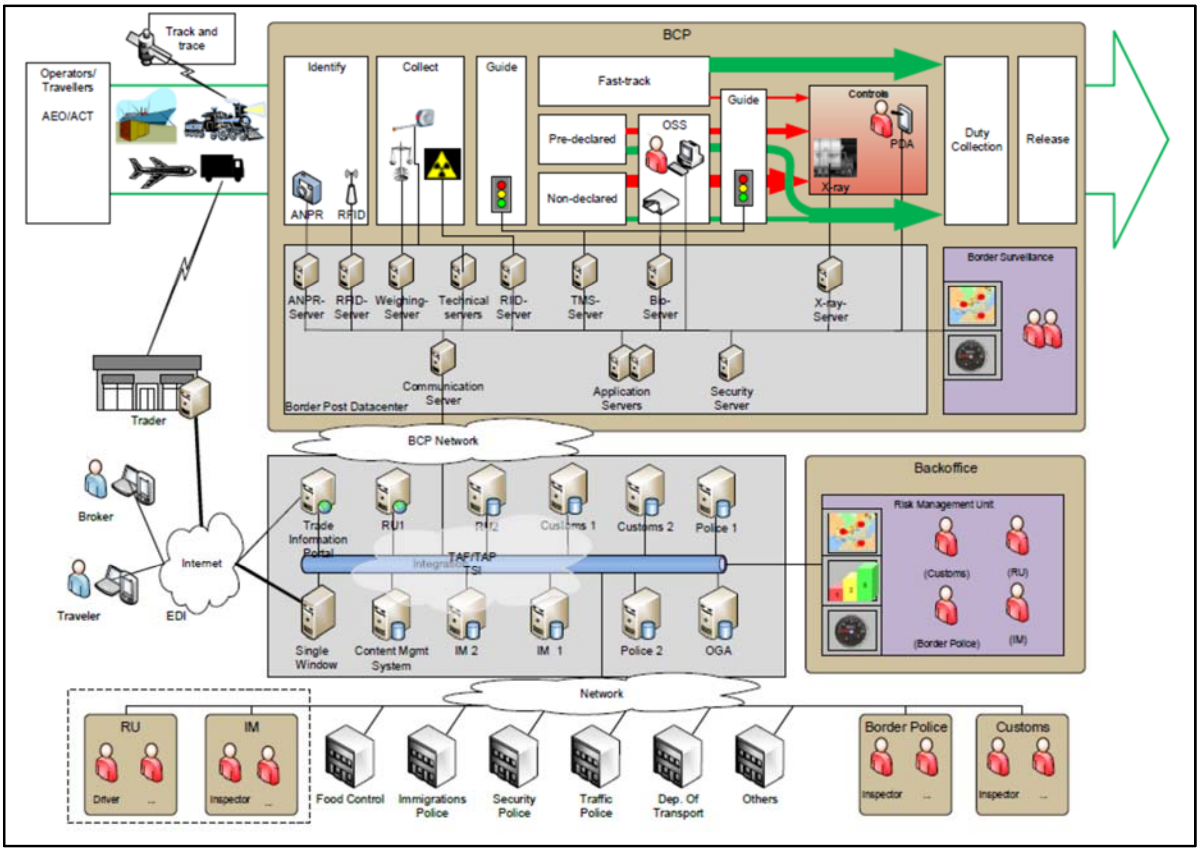
A border crossing is a complex environment involving many actors: the consignor and consignee, rail carriers, RIMs, traction companies, customs, border police, other government authorities such as phytosanitary and sanitary authorities, as well as authorities responsible for licenses and permits, among others. Actors in possession of wagons and actors responsible for maintenance of rolling stock may also be involved, and these multiple actors often operate on both sides of the border. In the EU, practice varies depending on a number of factors, including but not limited to whether the BCP is between two Schengen states or not, whether customs procedures are harmonised or not, and on compatibility issues related to cross-acceptance of rail vehicles (traction and wagons), drivers' licences, and other matters of interoperability. It is also important to keep in mind that detailed information required and/or available originates from actors often not present at the border crossing such as the consignor and the consignee. This information is sent to the lead rail carrier and to other actors in the supply chain where the transport is initiated, making integration and forwarding of information a complex matter.[32]

State-of-the-art border crossings have established a high level of mutual trust, making it possible to work in cooperation and not to repeat tasks. Regional or bilateral rail agreements are important to facilitate trade and minimise costs. They require integrated processes and harmonised legislation as well as significant national and international investments in information technology. Access to information is important, but information quality is what really matters.

The next figure illustrates the parties involved and the required information flow. It visualises back-office work at a central location using available information for risk analysis and administrative tasks, as well as the back office work done at the BCP. A number of technical solutions that identify, collect and guide the movements support the border processes. When an inspection or control is necessary, technical solutions such as non-intrusive inspection techniques, solutions to discover technical malfunctions on vehicles, among others, assist the officers performing controls.

[32] Source: Rail electronic data interchange in a border-crossing point in South East Europe: An assessment of options, The World Bank, May 2015

Figure 6-24: State-of-the-art rail border management



Note: ANPR-Automatic Number Plate Recognition, OSS-One Stop Shop, RID-Radio Isotope Detection, TMS-Traffic Management System, Source: KGH Group AB.

State-of-the-art border management is complex and can be implemented in different ways. It requires national and international cooperation and planning, as well as standards and harmonised legislation to support and guide the implementation. It is characterised by these main principles:

- Trust among the involved parties, such as authorities, private sector, traders, and operators, often making it possible for one party to perform tasks on behalf of another;
- Solutions are designed for all modes of transport;
- Reduction in the number of tasks performed at the border crossing, for example by the introduction of authorisation programs (Trusted Traders) and by moving activities from the border upstream;
- The flow of information between the owner of the information and the one requiring the information (not via someone else, as this creates problem from a data protection point of view, commercially or legally);
- Data exchanged in line with international standards;
- IT solutions established at a national and international level and kept at a minimum at the BCP. The IT infrastructure at the BCP is more or less limited to personal computers, mobile solutions and technical equipment for track and trace solutions, and solutions supporting technical controls;

- Single Windows ensure that information is submitted only once and then forwarded or shared with relevant parties; another feature of a Single Window is to enhance communication of decisions;
- Technical equipment standardised at a national or international level;
- Risk assessments and analysis used to avoid unnecessary controls (customs controls, customs clearance, technical controls, and commercial controls, among others); and
- The time required at the border is minimised using principles of a One-Stop Shop.

6.10.4 Dimitrovgrad (IŽS) rail border crossing solutions

The source for this content is the study "Rail electronic data interchange in a border crossing point in South East Europe: An assessment of options", The World Bank, May 2015.[33]

Fully automated electronic management of documentation of a railway corridor requires the conditions set out in the next table to be fulfilled in all countries that are traversed. When the internal IT systems of each party are operational, an obvious next step will be to start sharing information using TAF/TAP TSI standards and customs interfaces as well as interfaces with other government authorities. These requirements can only be met in the long term, but any short-term solution proposed should have the long-term goal in mind in order to avoid investments that are not compatible with them.

Table 6-20: Requirements for Electronic Data Interchange in Rail

Party	Condition
RIMs	Internal automated systems made available to rail carriers by using EDI interfaces as defined by TAF/TAP TSI. Integration with every rail carrier using the infrastructure is necessary.
Rail carriers	Internal automated systems made available to other rail carriers by using EDI interfaces as defined by TAF/TAP TSI. Integration with every rail carrier using the infrastructure is necessary.
Customs	Customs Declaration Systems made available to rail carriers by exposing EDI interfaces as defined by customs legislation and frameworks. Integration with every rail carrier (national and international) that is supposed to submit/exchange information.
Border police	N/A (in Serbia and Bulgaria).
Other government authorities	Other government authorities' systems made available to rail carriers by using EDI interfaces as defined by their needs and frameworks. Integration with every rail carrier (national and international) that is supposed to exchange information.
Shippers or freight forwarders	Need to integrate with the lead rail carrier in a manner defined by the lead rail carrier.

Source. KGH Group AB, Rail electronic data interchange in a border crossing point in South East Europe: An assessment of options, The World Bank, May 2015

[33] Some of the customs procedures have been changed since February 2016, because Serbia has started applying the joint transit procedure.

The solution must focus on providing access to information at train arrival or whenever possible before arrival. IT requirements to support parallel workflows have been identified and are presented in the next tables with regard to specific information exchange requirements that the options need to satisfy.

Table 6-21: Key Requirements of the Rail EDI Solution

Classification	Requirement
Functionality	1. Provide access to Consignment Note/Wagon list information to conduct railway and customs procedures, by (a) providing access to already existing electronic consignment notes; (b) supporting management of paper consignment notes; and (c) supporting viewing information, although paper documents still have to be stamped and signed to be used at next station. 2. Provide access to Train Tracking/Track and Trace information, including: (a) access to existing electronic information (existing Serbian web solution); and (b) manual entry by dispatcher when a signal is given (replacing the current procedure using telephone). 3. Support commercial and technical controls and reporting of controls by (a) providing access to consignment information using mobile equipment; and (b) submitting outcomes of technical and commercial controls. 4. Ensure that unauthorised access to data is not possible. 5. Provide an audit trail of system execution (log) to verify who has done what. 6. Provide printouts.
Usability	7. The solutions must not require more than one day of training to start operation.
Reliability	8. 24/7 access to information and systems, including reliable internet connection.
Performance	9. Solutions must be efficient from a cost perspective.
Supportability	10. All user deliverables must be available in Serbian. 11. All user deliverables must be available in Bulgarian. 12. All deliverables must be available in English.

Source. KGH Group AB, Rail electronic data interchange in a border crossing point in South East Europe: An assessment of options, The World Bank, May 2015

Table 6-22: Specific Information Exchange Requirements

Requirement	Specifics
Rail carrier and RIM information exchange	• Train number • Number of traction unit • Wagon list • Operational data of the train (length, weight) • Time schedule (planned/requested) • Special handling of wagons • Dangerous goods and extraordinary loads • Action train path (delays)
RIM and RIM exchange	• Train number • Number of traction unit • Wagon list • Operational data of the train

Requirement	Specifics
	• Time schedule (planned/requested) • Special handling of wagons • Dangerous goods and extraordinary loads • Actual train path (delays) • Short-term modification of timetable due to maintenance, accidents and other non-timetabled events.
Customs information requirements	• Pre-arrival declaration (Entry Summary Declaration) • Pre-departure declaration (Exit Summary Declaration) • Customs declaration (Transit, Import, Export)
Rail carrier and rail carrier exchange	Information in the CIM consignment note in accordance with the CIT-CIM consignment note. Includes information such as: • Consignor and consignee • Goods information, harmonised system and description • Destination/delivery point • Commercial specification • Tariffs, invoicing and payment instructions • Weights • Wagon information

Source. KGH Group AB, Rail electronic data interchange in a border crossing point in South East Europe: An assessment of options, The World Bank, May 2015

The following options to integrate EDI at Dimitrovgrad handover station have been identified and are further investigated:

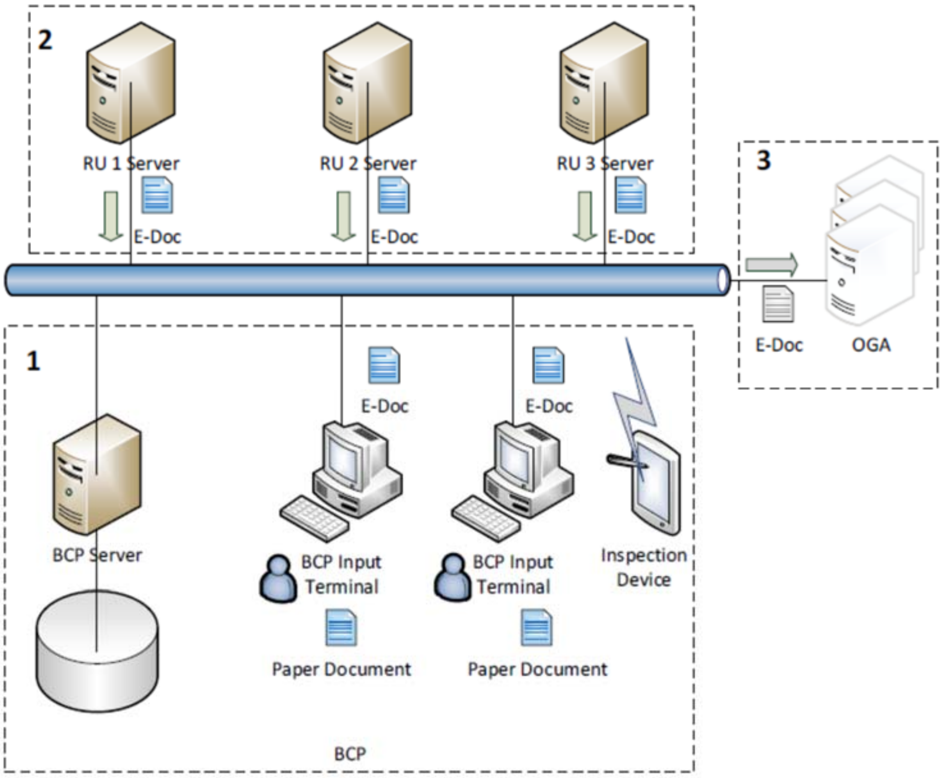
- Option 1: ICT solutions available on the market
- Option 2: existing solutions, electronic information and document scanning
- Option 3: Develop a local EDI solution

6.10.4.1 Option 1: ICT solutions available on the market

RailData is the international organisation of European Cargo Railway Undertakings, established as a special group of the UIC. The main purpose of RailData is to design, develop and run IT services to support the freight railway business of its members. On the European market, RailData is a solution with widespread usage, having many rail carriers as members and about ten of them use the services ORFEUS and Use-IT to exchange consignment note and wagon list information. Currently four main applications are operational:

- ORFEUS: Consignment note CIM data exchange
- ISR: Wagon movement and status reporting
- USE-IT (Uniform System for European Intermodal Tracking and Tracing): Intermodal train status reporting
- WMI (Web Manual Input): Web interface to participate in a common pre-arrival exchange.

Figure 6-25: Schematic representation of Option 1



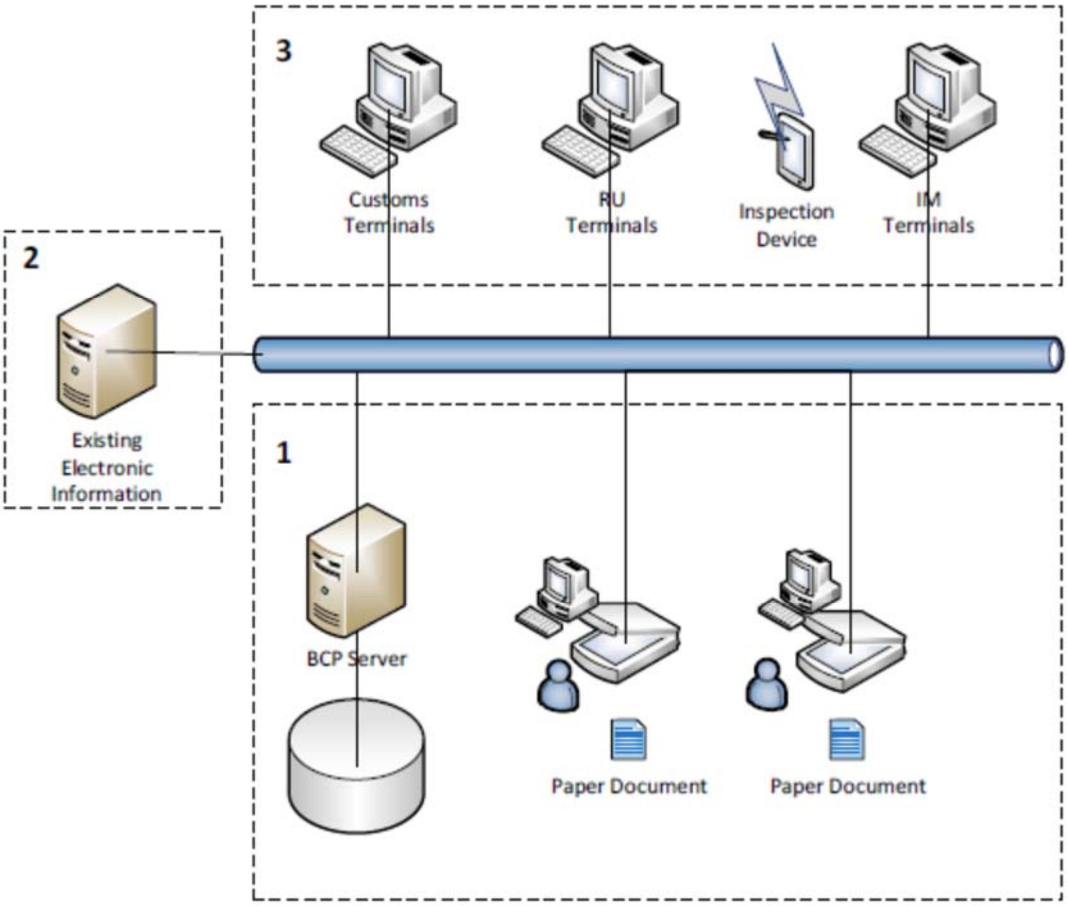
Source: KGH Group AB, Rail EDI at a border-crossing point in South East Europe, May 2015

Option 1 requires national investments in central systems and infrastructure supporting automatic transfer of data or the use of the Web Manual Input (community cloud) for exchange of data. Investments in BCP local infrastructure, such as extended network and internet access as well as a railyard Wi-Fi solution to support mobile access (controls) is required. Investments in internet reliability are required. No new technical solutions, such as hotbox detection or track and trace solutions, are needed.

6.10.4.2 Option 2: Existing Solutions

This option makes use of already existing electronic consignment notes and wagon information available in the central system of the rail carrier, which can be electronically received at the BCP. When the information is not available in electronic format, existing paper documents arriving with the locomotive driver would be scanned and made available to all actors at the same time using electronic based workflows, enabling parallel workflows regardless of how information is initially received. When electronic consignment notes are available, as for the movements coming from the north, the information available in the Serbian central systems, already RailData integrated, can be shared with all participants, making scanning of paper documents redundant. The presentation of information to end users would be equivalent regardless of how information was made available – scanned or available as structured information – using a portal concept, an electronic gateway unifying the information received electronically from the central systems of the rail carriers and others or from scanners in order to process them.

Figure 6-26: Schematic representation of Option 2



Source: KGH Group AB, Rail EDI at a border-crossing point in South East Europe, May 2015

Option 2 involves BCP input solutions and a BCP server with a portal solution to present consignment notes, wagon lists, track and trace information, among others, using existing web applications available in Serbia using the portal solution. A scanner and scanner application is necessary in order to scan paper documents when these are not available in electronic format. It also includes existing electronic information (structured) available in Serbia and possibly other rail carriers / RIMs that are willing to make user/web interfaces presenting consignment notes, wagon lists, track and trace, etc. Lastly, it requires terminals and devices – including inspection devices and applications to assist technical controls – so that all parties involved at the BCP can access information simultaneously and work in parallel. This option requires three types of software applications:

- scanner application,
- consignment note and wagon list information application and
- mobile control solution.

The technical infrastructure and hardware to support Option 2 include scanners, servers, data storage solutions, tablets, and a Wi-Fi solution covering railyard needs, as well as investments to improve internet reliability.

6.10.4.3 Option 3: Develop a Local EDI Solution

Option 3 is the development of a tailormade local EDI pilot solution for Dimitrovgrad. In this scenario, rail carriers would need to make investments to integrate into the BCP solution. Solutions to automate rail carrier handover procedures would be a major investment and would not manage consignments without electronic information, requiring manual entry. Option 3 is the same as Option 1, except that it would not use an ICT solution available on the market but would build one from scratch. This option is less attractive, as it does not support ongoing initiatives, including use of RailData by Serbia, and because a corridor level approach suggests the need to take existing ICT solutions currently in use in Europe or build a custom solution for the international rail freight corridor, as opposed to one BCP along the corridor.

6.10.4.4 Assessment of Options

In the long-term a well-integrated solution compliant with EU regulations that uses technical equipment and exchanges data in a standardised fashion with other countries and across an entire rail corridor is crucial, in order to reduce border-crossing times. What is proposed as a short-term solution needs to keep this fact in mind in order to support this long-term objective.

The next table presents the advantages and disadvantages of all three proposed options.

Table 6-23: Specific Information Exchange Requirements

	Advantages	**Disadvantages**
Option 1	• Reuses existing structured data • Requires deploying an existing solution in combination with development/reuse, a balanced approach • May be further developed into a long-time solution if ongoing initiatives do not succeed • Low risk as it uses an existing solution already in operation.	• Creates a "digital island" that needs integration with all parties involved • Manual input of data is needed and may result in longer lead times for some trains • Requires rail carriers to invest in integration software to make sense of the information, but this might be seen as in conflict with long-term initiatives of each rail carrier • Costly to introduce • Advanced and will require training • Works well at Serbian BCPs having access to RailData information, but might work less well in other countries if RailData information is not available (more manual entry). • Limited to freight trains
Option 2	• Reuse of already existing data/information • Uses existing solutions in combination with development/reuse, a balanced approach	• Could be perceived as a low-technology solution (scanned paper documents used in combination with existing user interfaces) with limited impact and would require

	Advantages	Disadvantages
	• No new/extra tasks introduced (photocopying documents would be replaced by scanning) • Low risk using existing solutions • High level of control (not depending on external factors) • Works on all trains (also passenger trains)	active buy-in from all actors at the BCP to shorten BCP lead times.
Option 3	• Has the potential to be a long-term solution deployed centrally if ongoing initiatives run into problems.	• Competes with ongoing initiatives. • Creates a "new digital island" that needs integration with all parties involved. • Rail carriers might not be interested in the investments required to integrate with this short-term solution. • Development of a new solution carries more risks and is more expensive. Any positive impacts may not be reached, if not implemented at many BCPs to justify the investment costs.

Source: KGH Group AB, Rail EDI at a border-crossing point in South East Europe, May 2015

The next table compares the three options along several dimensions, although a comparison of time-savings among them is intentionally absent. Manual key-in of information – if the solution is not integrated with rail carriers and RIMs information systems – will reduce time-savings, making Options 1 and Option 3 generate time-savings that may not be significantly higher than Option 2, while requiring integration of rail carrier and RIM systems, which will result in additional integration costs. For these and other reasons, time-saving and cost-saving comparisons must be handled with care – the differences in time-savings between Options 1, 2, and 3 could be insignificant. On the other hand, if all parties are interested in integration and integration is successful, further automation can be done and time saved at the border could be much greater than would happen with full implementation of the long-term TAF TSI compliant solutions. Automation using technical equipment and EDI can result in up to 70 minutes reduction in he time needed – compared to the estimated time-savings of 35 minutes under Option 2 – leaving only time for physical manoeuvres and dispatching.[34]

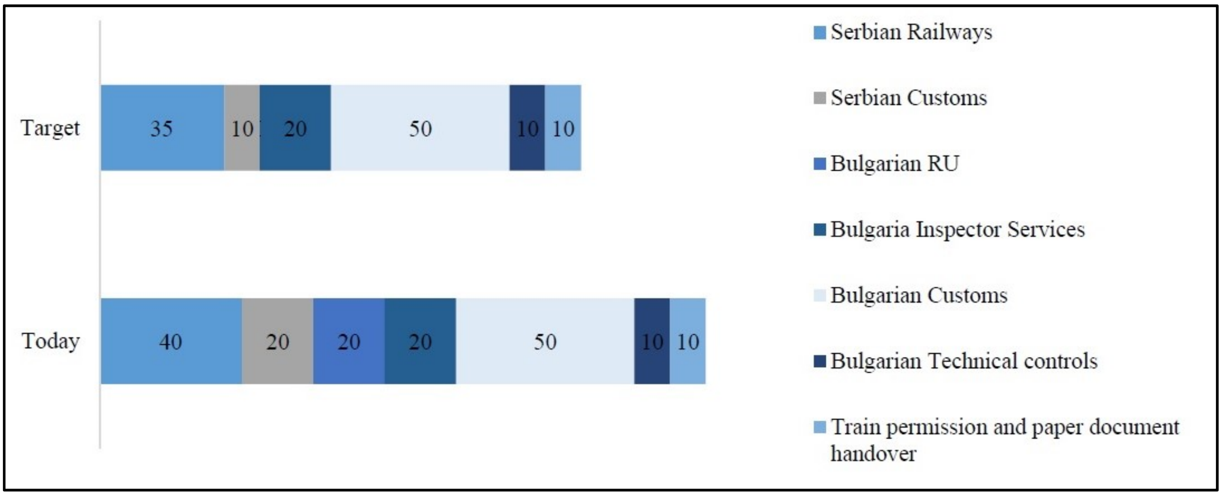
[34] Additional technical, administrative, and legislative (open access) changes can remove the task of changing locomotive and drivers, technical inspections (by applying mutual trust agreements – already existing at EU border-crossings, which in the long-term can even remove the need to stop at the border leading to in reality zero minutes of dispatching time.

Table 6-24: Comparisons of Options

	Option 1	Option 2	Option 3
Description	Use ICT solutions already available on the market.	Use existing solutions, electronic information and document scanning.	Develop local EDI solution.
Legal	BCA does not need to be amended. Subsequent agreement may be required among the stakeholders.	BCA does not need to be amended. Subsequent agreement may be required among the stakeholders.	BCA does not need to be amended. Subsequent agreement may be required among the stakeholders.
New Tasks Introduced	Yes. Manual entry and central integration.	No. Scanning will replace photocopying.	Manual entry and central Integration
Investment Cost	150.000 EUR	106.500 EUR	Customised solution more expensive than off the shelf Option 1.
Annual Cost	43.140 EUR	32.525 EUR	N/A, but likely to be similar to Option 1.
Integration Costs	High, since the option is based on a BCP local solution.	None, since Serbia could already display existing information via internet/intranet.	High, since the option is based on a BCP local solution.
Transition	Mobile Control Solutions can be used with long-term options.	Mobile Control Solutions can be used with long-term options and document scanning can be used until all stakeholders are integrated.	Mobile Control Solutions can be used with long-term options.

Source: KGH Group AB, Rail EDI at a border-crossing point in South East Europe, May 2015

Figure 6-27: Dimitrovgrad targeted stopping times



Source: KGH Group AB, Rail EDI at a border-crossing point in South East Europe, May 2015

6.11 TERMINALS

The terminal operators gave details of future demands and needs at terminals in the survey (for detailed information's see ANNEX I: Survey analysis – transport demands).

The reported future demand for maximum train length at terminals was as follows.

- 36% of terminals predicted between 601-700 m,
- 32% of terminals predicted between 701-740 m,
- 16% of terminals predicted over 741 m,
- 8% of terminals predicted between 501-600 m,
- 8% of terminals predicted up to 500 m.

Future demand for axle load per metre at terminals.

- 74% predicted 8,0 tonnes / metre (category D4),
- 26% predicted 7,2 tonnes / metre (category D3).

Future demand for maximum weight of freight trains at terminals.

- 40% of terminals predicted between 2.001-2.500 gross tonnes,
- 24% of terminals predicted between 1.501-2.000 gross tonnes,
- 24% of terminals predicted between 1.001-1.500 gross tonnes,
- 8% of terminals predicted up to 1.000 gross tonnes,
- 4% predicted over 2.501 gross tonnes.

The future demand for train length at terminals is predicted to be over 600 metres, which is too long for many tracks inside terminals. These tracks should thus be extended, if the area and space around terminals allows that. If not, the trains will be split as today into two or three sets of wagons. Splitting of the trains and marshalling of this takes time and terminal capacities.

Special attention in the near future should be given to the axle load and load per metre in terminals, because some terminals in Slovenia and Croatia have the tracks for 20,0 t/axle and (also in Serbia) 7,2 t/m.

Some transhipment machinery of intermodal units (portal cranes, reach stackers, forks …) is old and should be replaced in the near future to assure the quality of service at terminals.

In the future, modern intermodal terminals could have a usable track length over 750 m, under the gantry (portal) cranes. The tracks could be electrified only for the first 50 m at both sides for electric locomotives that could arrive to the terminal tracks with downed pantographs or maybe with a "last mile" diesel engine. In this case the shunting (diesel) locomotive and train marshalling are not necessary. The time benefit (container train) for such technological operations is very significant (a few hours).

Figure 6-28: Partial electrification of the terminal tracks

Source: www.wirtschaft.bremen.de

Construction of a new intermodal terminal in Beograd[35]

The investors in a new terminal are the Ministry of Construction, Transport and Infrastructure, City of Belgrade, and the Directorate for Construction Land and Construction of the City of Belgrade. The goal of the project is to contribute to the long-term sustainable development of logistics infrastructure and multimodal transport in Serbia. The investment value is 14,5 million EUR. The construction of the Intermodal Terminal started in September 2020, and completion of the project is expected in July 2022.

The new intermodal terminal will have a direct connection with AWB RFC through the Batajnica railway station. The terminal area is about 13 hectares. In the wide area of the terminal a logistics centre is planned on an area of about 82 hectares. The most important part of the terminal will be a manipulative area, consisting of:

- 3 tracks (each 650 m long);
  - 2 loading and unloading tracks for loading and unloading of the contractor;
  - 1 additional manipulative track for the locomotive;
- 4 lanes for truck passage;
  - 1 passing,
  - 1 loading / unloading,
  - 1 spare and
  - 1 emergency exit bar;
- Plateau for temporary disposal of the container;
  - 3 container lines for temporary disposal of containers, frigo-containers, interchangeable transport vessels and containers with dangerous goods.

[35] Source: https://www.mgsi.gov.rs/en/projekti/construction-intermodal-terminal-belgrade-0

7 WP9: SUMMARY AND RECOMMENDATIONS

The measures and recommendations are listed as follows:

- soft measures as non-investment related, such as optimisation of the border procedures
- hard measures as investment related, for example in railway infrastructure.

The timeframe for the measures is divided to three categories:

- short-term approach (up to 2025),
- medium-term approach (up to 2030) and
- long-term approach (after 2030).

7.1 ORGANISATION AND OPERATIONS

In order to improve the competitiveness of rail transport along the AWB RFC states, measures should be taken to reduce the border-crossing stopping times. The most promising soft measures (proposals) to be realised in the short- to medium-term approach with high-impacts are border operations.

7.1.1 WP7: Border operations

The first example of highly efficient cross-border operations is the border section between Germany and Austria, between the Freilassing and Salzburg stations (the connection to the west branch of the AWB RFC in Austria). At this section the trains have no stops at the border because the train control system, line electrification and the most important language of communication are the same in both states. This example between Germany and Austria has worked for many decades, without changing the locomotives.

Another best practice on the AWB RFC route was demonstrated by the container train “Bosphorus Europe Express” running from Slovenia to Turkey in 2009, with very short procedures on the cross-border sections. The travel time between Ljubljana and Halkali was only 38 hours. It should be mentioned that today the freight trains stop at the borders for over 52 hours. However, this earlier example shows that almost everything could be possible, even 11 years ago.

The third good practice on the AWB RFC regarding the cross-border sections is the border section between Austria and Slovenia, Spielfeld-Strass and Šentilj (Maribor), with the shortest stopping times at the handover station of the AWB RFC. When Slovenia has upgraded the line to Austria (Zidani Most-Šentilj) with the 22,5 t/axle, the stopping times will be even shorter, without changing the locomotives, only staff. As mentioned in the cross-border analysis of the current situation, the longest stopping times at the borders occur with regard to authority procedures and rail carriers. The next table presents the cross-border procedures, with special attention to long stopping times at cross-border sections along the AWB RFC.

Table 7-1: Border procedure sections with further improvements of operations

Procedure / Section	Authorities		Rail carriers	
	Police	Customs	Loco change	Mutual trust agreement
A/SLO	✓	✓	✗	✓
SLO/HR	✗	✓	✗	✗
HR/SRB	✗	✗	✗	✗
SRB/BG	✗	✗	✗	✗
BG/TR	✗	✗	✗	✗

✗ - further improvements to be done ✓ - no need for further improvements

Not changing the locomotive at the border is a challenge at all AWB RFC border crossings. Besides an interoperable locomotive, interoperable infrastructure (ERTMS) is also required. Interoperability on the railways could only be done with good cooperation between rail carriers and infrastructure managers.

7.1.1.1 Border working groups for improvement

The first (and the easiest) task is to set up an international working group for improvement at every cross-border section with the operative staff working at the border stations. The working group should connect and combine different types of experts **from both sides of the borders**, with at least: railway infrastructure managers (for example, the chief of the station), border police, customs, relevant ministries (for example, the Ministry of Transport) and rail carriers (at least national carriers with the highest market share in freight transport).

In the short-term it is recommended[36] to introduce **key performance indicators** and monitoring mechanisms that will enable efficient performance measurement at railway border-crossing stations. The recommended process for introduction of the monitoring mechanism could be organised through several stages:

1) Define the objectives of the monitoring mechanism
2) Agree on the methodology to be used
3) Prepare for implementation of the monitoring mechanism
4) Implement the monitoring mechanism.

Without monitoring the situation at borders it is not possible to know exactly what is happening during the cross-border procedures. The most important key performance indicator is the total time stopping at the border station, and it is based on different types of time operations at the crossing. Time monitoring will show the progress over the years regarding the time needed at cross-border sections.

[36] Source: Study on border crossing practices in international railway transport, United Nations, Bangkok, 2018

Every expert knows how to optimise the working process at the border station, which stopping times are too long and could be optimised and reduced. The working group could be managed by the AWB RFC office, but only with additional staff in the office.

7.1.1.2 AWB RFC office as a "Regional railways coordination centre"

The benefits of coordination relate to improvements in the competitiveness of the corridor as a whole, eventually leading to the attraction of more freight. Synchronisation in planning and realisation among all parties is assured, not only in one station or one national rail network, but also along the whole logistical chain, leading to transport cost reductions. In all states procedures between railway, customs and police are similar and based on the same principals, again leading to transport cost reductions.

A "coordination centre" would be an appropriate instrument to adapt to the circumstances for international cooperation in the AWB RFC. This coordination unit should be responsible for the border working groups, timetable suggestions and coordination, border process planning, supranational traffic management including delay management, rerouting, re-planning of resources, train monitoring, communications about train running, assistance in problem solving like missing documents in case of delays and the provision of advanced information to all border parties.

The costs for the expansion of the corridor office to the "Regional railway coordination centre" consist of office rent, staff, equipment and training, estimated at up to 0,3 mill. EUR/year.

7.1.1.3 Border crossing staff

Border operations include many employees from the RIMs, border authorities, rail carriers and logistics operators. In the short-term approach the working conditions on the borders should be improved with the following measures.

- Elimination of the language barrier at cross-border communication with education in the English language. This will improve co-operation and planning between successive rail carriers and RIMs.
- Permanent education of the employees with regard to ICT, for example using computers and special programs (software).
- Improvement of the working conditions at the borders with new/renovated offices, desks, chairs, lights, computers, lunchrooms, kitchens. Good quality of clothes for bad weather conditions (rain, snow, cold….), better lights at night (lights between tracks). The station's walking routes for the staff should be as short as possible.
- The presence of the necessary staff at the border for 24 hours/day and 7 days/week. The railway transport should not be disturbed or restricted because of a lack of staff. An additional number of employees (if needed) would speed up the procedures at the borders.
- Financial improvement of the salaries, especially if the stopping times will be shorter.

7.1.1.4 Police procedures

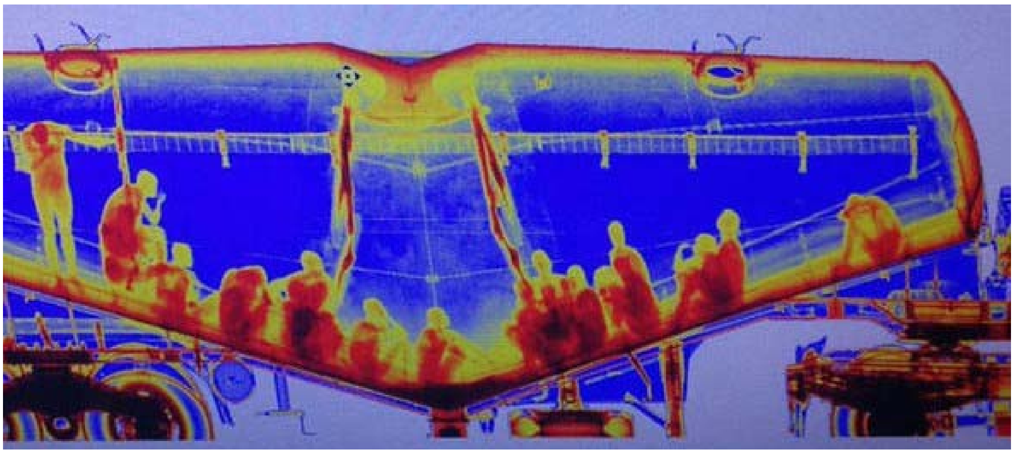
Police forces at border railway stations have had a lot of work since the mass wave of immigration started a few years ago. Detailed inspection of freight trains at border (handover) stations cause great delays at international railway freight transport. The problems with immigrants must be solved between origin and destination states of the immigrants (higher levels). Meanwhile, some other measures are available to limit immigrants travelling on freight trains. The relevant technologies can significantly contribute to the improved organisation of police procedures at railway border crossings with:

- information and communication technology,
- video and electronic surveillance systems,
- detection systems at the railway border stations for unauthorised movement of persons,
- infrared cameras,
- thermal imaging system.

Freight trains at the border stations could be scanned with a thermal imaging system. It is not necessary to scan all freight trains, but only individual trains that could potentially transport immigrants.

A thermal imaging system could scan freight wagons while driving to the station at slow speed, or could be scanned during the stopping of the train at the station's tracks.

Figure 7-1: A thermographic image of immigrants hiding in a tank



Source: www.express.co.uk/news/world/919468/illegal-immigrants-crisis

The estimated benefits are significant: faster border processing, a better catch rate for smuggling / illegal immigration and improved cooperation between border stakeholders. With optimisation of the police procedures at the borders, **at least 30 min could be saved for every border crossing with police procedures.** A thermal imaging system could be installed at every border crossing station (or section), but the most important are those at the EU's Schengen borders.

7.1.1.5 Customs procedures

Traditionally, shipments were cleared at the border. This corresponded to the objective of placing goods in compliance with national legislation as soon as they entered the customs territory. Inland clearance started to be the standard in Europe in the 1960s, when Germany and France decided that border clearance should be the exception and not the rule. Inland clearance has a number of benefits:[37]

- Clearing at the destination means that contact between customs and importers is more direct, thus facilitating requests for additional information, clarification, or even simply the collection of penalties;
- Importers can set up their own clearance unit within their own company, which can benefit from customs guidance. If they choose to use the services of clearing agents, the contact is more direct;
- The fact of simpler formalities expedites traffic at the border;
- Goods are cleared where they are consumed, thus eliminating the need for repeated unloading and reloading. Inland clearance reduces the number of stops and waiting time.

There are also a number of technical reasons why inland clearance is more practical. Another benefit of large centralised locations for customs clearance, as opposed to remote border crossing stations, is better control over potentially corrupt officials, who thus become more accessible to auditors. Additionally, when clearance is performed in centralised locations it becomes easier to ensure policy consistency. Customs administrations all over the world encounter the problem of different locations interpreting customs rules and procedures differently. This obviously has an impact on revenue collection and also results in the distortion of trade patterns due to "port shopping".

Should customs clearance be at the border or inland? When deciding upon the best policy, several issues need to be taken into consideration.

- The size of the country and its geography are important. Waiting at the border of a large country represents a smaller fraction of overall transport time than waiting at the border of a small country. Inland clearance makes more sense in smaller countries and is thus the preferred practice in the EU. However, the location of major economic centres is also a factor. Border clearance is often sufficient if a major city is near the border. However, if border stations are far from a major city, it may be better to clear inland.
- Policies regarding traffic flow need to be taken into account. In theory, inland clearance reduces border bottlenecks. If the priority is to keep railway lines open and clear, then it is better to clear inland. However, if traffic volumes are low, clearing goods at the border is sufficient. Indeed, there may also be other reasons for stopping traffic at the geographical border.

[37] Source: Handbook of Best Practices at Border Crossings – A Trade and Transport Facilitation Perspective, Organization for Security and Co-operation in Europe, 2012

- ICT resources are important. When computerised data is used for border procedures (preferably captured automatically), and if that record is properly audited, any lack of consistency in procedures or duty shortfalls can be better controlled with inland clearance.
- Dual procedures should be eliminated. Clearance processes that are formally conducted inland are often preceded by border procedures that are just as extensive. In such cases, there is a large measure of duplication. Clearing inland then amounts to clearing the goods twice (or even three times when detailed advance notification is required). Such policies should be changed.
- A reliable transit system is a necessity for inland clearance. Although cross-border commercial traffic is covered by international transit arrangements, policies remain to be made concerning bilateral railway traffic. A distinction may be made between various transit regimes for deciding who is required to clear at the border and who is allowed to proceed inland.

Pre-clearance and advance information: in a well-organised and well-managed environment with functional cross-border ICT links and interconnections between authorities and their ICT systems, it should be possible to follow a shipment, both physically and administratively, from its point of origin through to its destination. The location of the clearance point would then be irrelevant, since clearing would be done according to the data available before departure and duty paid at some point during the transport chain.

Customs in Serbia

Serbia is the only state along the AWB RFC that is currently not included to the EU Customs Union. This is one of the challenges and opportunities, because after Serbia will join the EU Customs Union it will be no border customs procedures between Austria, Slovenia, Croatia, Serbia and Bulgaria. For example, some Non-EU European states already participate in the Customs Union, or are in bilateral customs unions with the EU.

Serbia is at a good level of preparation[38] with regard to the Customs Union. Some progress has been made with the adoption of the customs law and the law on customs services. In the coming year, Serbia should in particular[39]:

- further upgrade the customs processing system by integrating risk management;
- further invest into the IT system of the national customs to enable integration with the EU system.

As regards customs legislation, there is a high level of alignment with the acquis. A new customs law was adopted in December 2018 to ensure further alignment with the EU Customs

[38] COMMISSION STAFF WORKING DOCUMENT Serbia 2019 Report Accompanying the document Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions 2019 Communication on EU Enlargement Policy for Chapter 29: Customs union.
[39] Source: www.carina.rs/en/internationalcooperation

Code. A new law on customs service was also adopted in December 2018, aiming to modernise the work of the Serbian customs administration. Serbia is a party to the Common Transit Convention, applying EU rules on transit movements. Rules on customs enforcement of intellectual property rights are broadly in line with the EU acquis. The Regional Convention on Pan-Euro-Mediterranean preferential rules of origin is applied in Serbia. The customs tariff nomenclature was aligned with the 2018 EU Combined Nomenclature in November 2017 and was amended twice in February and July 2018. The customs tariff nomenclature for 2019 was aligned with the EU Combined Nomenclature in November 2018. However, legislation on duty relief, drug precursors, cultural goods, free zones, and security aspects still needs to be aligned with the acquis. Moreover, fees charged on lorries entering customs terminals to discharge customs obligations are not in line with the acquis. The customs administration has continued to strengthen its administrative and operational capacity. The customs administration's IT strategy needs to be updated in line with the new business strategy and the accompanying action plan for 2017-2020. Strategic and modern management techniques, including quality assurance and change management, are lacking. Work on setting up a functional, interconnected IT system has progressed, but the IT division continues to lose qualified staff. A system for retaining qualified IT engineers should thus be established. Significant effort and investment are needed to ensure interconnectivity and interoperability with EU IT systems. This investment needs to be appropriately budgeted over the coming years. The risk management system needs to be strengthened. Pre-arrival/pre-departure risk analysis should be conducted consistently and across the board and harmonised with the EU Customs Code. Work on strengthening the capacity of the customs laboratory is underway, but the laboratory remains under-equipped. In terms of the fight against tobacco smuggling, Serbia has been a party to the Protocol to Eliminate Illicit Trade in Tobacco Products since 2017.

Customs technical equipment

Detailed customs control for goods in transit should be occasional, only if it is duly justified in accordance with risk analysis or if reliable intelligence information on suspected fraudulent activity is provided.

The relevant technologies can significantly contribute to improvement of organisation of customs procedures at railway border crossings with:

- information and communication technology,
- radiation scanners and
- x-ray scanners.

At the border section between Turkey and Bulgaria (border stations Kapikule and Svilengrad) there already exists an X-ray detector system. At the border section between Bulgaria and Serbia (border stations Kalotina zapad-Dimitrovgrad) there are already sensors for radioactivity.

X-ray inspection systems can be used for the protection of the EU's external borders for the Customs Union. Use of train scanners can reduce train clearance and train set formation times. Border control procedures, such as taking X-ray images in motion, enable more effective management of shipments and indirectly reduce the costs associated with railway car leasing. Devices for X-ray scanning can detect illegal and hazardous goods, such as explosives, radioactive substances, firearms and cigarettes. In addition, they can detect hidden compartments or additional structural elements in freight cars and containers (double walls, doors, enclosures, etc.) without opening the car. After scanning the train set by moving it slowly through the scanner, the resulting image is processed electronically.

Europe's largest and most modern train scanning terminal is located at the Terespol-Brest border crossing between Poland and Belarus. A staff building, accelerator bunker and detector towers have been erected at the trackway near the border crossing. The range of the scanning device at the terminal covers three tracks. Images of scanned wagons are displayed on computers at the terminal and analysed by customs officers. **The investment costs for the scanning terminal have been about 5 million EUR.**

Figure 7-2: Train scanning terminal between Poland and Belarus

Source: UIC Security Platform, Paris, April 2019

The estimated benefits are significant: a faster border processing, better catch rate for smuggling and improved cooperation between border stakeholders. With optimisation of the customs procedures at the borders, **at least 30 min could be saved for every border crossing with customs procedures** at the borders HR/SRB and SRB/BG.

7.1.1.6 Combined cross-border procedures

Combined cross-border procedures at handover stations are a solution for optimised and parallel border procedures of neighbouring states. This proposal is similar to the agreement between Serbia and Bulgaria on border control and procedures for railway transport at Dimitrovgrad (IŽS) handover station, without any procedure on the Bulgarian side.

The next table presents an example of existing stopping times at border stations for the option "combined border procedure only at handover station". This option is already performed at the borders between Austria-Slovenia and Slovenia-Croatia. The different procedures at four border stations Tovarnik (HŽ-I), Kalotina zapad (NRIC), Dragoman (NRIC) and Svilengrad (NRIC) are transferred to neighbouring handover stations (coloured in red cells), together with the staff. Common procedures work parallel at handover stations with all available conditions for additional staff from neighbouring state (offices, equipment, computers, language,….).

Table 7-2: Simulated stopping times – combined border procedures at handover station

Cross border states	RIM	Station	Border stopping times (min)	
			Planned	Actual
Austria-Slovenia	ÖBB-I	Rosenbach	0	0
	SŽ-I	**Jesenice**	80	180
Austria-Slovenia	**ÖBB-I**	**Spielfeld-Straß**	20	40
	SŽ-I	Šentilj	0	0
Slovenia-Croatia	**SŽ-I**	**Dobova**	110	240
	HŽ-I	Savski Marof	0	0
Croatia-Serbia	HŽ-I	Tovarnik	×	×
	IŽS	**Šid**	131	537
Serbia-Bulgaria	**IŽS**	**Dimitrovgrad**	215	922
	NRIC	Kalotina zapad	×	×
	NRIC	Dragoman	×	×
Bulgaria-Turkey	NRIC	Svilengrad	×	×
	TCDD	**Kapikule**	315	810
Total cross border time (minutes)			**871**	**2.729**
Total cross border time (hours)			**14,52**	**45,48**

× - without stops at border stations

Planned stopping times are reduced by 30% (from 20,77 hours to 14,52 hours). However, actual stopping times are reduced by "only" 14% (from 52,90 hours to 45,48 hours), because most of the procedures and delays (together with the change of locomotives) are performed at the handover stations.

The use of combined border procedures at a handover station keeps the process one step ahead, thus reducing stopping times. However, this needs some investments in the handover station facilities and equipment for additional staff from the neighbouring state, as well as a border agreement between two states in accordance with the EU legislation, especially with regard to the Schengen Area and EU Customs Union. National legislation should also be adopted to help this.

7.1.1.7 Optimisations at Kapikule (TR) handover station

International freight trains could cross borders faster. Legislation about speeding up the border crossing of freight trains at Kapikule handover station was accepted and published in 2018, with the following highlights.[40]

- *24/7 service:* border stations will keep open 24 hours a day if the freight volume is sufficient.
- *Plant/animal checks:* checks of plants and animals were being done at other locations, which cause delays. The border stations will be equipped for these checks.
- *Bonded warehouses:* will be built for temporary storage of goods before customs clearance.
- *IT systems:* stations will be equipped with necessary IT systems to follow the information about loads before they arrive at the border.
- *Staff:* in order to overcome the dense traffic, staff working for the railway, customs etc. will need be strengthened.
- *Customs checks:* double checks for the same objective on both sides of the border will be eliminated. The checks at the border will be simpler, and the main checks will be done at departure/arrival stations. In general, if information is complete and seals are OK, there will be no physical checks at border.
- *Crossing time:* will be in line with the agreements. Delays will be examined and related parties informed.
- *CIM and other agreements:* will be used instead of other consignment notes.

7.1.2 Rail freight carriers

Beside the RIMs and railway infrastructure, the tasks for the optimisation of the railway transport, especially on the cross-border sections, should also be improved by rail freight carriers at the next segments: rolling stocks, mutual trust agreements and ICT.

7.1.2.1 Rolling stock

Rolling stock equipment, owned by the rail carriers, has a significant impact on the organisation of railway transport. As the bottleneck study shows, lack of the locomotives is one of the problems at cross-border sections. This problem is often seen at the national rail freight carriers. Most of carriers' fleet is old, with non-interoperable locomotives, and they have the longest stopping times at border handover stations because they need to change the locomotives.

The new (small and private) rail carriers that have their own traction and wagons have fewer problems. They have the full responsibility for contracting, liabilities, logistics, timetable and technical issues, and are much more organised compared to the national rail freight carriers.

[40] Source: https://railturkey.org/2018/04/06/border-crossing-of-trains-will-speed-up/

Another problem is the availability of locomotives at the right place and time. Proper allocation of locomotives to international freight trains is one solution, but this is relatively expensive, and is a difficult task on all corridors in Europe. The use of interoperable locomotives is more efficient, probably cheaper, and it increases the speed and reliability of trains. It also ensures that there is always a locomotive, and even in the case of delays it would be possible to find another locomotive at the border. Whatever form of cooperation is applied, there is always cross-border use of the same locomotive as a foundation for success.

The rail carriers should provide an adequate number of interoperable locomotives and engine drivers, without changing the locomotive at the borders. However, the engine drivers could easily be changed at the borders, because it takes only a few minutes.

The best solution is that on a train route between different states, from the start to the end, one interoperable locomotive is used, without changes (staff only) at the borders. The condition for this solution is compatibility between locomotives and infrastructure, regarding train control systems (ETCS, INDUSI, etc.), communication devices (GSM-R, analogue radio) and line electricity (AC, DC). One locomotive from the start to the end of a route could be achieved with an agreement between different rail carriers or between the rail carriers and subsidiaries in different states.

In the near future, the rail carriers (especially national freight carriers) should expand and modernise their rolling stock (locomotives) with new, state-of-the-art interoperable locomotives. As an example, the investment costs for one interoperable electric locomotive are estimated to be between 4 to 5 mill. EUR. The costs depend on the locomotive equipment, number of axles (4 or 6 driving axles) and maintenance agreement.

Electric locomotives have pantographs with standard voltages 3, 15 and 25 kV. The maximal speed of the locomotive is about 120 km/h, with a starting tractive effort (6-axle loco) of between 400 to 500 kN and engine power of 5-6 MW.

Figure 7-3: Stadler 6-axle electric locomotive EURO 6000

Source: http://ferrmed.eu/sites/default/files/2019-03/12_00_7_MAR%20RIVAS_2.pdf

With the strongest locomotives – such as a 6-axle Stadler EURO 6000 –some double traction (two hauling locomotives, each with 4-axles at one train) could be eliminated at AWB RFC sections. The next table shows a practical example with regard to train loads on the AWB RFC section in the direction Ljubljana-Jesenice (SŽ-I) with a longitudinal slope of 19‰ (and with different types of hauling locomotives, only one locomotive per train). Six-axle locomotives have better technical performances than 4 axle locomotives.

Table 7-3: Train loads and types of locomotives on the section Ljubljana-Jesenice

Type of locomotive	Axles	Train load (gross tonnes)
Stadler Euro 6000 (430 kN)	6	1.860
Newag Dragon 2 (375 kN)	6	1.775
Bombardier Traxx 3 (320 kN)	4	1.530
Siemens Vectron X4 A35 (300 kN)	4	1.424
Siemens Taurus (275 kN)	4	1.260

Source: Different sources

With the elimination of the locomotive change at the borders, and introduction of the interoperable locomotives and railway infrastructure, **at least 20 min could be saved for every border crossing.**

Many delays at handover stations occur due to a lack of locomotives, because trains are waiting for locomotives from the next rail carriers. if only one locomotive was used from departure to the final destination a lot of time could be saved at the borders.

7.1.2.2 Tablet PCs for engine drivers

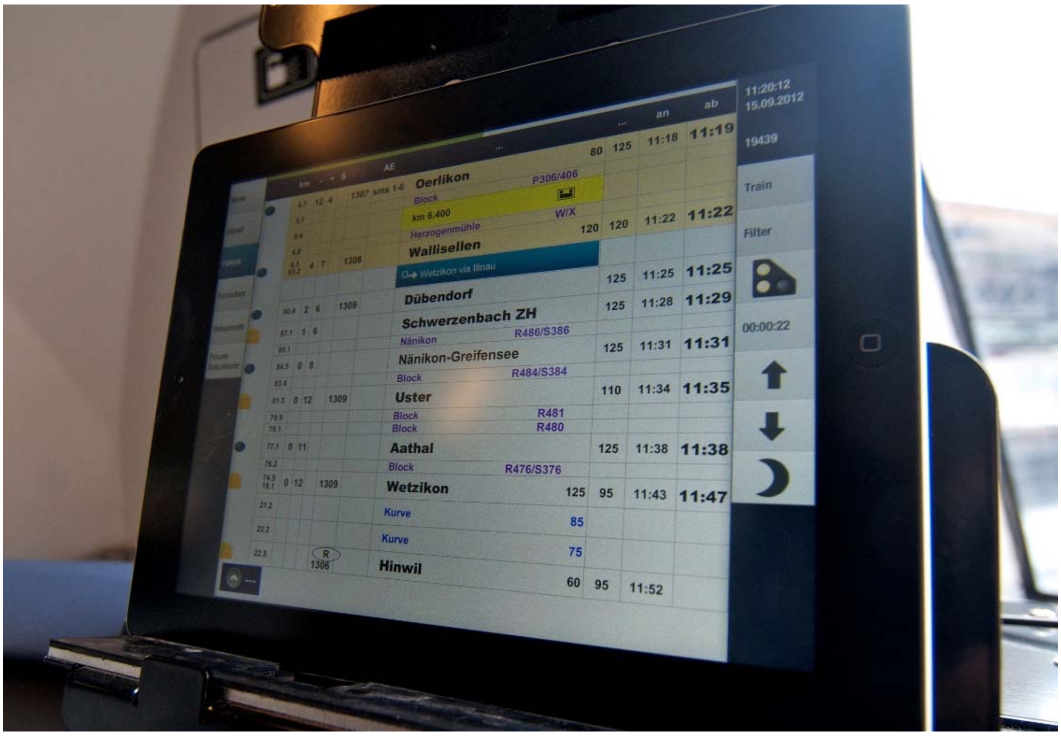
A lot of paper is used for printing different documents for trains, from the timetables to the different restrictions (speed restrictions, closures, etc..). All this printed paper must be distributed to the engine drivers at the railway stations. Personalised tablets for engine driver could replace all printed documents on the locomotives (timetable, regulations, orders and other evidence on the vehicle). These must be equipped with Wi-Fi and SIM cards, Android or OS X operating system, simple document viewer, etc. Use of tablet PCs for engine drivers, instead of paper, have many advantages:

- Easier to use – all information and data are collected in one place,
- Minimising the number of errors during the train run,
- Notifying engine drivers during their working shift,
- Compatibility with GSM-R,
- Notifying engine drivers using GMS-R about traffic and safety information.
- Possibilities for additional functions include:
    - Periodic notification of the engine drivers about take up duties
    - Notification about telegrams and business notifications
    - Electronic list of locomotive errors
    - Notifications about traffic and transport conditions on the lines

Investment costs depend on the number of engine drivers, locomotive fleet and software requests. Investments include:

- Tablet PCs for engine drivers,
- Special software,
- On-board devices (for locomotives).

Figure 7-4: Tablet PC



Source: https://www.iphone-blog.ch/wp-content/uploads/2013/08/sbb_lea3_6.jpg

National rail carriers in Austria and Slovenia have already used tablet PCs for engine drivers for many years, as have many other private rail carriers. In a short time period the usage of tablets could be extended to other national carriers along the AWB RFC.

7.1.2.3 Mutual trust agreement

A mutual trust agreement can speed up the handover process at borders, and this is a domain of the rail carriers at separate transport routes. Such an agreement could contain more rail carriers for a defined route via border crossings. According to analysis the national rail carriers usually have higher delays at border crossings than private (small) rail carriers. With mutual trust agreements, some detailed procedures at the borders could be abandoned such as technical wagon inspections.

With mutual trust agreements between rail carriers all along the route, **at least 30 min could be saved for every border crossing.**

7.1.3 ICT and legislation harmonisation

ICT

On the market there are already many ICT solutions, and the main goal in railway transport should be paperless procedures from departure to the final destination, with emphasis on cross-border sections. Information systems already include TAF TSI, which is necessary to harmonise data exchange in the railway transport from different stakeholders: rail carriers, logistics, RIMs, authorities (customs, police…). Available information systems for railway transport include ORFEUS, Heroes, Hermes, ISR, and RNE tools.

As example for Dimitrovgrad (IŽS) handover station shows that the costs of an information system at cross-border section for optimising and speeding up international freight railway transport could be from 100.000 to 200.000 EUR. It depends on the ICT solution and border station.

Use of proper ICT and EDI can result in a significant reduction of time, between 35 to 70 minutes, for one train, and depends on the different options of the ICT.

Operational legislation for interoperability

Achieving operational interoperability is less costly than technical interoperability, but it is highly dependent on the existing level of technical interoperability. Although the operational interoperability is less expensive, it requires strong political willingness and synchronised efforts of the states involved to work together in order to define and implement compatible procedures between the various entities concerned. Any missing link on RFC, due to the lack of cooperation of one entity from one country, will make all investments in technical interoperability useless and jeopardise the competitiveness of the entire RFC (a missing link could be due to the lack of cooperation of a railway, a customs authority, an immigration entity, etc.).

Operational interoperability is built on the common platform created by the achieved technical interoperability. By using common operational practice along RFCs, railways can capitalise on their advantages (high safety, large volumes, low costs on long distances) due to the more rapid movement of trains with lower costs. For full operational interoperability, the harmonisation of activities of other authorities which interfere in the operation of the international trains is also necessary (customs, immigration, phytosanitary, etc.).

Consequently, the common operational parameters can be grouped in two categories:

- Operational interoperability of the railways for the organisation of traffic according to compatible operating rules (train tonnage, train composition, speed of train, management of traffic, maintenance rules for assets, etc.),
- Operational interoperability of other state entities involved in the border-crossing activities through commonly agreed upon procedures.

The continuation of the train route from the exit railway to the entry railway via an unchanged train (same locomotive) requires the railways along the corridor to agree upon supplementary operational interoperability. Harmonised operating rules for this case are very complex, and include harmonisation of:

- Traffic management, including rules for communication between engine drivers and Traffic Control Centres, language of communication,
- Engine drivers operating locomotives on the tracks of different railways,
- Locomotive fuelling and maintenance,
- Criteria and procedures for certification of safety critical staff,
- Training of drivers and other safety critical staff.

This level of interoperability is difficult to achieve and requires advanced integration of operating rules among the railways along a corridor. However, it offers the highest operational performance along corridors.

Technical specifications for interoperability (TSI)

TSI mean the specifications by which each subsystem or part of each subsystem is covered in order to meet the essential requirements and ensure the interoperability of the European Union's high speed and conventional rail systems. These activities were institutionalised under the umbrella of the European Railway Agency which was succeeded by the European Union Railway Agency, in charge of the activities for the enhancement of the level of interoperability of rail systems. The goal is to develop a common approach to safety on the European railway system and create a Single European Railway Area without frontiers. The issue of interoperability is addressed by specific activities in four directions of action:

- Rolling stock sector, which is responsible for all the safety issues related to the vehicles,
- Fixed installations sector, which is responsible for all the safety issues related to the power supply and infrastructure subsystems,
- Operational sector, which is responsible for drafting and revising the TSIs on telematics applications and on operation and traffic management,
- Conformity assessment, registers and standards sector, which is responsible for the conformity assessment, setting up and maintaining interoperability registers, collaboration with European standardisation organisations and OTIF, and monitoring railway interoperability.

Technical specifications for interoperability relating to the TAF subsystem of the rail system in the EU play a vital role in achieving greater higher competitiveness of railway transport along international corridors.

7.2 RAILWAY INFRASTRUCTURE

In order to improve the competitiveness of rail transport along the AWB RFC states, measures should be taken to improve the railway infrastructure in accordance with the TEN-T core network standards. The hard measures and proposals could be realised using short- (investments already in progress), medium- or long-term approaches.

7.2.1 WP1: Train length

According to the types of cargo and their potential, 740 m trains could represent about one third of all freight trains in the future, but at first the base conditions for operation of 740 m train must be established. With base (minimal) conditions the market share for 740 m trains could be about 9%.

For operations of 740 m trains the railway stations, especially handover stations, should have a usable length of at least 750 m. The status of the longest tracks at handover stations is presented in the next table.

Table 7-4: Longest tracks at border handover stations

Handover station	750 m track	Longest track (m)
Spielfeld-Straß (ÖBB-I)*	✘	665
Jesenice (SŽ-I)	✘	702
Dobova (SŽ-I)	✘	737
Šid (IŽS)	✓	837 (running, platform)
Dimitrovgrad (IŽS)	✘	745 (running, platform)

At handover stations it is thus necessary to make some investments for track extensions, or less costly operational changes for operations of 740 m trains on cross-border sections.

A significant effort to improve the track length for 740 m trains in Serbia (IŽS) should be made until 2030, since lines are currently not available for such trains.

*An example of an operational change is going to be done at the end of 2020, because of the temporary closure of the Karavanke Tunnel between SLO/A (Jesenice-Rosenbach). The six-month closure of the tunnel will be due to its upgrade and maintenance, and freight trains will be rerouted to the border crossing Šentilj (SŽ-I) - Spielfeld-Straß (ÖBB-I). At Spielfeld-Straß (ÖBB-I) handover station there will no longer be any changes of locomotives, and only the engine drivers will change. Non-interoperable locomotives will be changed at Maribor Tezno (SŽ-I) and Leibnitz (ÖBB-I) freight stations, and both have tracks for 740 m trains. Similar measures could be taken at any other border crossings in the future, based on agreements between rail carriers and RIMs.

7.2.2 WP2: Loading gauge

The first task is to perform measures for P/C codification in Serbia (IŽS) for 565 km AWB lines. The codification will present the real situation with regard to the loading gauge and list those sections with an insufficient loading gauge in terms of intermodal railway transport.

The second task is to upgrade the loading gauge in Serbia and Bulgaria. This could be done in the following ways:

- in a medium time period (up to 2030) for upgrading sections that are already included in the national investment plans (section SRB/BG border Dragoman-Sofia-Kazichene in Bulgaria and some sections in Serbia) and
- in a long time period (after 2030) for potential rail sections without current investment plans (in Serbia).

7.2.3 WP3: Axle load and load per metre

Axle load category

Regarding the axle load category, after 2021 the entire AWB RFC will be available for 22,5 t per axle. Currently there are no specific actions regarding such future investments along the AWB RFC principal routes.

Load per metre

Insufficient load per metre could cause bottlenecks for the transport of very heavy goods on short wagons (especially for heavy exceptional consignments). With a four-axle wagon it is possible to transport 90 gross tonnes (22,5 tonnes per every axle). If the wagon length is up to 12 metres, its load per metre is at least 7,5 t/m, which exceeds 7,2 t/m.

The increase in the transport capacity with the upgrading of the load per metre from 7,2 to 8,0 t/m **could be up to 10%,** but only for **defined types of cargo and wagons.** Another relevant factor is that the combination of heavy cargo and short wagons is not very common on the AWB lines, in contrast to other types of cargo (containers, cereals, etc.).

Taking into consideration all the given facts, and the load per metre of 8,0 t/m will not be achieved on all AWB lines until 2030. Upgrading the load per metre from 7,2 to 8,0 t/m needs the complete renewal of both super- and sub-structure. The measures for upgrading the load per metre could be implemented using a long-term approach, probably after 2030.

7.2.4 WP4: Speeds

In accordance with the investment plans of RIMs, the line speed of 100 km/h for freight trains along the AWB RFC will not be achieved 100% until 2030. The increase in line speed could only be achieved with the complete upgrade of the line section – which could required the highest investment in the railway infrastructure. In some cases, it is better to build a completely new parallel line or line section than increases the speed at the old sections.

The focus regarding increasing speed should be on permanent speed restrictions (for lines in bad condition because of lack of maintenance) and their elimination. Every speed restriction causes delays and increases the energy costs. The next table presents the estimated time benefits due to elimination of speed restrictions along the AWB RFC.

Table 7-5: Estimated time benefits due to elimination of speed restrictions

RIM	Time benefit (min)
ÖBB-I	15
SŽ-I	7
HŽ-I	36
IŽS	83
NRIC	20
Total (min)	**161**
Total (h)	**2,68**

The RIMs with the longest length of speed restrictions already have plans to eliminate these with complete upgrades of the line sections (for example: HŽ-I at sections Savski Marof and Dugo Selo-Banova Jaruga, IŽS at section Lapovo Stalać-Niš-Dimitrovgrad).

7.2.5 WP5: Line electrification

According to the investment plans, after 2024 the entire AWB RFC will be electrified. There are currently no specific actions regarding further investments at AWB RFC principal routes (maintenance only).

The time benefit because of electrification of the non-electrified section between Niš and Dimitrovgrad (IŽS) will be **at least 2 hours** due to elimination of the locomotive change (electric for diesel) and better traction characteristics for electric locomotives (hauling force, resistance and speed).

7.2.6 WP6: ERTMS (ETCS + GSM-R)

ETCS

ETCS is one segment of the ERTMS and it has an important role in railway interoperability, especially at the border-crossing sections. It is one of the most representative infrastructure (and rolling stock) parameters to assure interoperability in railway transport. ETCS is one of the key parameters with high priority, which must be achieved before 2030 on the TEN-T core network.

ETCS L1 and L2 will be installed along the AWB RFC. By 2030 Slovenia (SŽ-I), Serbia (IŽS) and Bulgaria (NRIC) will have all lines 100% equipped with ETCS. However, the corridor will not be 100% covered by ETCS in Austria (ÖBB-I) and Croatia (HŽ-I).

GSM-R

GSM-R is another segment of the ERTMS, and it has an important role in railway interoperability with regard to the communications between rail carriers and RIMs, especially at the border-crossing sections. It is one of the most representative infrastructure (and rolling stock) parameters to assure interoperability in railway transport. GSM-R is one of the key parameters with high priority, that should be achieved before 2030 on the TEN-T core network.

Austria (ÖBB-I), Slovenia (SŽ-I), Croatia (HŽ-I), Serbia (IŽS) and Bulgaria (NRIC) will have all lines 100% equipped with GSM-R by 2030.

7.2.7 Capacity improvement

Capacity improvement on the AWB lines should be focused on two priorities:

1. **Priority:** Bottlenecks with capacity consumption between **80-100%** (in 2020)
2. **Priority:** Bottlenecks with capacity consumption between **60-80%** (in 2020)

High (first) priority bottlenecks, with the capacity consumption between 80-100% in 2020, already have investment plans to eliminate bottlenecks and increase the line capacity until 2030.

- Austria (ÖBB-I):
  - Salzburg-Bischofshofen; investment plans to upgrade the section until 2030
  - Marchtrenk-Wels; four-track expansion; the project includes the construction of two lines that will complement the two existing lines
  - Bruck a.d. Mur-border A/SLO (Maribor); investment plans to upgrade the section until 2030
- Slovenia (SŽ-I):
  - Ljubljana-Jesenice; investment plans to upgrade the section until 2030

Potential bottlenecks (second priority) with the capacity consumption between 60-80% in 2020 should have special attention in the future regarding the lack of line capacities.

- Austria (ÖBB-I):
  - Spittal-Milstättersee-Villach
  - St. Michael-Bruck a.d. Mur
- Croatia (HŽ-I):
  - border SLO/HR-Savski Marof-Zaprešić; investment already started, finished at 2021
  - Dugo Selo-Novska; investment plans after 2022
  - Vinkovci-Vukovar, investment already started, finished in 2021
- Bulgaria (NRIC):
  - Dragoman-Sofia; investment plans to upgrade the section until 2030

7.3 SUMMARY

Soft measures

Soft measures are border crossing procedures with the goal to reduce stopping times at the borders, with the following proposals.

- Border working groups for improvement of the conditions at border crossings, with permanent monitoring and different indicators (stopping time, transport volume…).
- AWB RFC office as a "Regional railways coordination centre" for better cooperation at the border crossings. Cooperation and connection with different involved parties from authorities (ministries, customs, police…) to rail carriers and RIMs.
- Better working conditions for border crossing staff (salaries, new offices and equipment,….).
- Introduction of ICT (TAF TSI) between rail carriers, RIMs and border authorities.
- Police procedures with new border equipment for faster train checks (scanners for illegal immigrants on freight trains), especially at the Schengen borders.
- Customs procedures with new border equipment for faster train checks, electronically based procedures, without papers.
- Joint cross-border procedures of two states at handover stations, agreements between states.
- Modernisation and optimisation of the rolling stock at rail carriers, with interoperable locomotives and engine drivers. With the growth of the cargo the rail carriers should expand their fleets of locomotives and wagons.
- Usage of the mutual trust agreements between rail carriers for simplified border operations during the train handover process.
- Harmonised legislation along corridors (operating rules), based on TSI and operational legislation for interoperability.

The costs for soft measures are very different and depend on the type of measures. For example, the costs for harmonised legislation (operating rules, TSI) could not be estimated. Mutual trust agreements between rail carriers are without costs. Better organisation at a border crossing could also be achieved with almost no costs. Information communication systems could be introduced for a few hundred thousand EUR, while special equipment for customs and police is more expensive, and could cost a few million EUR.

Reducing the stopping times of freight transport at the borders with soft measures could be an opportunity for co-financing with EU funds. With relatively small investment costs, significant time benefits could be achieved.

Hard measures

Hard measures are related to the railway infrastructure with the goal of having TEN-T core network standards along the AWB RFC. The next table presents a set of measures listed as hard measures (investment related) for the short, medium and long term for the public railway infrastructure of the AWB RFC.

Table 7-6: Hard measures and timeframe for AWB RFC

Measures	Short Up to 2025	Medium Up to 2030	Long After 2030
Track gauge 1435 mm	Without measures.		
Axle load 22,5 t	Yes	X	X
Line electrification (Yes)	Yes	X	X
ERTMS – GSM-R	Yes	Yes	X
Train length 740 m	Yes	Yes	Yes
Load per metre (8,0 t/m)	Yes	Yes	Yes
ERTMS – ETCS	Yes	Yes	Yes
Freight train speed 100 km/h	Yes	Yes	Yes

Investment projects in progress for upgrading to a 22,5 t axle load and line electrification will be finished in the short term, before 2025. Minimal standards for 740 m trains could be achieved by 2030. After 2030 further improvements to the extension of the station tracks will be necessary to satisfy the future potential market demands for 740 m trains.

Load per metre, ETCS and a the aim of speed of 100 km/h are continuously being upgraded, but probably will not be finished until 2030. Because of this they are selected as long-term measures after 2030.

Based on the RIMs investment plans and cost estimations (see chapter 6.1 INVESTMENT PLANS), the next table presents summarised investment values in EUR for the period until 2030.

Table 7-7: Planned investment costs for AWB sections until 2030

RIM	mill. EUR
ÖBB-I	2.426
SŽ-I	1.799
HŽ-I	695
IŽS	2.944
NRIC	1.047
Total	**8.912**

Source: Different sources

Estimated costs for achievement of defined infrastructure parameters along the AWB RFC in the future are presented in the following table.

Table 7-8: Estimated costs for achievement of infrastructure parameters

RIM	in million EUR				
	740 m tracks	**8,0 t/m**	**ETCS**	**GSM-R**	**Total**
ÖBB-I	224	132	353	0	709
SŽ-I	126	1.380	7	0	1.513
HŽ-I	154	0	122	69	345
IŽS	280	0	295	113	688
NRIC	182	0	20	11	214
Total	**966**	**1.512**	**797**	**193**	**3.468**

Source: Different sources

Planned investment costs of 8.912 mill. EUR and estimated investment costs for the achievement of the set infrastructure parameters (ERTMS, 740 m trains, load per metre) of 3.468 mill., represent a total of 12.380 mill. EUR for the short-, medium- and long-term periods.

8 CONCLUSIONS

The current study deals with the border and infrastructure obstacles caused by a lack of technical interoperability between national railway systems, as well as infrastructure bottlenecks caused by insufficient coordination of investment between states. The following main problems have been identified:

- infrastructure bottlenecks hampering capacity and speed (limited axle load, limited train length, speed restrictions…), mainly due to problems with a lack of the money and delayed infrastructure investments in different states,
- lack of technical interoperability (electrification, train control systems, communication…) requiring multi-system locomotives or change of locomotives at the borders,
- border procedures and stopping times (repeating procedures, data exchange, communication, lack of locomotives…).

The major consequences of the lack of interoperability and infrastructure bottlenecks are:

- stopping times at the border hamper commercial speed and therefore lead to lower attractiveness for customers and to higher operational costs for rail carriers;
- problems with reliability and punctuality due to frequent delays,
- financial costs for investments in infrastructure and rolling stock (multi-system equipment…)

Delays in rail transport caused by border-crossing transit times are one of the key factors affecting the competitiveness of rail transport vis-à-vis other transport modes – increasing logistical costs and creating a negative perception of rail, in terms of reliability, predictability, and punctuality. For example, about 55% of delays in rail freight in Austria are caused by delays in train handover at national borders.[41] Nevertheless, the problem is more acute in South East Europe, and suggests that tackling rail infrastructure investment needs, in and of itself, will be insufficient to allow a rapid increase in the modal share of international rail freight, in the absence of measures aimed at addressing delays at border points.

Rail corridor performance in South East Europe is generally poor in terms of commercial speeds achieved and modal share, reflecting a potential largely unfulfilled to date. As the "Bosphorus Europe Express" (2009) test run along the AWB RFC demonstrated, commercial speeds can rise dramatically if border-crossing delays are reduced, even without major improvements to rail infrastructure. While the improved performance in the test run was not related to EDI, it demonstrates how improvements in rail BCPs are possible when a corridor level approach is adopted and there is political commitment among the participating countries. The general drive by a number of countries to upgrade key rail infrastructure to 160 km/hour at great expense is

[41] Source: Rail electronic data interchange in a border crossing point in South East Europe: An assessment of options, The World Bank, May 2015

not necessarily as cost-effective as substantial reductions in border-crossing delays, which come at limited expense and require no or very limited infrastructure expenditure. The intermodal train test run in 2009 thus serves as an important lesson to governments and rail companies in the region on what can be done along a specific rail corridor if a regional approach, focusing on harmonisation, synchronisation, and cooperation, is adopted.

Track gauge 1435 mm is the only (standard) track gauge along the AWB RFC today, and this will remain so long into the future. AWB RFC has no other types of track gauges. **Axle load category 22,5 t/axle** will fulfil the TEN-T core network criteria on the AWB RFC before 2025, and AWB RFC will be **completely electrified** within the same timeframe.

740 m trains are one way to improve the effectiveness and efficiency of the rail freight system, allowing more efficient operation and an increase in transport capacity before 2030. Rail carriers see longer trains as a key approach to competitive rail freight, whereas RIM could face a major investment effort. A win-win situation for both rail carriers and RIM has to be established, as the necessary investments are mainly on the infrastructure side. According to the plans of RIMs, the corridor will be available for 740 m trains by 2030.

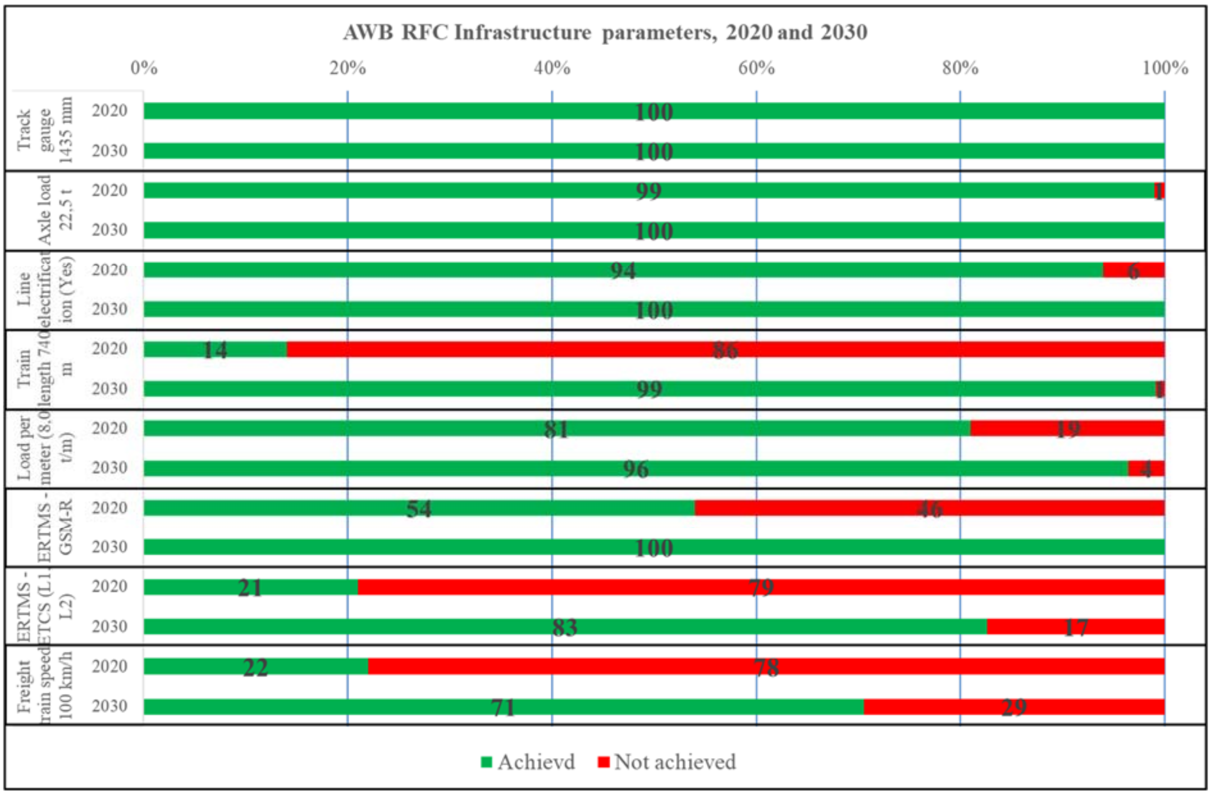
Load per metre 8,0 t/m will not be reached before 2030 and stays on the list for long-term measures after 2030. The parameter does not belong to the TEN-T core network criteria, and is less important than other, already mentioned infrastructure parameters.

ERTMS with ETCS and GSM-R is the key parameter for interoperability in the future and combines railway infrastructure and rail vehicles (locomotives). The ERTMS will probably not be completely installed along the AWB RFC until 2030 (an exception is GSM-R), because 23% of the AWB RFC belongs to the comprehensive TEN-T network.

Freight train speed 100 km/h is an investment with the highest price of all relevant infrastructure parameters. According to the plans, about half of the lines of the AWB RFC will be available for the freight trains with a speed of 100 km/h.

Planned investment costs of 8.912 mill. EUR and estimated investment costs for achieving the infrastructure parameters (ERTMS, 740 m trains, load per metre) of 3.468 mill., represent a total of 12.380 mill. EUR for the short-, medium- and long-term periods.

Figure 8-1: Comparison of infrastructure parameters for years 2020 and 2030



The proposed measures for the further improvement of the services along the AWB RFC.

1) **Reduce the stopping times for freight trains at cross border sections:**
   - monitoring of the border procedures with working groups,
   - parallel border procedures at handover stations,
   - use of ICT at the borders,
   - rolling stock improvement (lack of interoperable locomotives).
2) **Elimination of permanent speed restrictions:**
   - already in plans with investments for infrastructure,
   - increase of the maintenance on critical railway sections.
3) **ERTMS installations with ETCS and GSM-R:**
   - interoperability of the lines,
   - interoperable locomotives.
4) **Operating lines and stations for 740 m trains:**
   - high market demand for longer trains,
   - increase in transport capacities.
5) **Capacity improvements:**
   - sections with capacity utilisation from 80 to 100%,
   - capacity increase with infrastructure investments.

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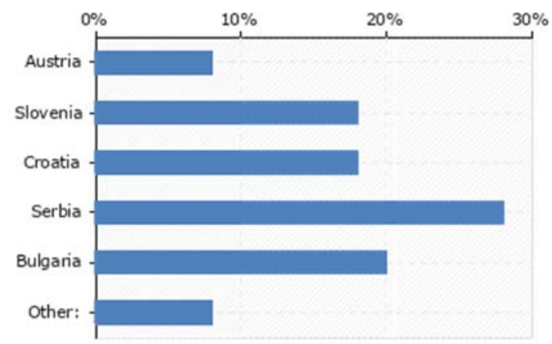
10 ANNEX I: SURVEY ANALYSIS – TRANSPORT DEMANDS

Two different types of survey have been made, one for rail freight carriers and the second for terminal operators, all along the AWB RFC. The focus was to investigate current problems and future demands. The links to online surveys were sent by email to contact persons of the rail carriers and terminals.

10.1 RAIL FREIGHT CARRIERS

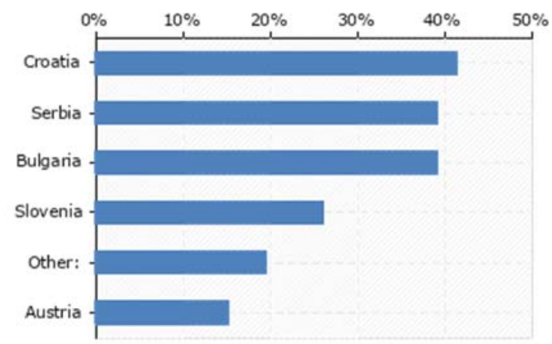
Along the AWB RFC there are five member states with almost 60 rail freight carriers, most of them in Austria and Bulgaria. The anonymous survey with 20 questions was sent to rail carriers in April 2020, and 46% of rail freight carriers responded.

1) The states in which the rail carrier headquarters are located.



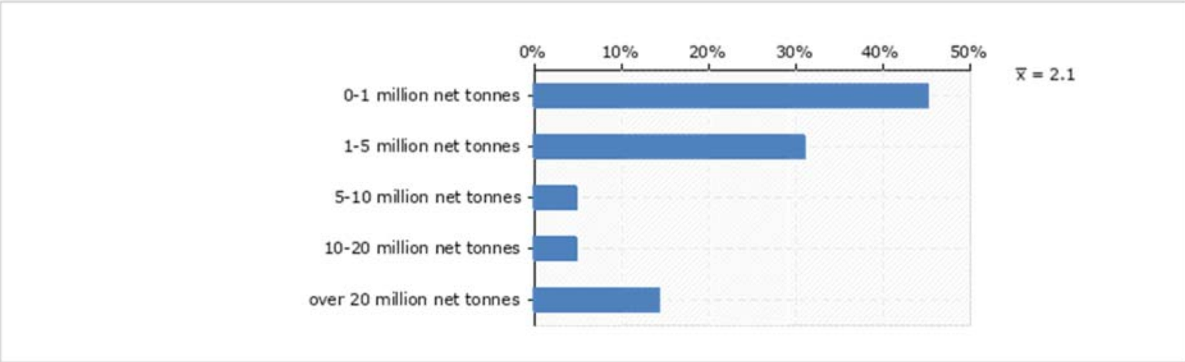
Other: Germany, Italy

2) AWB states with rail carrier services (more options).

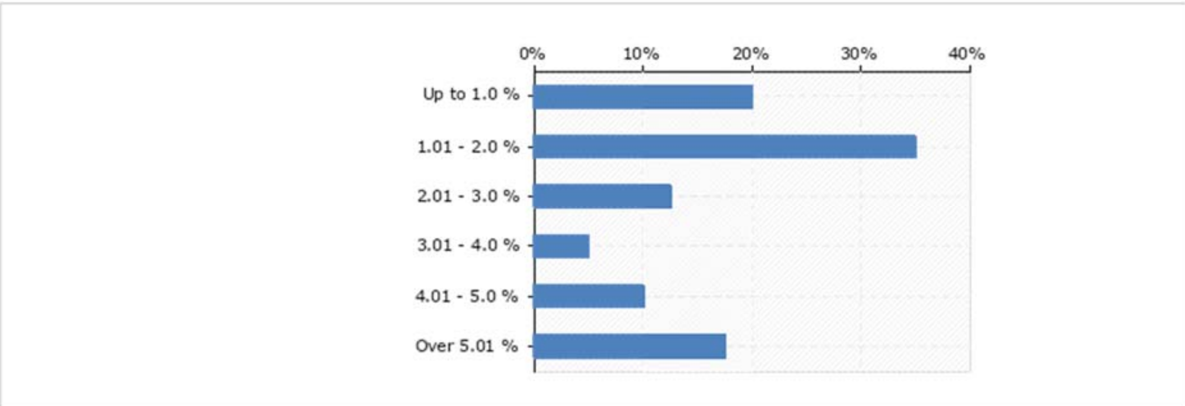


Other: Germany, Czech Republic, Hungary

3) Estimated annual rail transported volume (net tonnes).

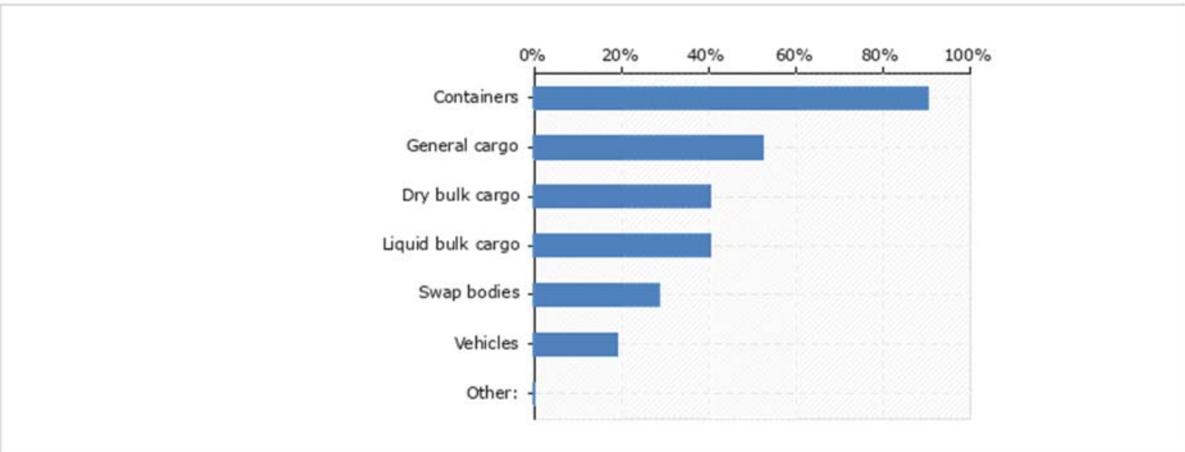


4) Estimated future annual growth of transport volume/services.

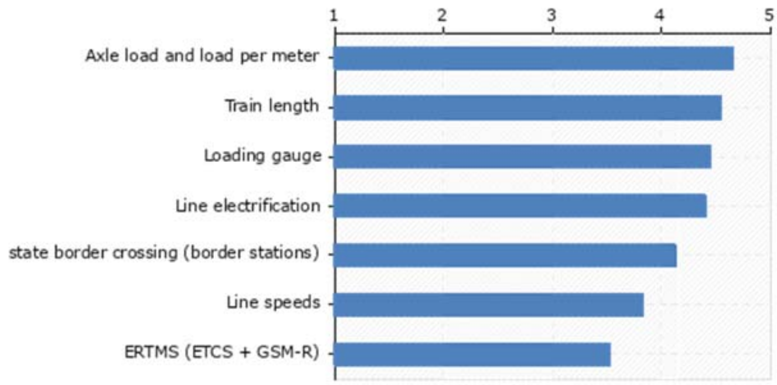


Comment: 35% of rail carriers predict the future annual growth of the transport between 1 – 2%.

5) Future types of cargo (more options).



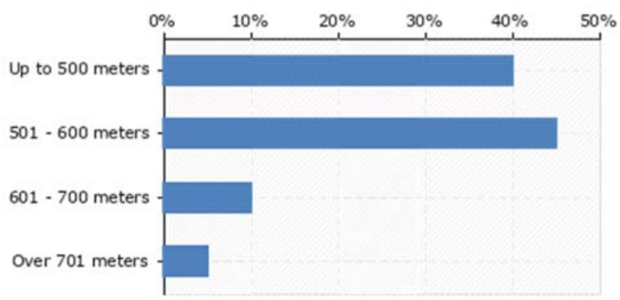
6) **Classification of rail infrastructure parameters** (1-not important, 2-less important, 3-important, 4-fairly important, 5-very important).



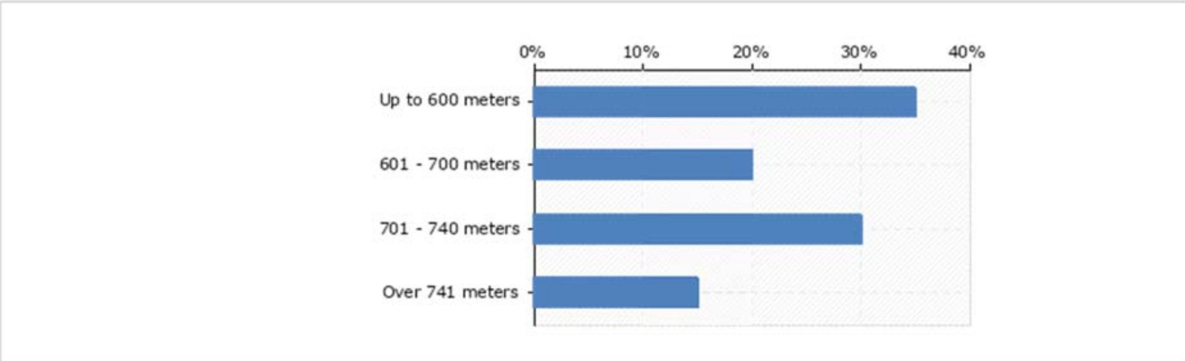
	1-less important	2	3-important	4	5-very important	Average
Axle load and load per metre	/	5%	5%	10%	80%	4,7
Train length	/	/	10%	25%	65%	4,6
Line electrification	/	5%	5%	35%	55%	4,4
Loading gauge	/	/	8%	39%	53%	4,4
State border crossing	/	8%	23%	20%	50%	4,1
Line speeds	/	3%	43%	25%	30%	3,8
ERTMS (ETCS + GSM-R)	11%	8%	25%	28%	28%	3,5

Comment: With regard to rail freight carriers, the following parameters are very important (over 50%): axle load and load per metre (80%), train length (65%), line electrification (55%) and loading gauge (53%).

7) **Current (today) maximum train length.**

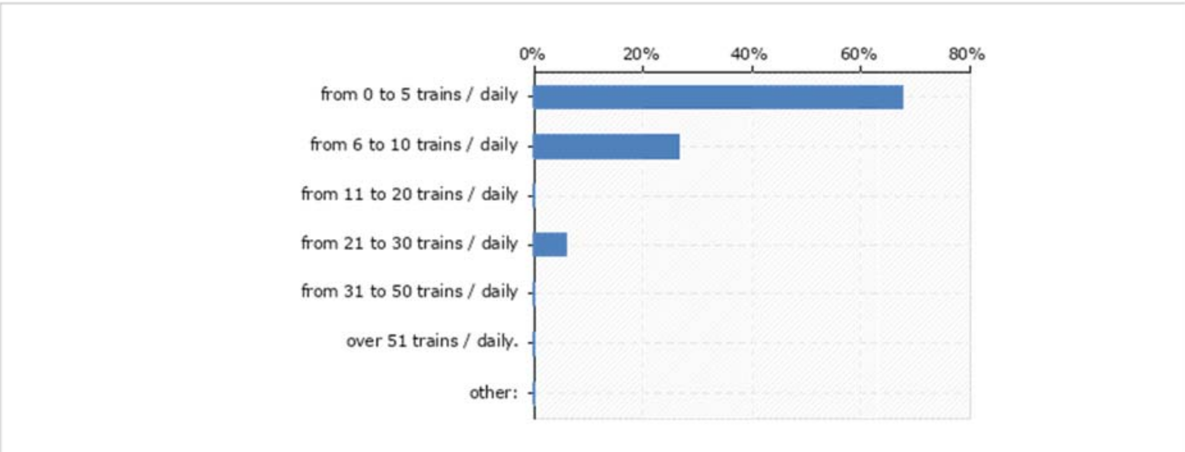


8) Future demand for maximum train length.

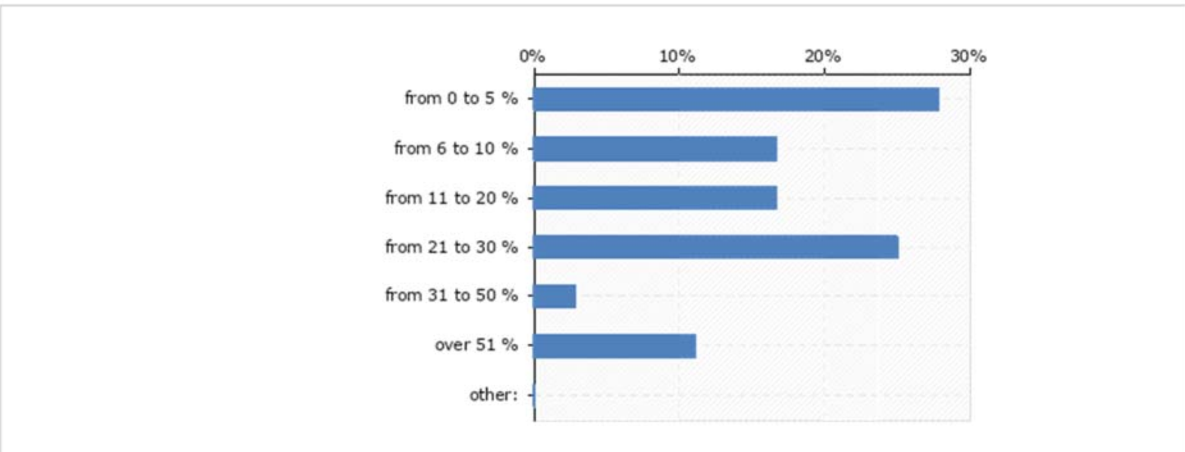


Comment: 35% of rail carriers have a future demand for train length up to 600 m and 65% of carriers for over 600 m.

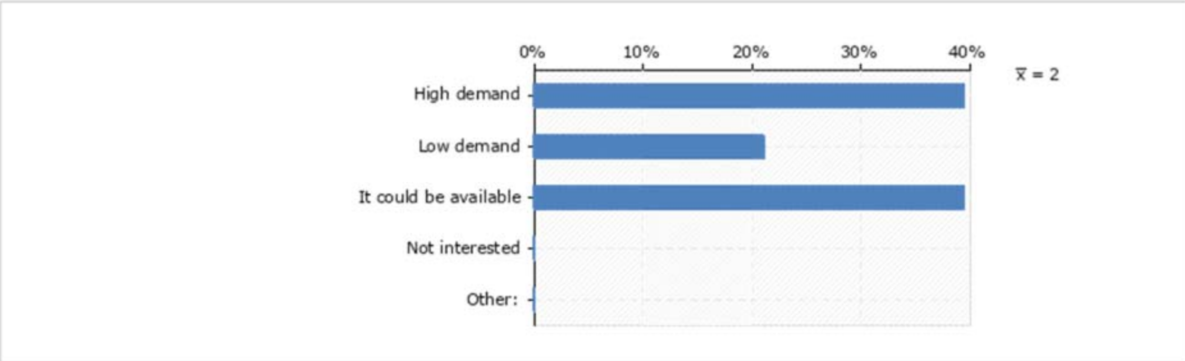
9) Estimated daily needs in the future for 740 m trains.



10) Estimated future share of 740 m trains.

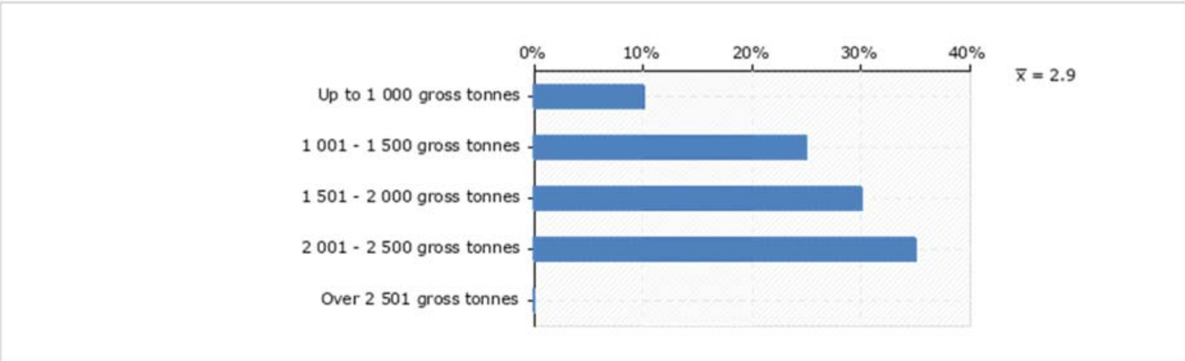


11) Future demand for line loading gauge P/C 70/400 for intermodal transport.

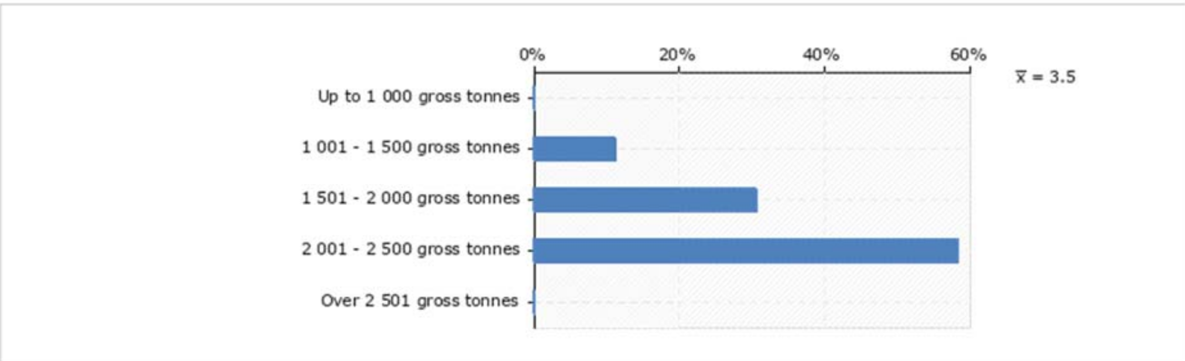


Comment: 39% of rail carriers expressed future demand for loading gauge P/C 70/400. Another 39% of carriers indicated possibilities in terms of "It could be available".

12) Current (today) maximum weight of freight trains.

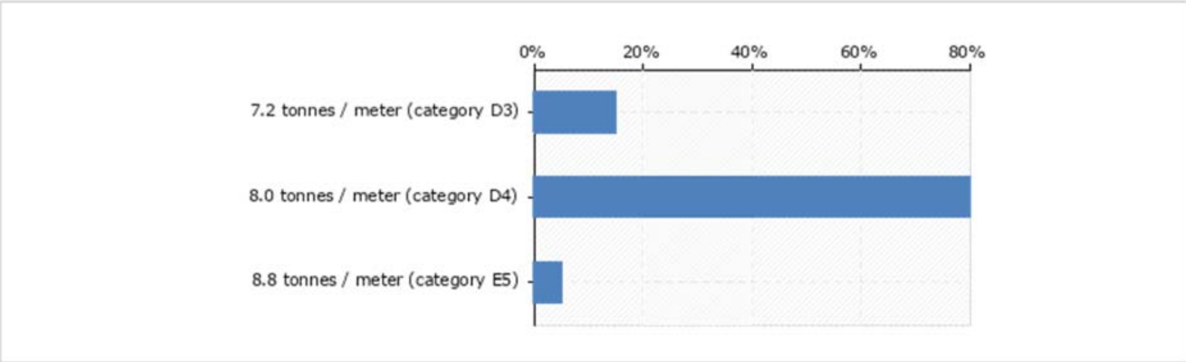


13) Future demand for maximum weight of freight trains.



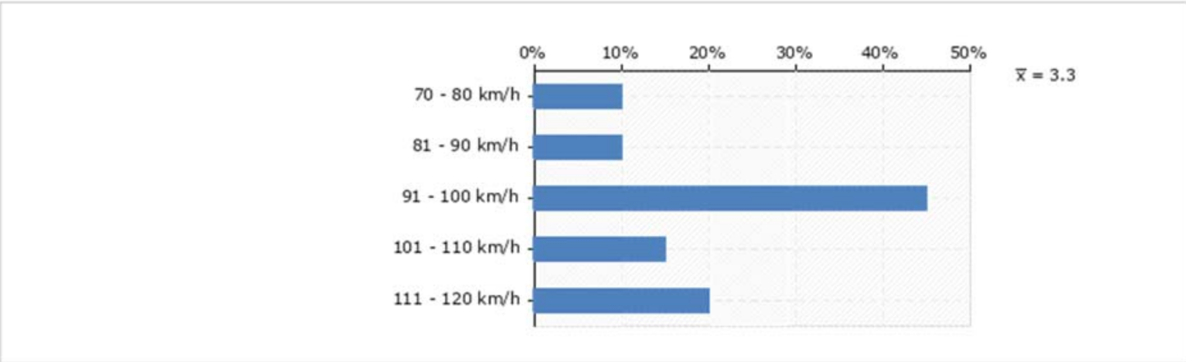
Comment: 58% of rail carriers expressed future demand for train gross mass between 2.001 – 2.500 tonnes.

14) Future demand for axle load per metre.



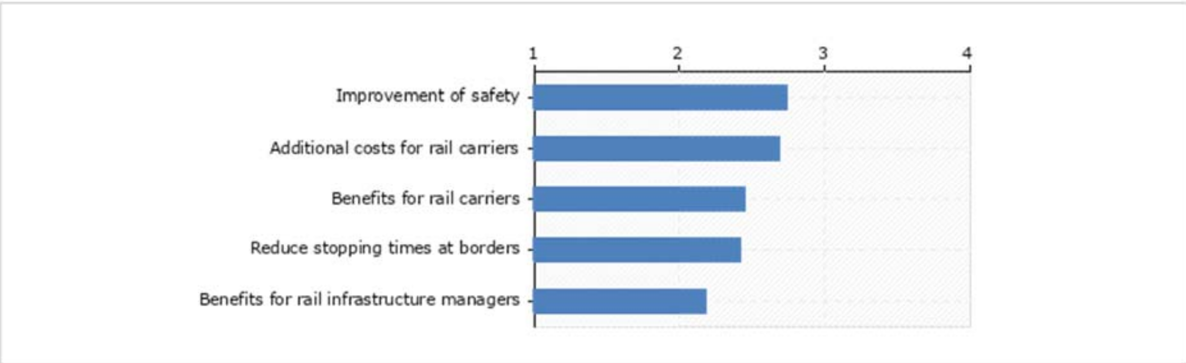
Comment: 80% of rail carriers expressed future demand for axle load per metre of 8,0 tonnes/metre.

15) Future demand for line speeds (km/h).



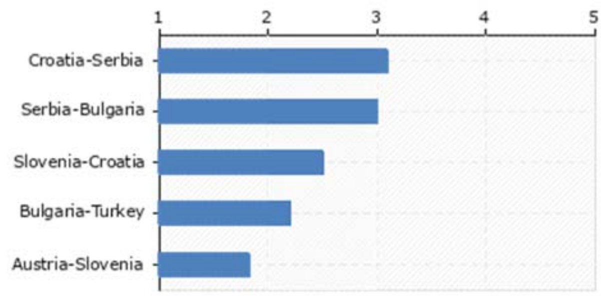
Comment: 45% of rail carriers expressed future demand for line speeds between 91-100 km/h.

16) View of the interoperability (ETCS and GSM-R) in rail transport (1-disagree, 4 fully agree).



	1-disagree	2	3	4-fully agree	Average
Additional costs for rail carriers	5%	5%	47%	42%	2,7
Improvement of safety	/	5%	55%	39%	2,7
Reduce stopping times at borders	11%	14%	36%	39%	2,4
Benefits for rail carriers	/	18%	50%	32%	2,4
Benefits for RIMs	/	24%	55%	21%	2,2

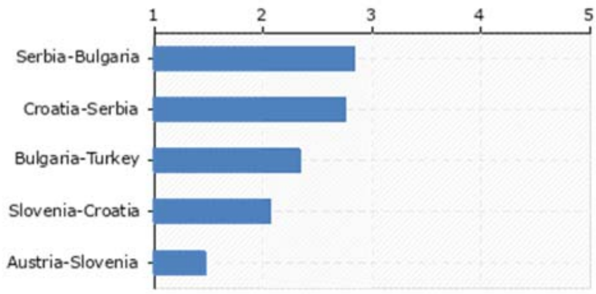
17) **Classification of the state border crossing times on AWB RFC** (0-do not cross, 1-short stopping time, 2-acceptable, 3-long, 4-very long stopping time).



	0-do not cross	1-short	2-acceptable	3-long	4-very long	Average
Austria-Slovenia	46%	25%	29%	/	/	1,8
Bulgaria-Turkey	60%	7%	/	20%	13%	2,2
Slovenia-Croatia	30%	23%	27%	7%	13%	2,5
Serbia-Bulgaria	33%	/	17%	33%	17%	3,0
Croatia-Serbia	28%	/	25%	28%	19%	3,1

Comment: The shortest acceptable stopping times at borders are between Austria-Slovenia and Slovenia-Croatia. Long and very long stopping times are between Serbia-Bulgaria and Croatia-Serbia. Many rail carriers do not cross all borders along the AWB RFC.

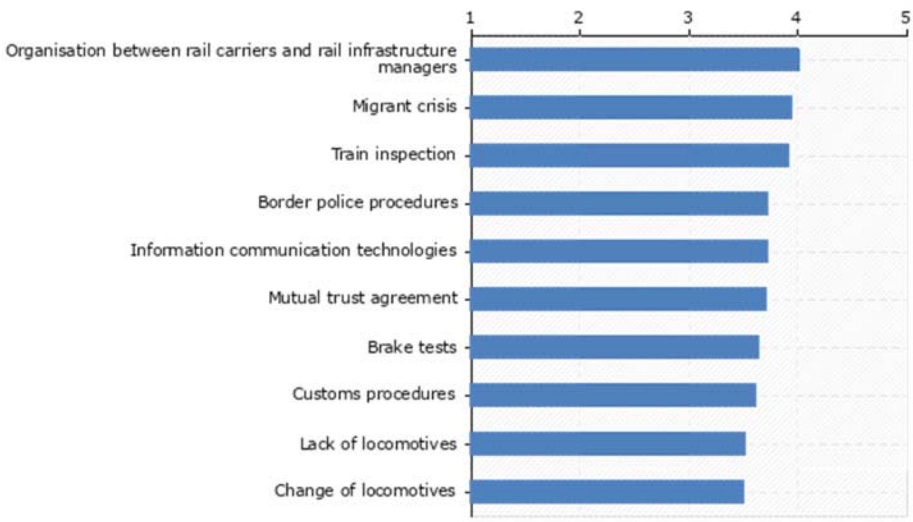
18) **Estimated average cross-border stopping time** (do not cross, up to 2 hours, between 2-4 hours, between 4-8 hours, over 8 hours).



	do not cross	up to 2 hours	between 2-4 hours	between 4-8 hours	over 8 hours	Average
Austria-Slovenia	54%	46%	/	/	/	1,5
Slovenia-Croatia	30%	40%	23%	7%	/	2,1
Bulgaria-Turkey	60%	/	7%	13%	20%	2,3
Croatia-Serbia	31%	13%	19%	25%	13%	2,8
Serbia-Bulgaria	39%	/	22%	17%	22%	2,8

Comment: The shortest cross-border stopping time (up to 2 hours) is between Austria-Slovenia (46%) and Slovenia-Croatia (40%). Over 8 hours stopping times are at the cross-border sections Bulgaria-Turkey, Serbia-Bulgaria and Croatia-Serbia. Many rail carriers do not cross all borders along the AWB RFC.

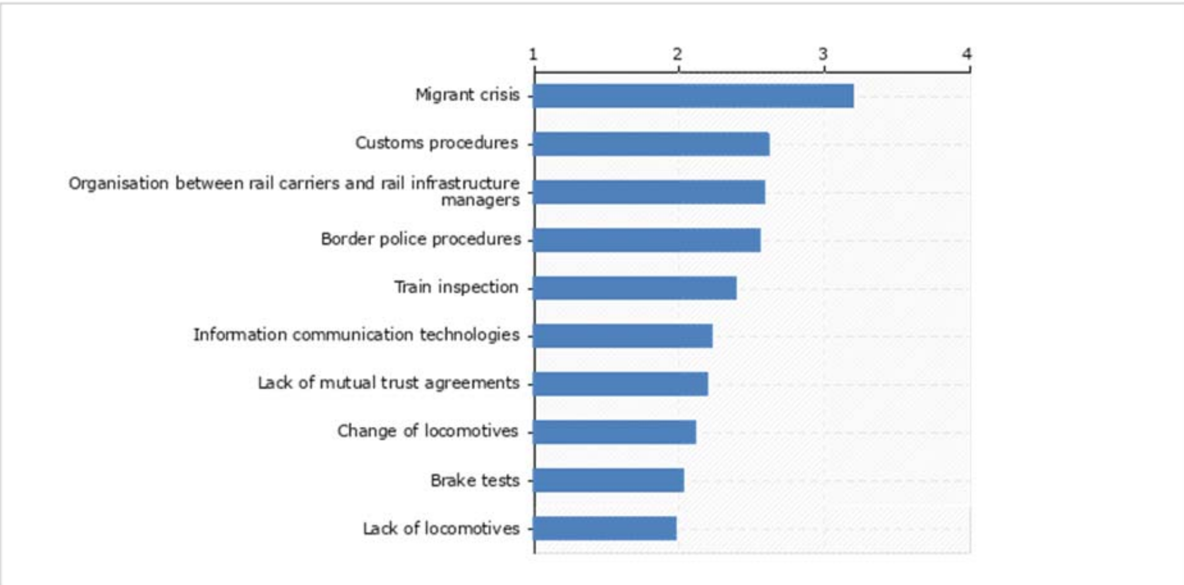
19) **Classification of the border-crossing procedures with regard to the stopping time** (1-not important, 2-less, 3-important, 4-fairly, 5-very important).



	1-not important	2	3	4	5-very important	Average
Organisation between rail carriers and RIMs	/	/	33%	33%	33%	4,0
Migrant crisis	/	6%	31%	28%	36%	3,9
Train inspection	/	/	31%	47%	22%	3,9
Border police procedures	/	22%	25%	11%	42%	3,7
Information communication technologies	/	6%	33%	44%	17%	3,7
Mutual trust agreement	/	/	41%	47%	12%	3,7
Customs procedures	/	6%	47%	28%	19%	3,6
Brake tests	/	11%	36%	31%	22%	3,6
Change of locomotives	/	6%	56%	22%	17%	3,5
Lack of locomotives	/	11%	43%	29%	17%	3,5

Comment: Regarding the average value, all border crossing procedures are classified between 3.5 (important) and 4.0 (fairly important).

20) Procedures and delays in rail transport (0-no delays, 1-low delays, 2-medium delays, 3-high delays).



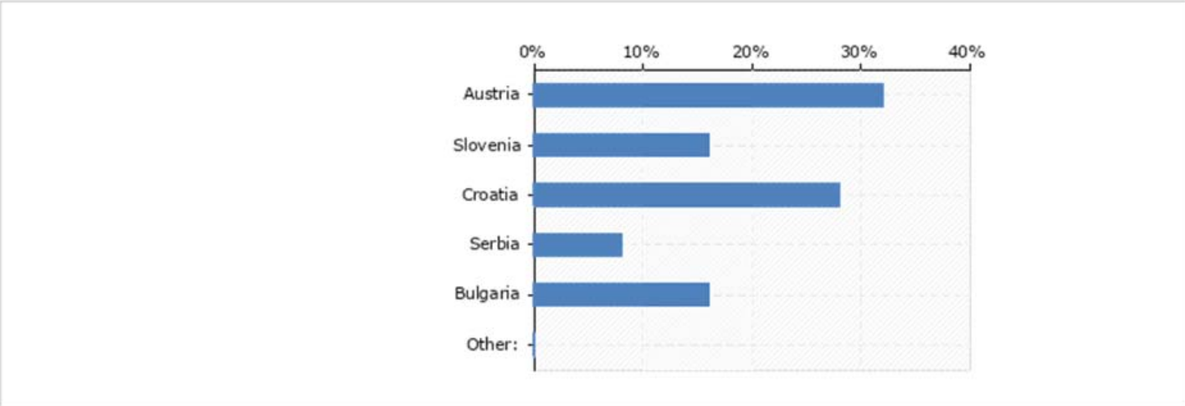
	0-no delays	1	2	3-high delays	Average
Migrant crisis	6%	17%	31%	47%	3,2
Border police procedures	11%	42%	28%	19%	2,6
Customs procedures	17%	25%	39%	19%	2,6
Organisation between rail carriers and RIMs	17%	25%	42%	17%	2,6
Train inspection	11%	44%	39%	6%	2,4
Information communication technologies	28%	33%	28%	11%	2,2
Lack of mutual trust agreements	28%	31%	36%	6%	2,2
Change of locomotives	28%	39%	28%	6%	2,1
Lack of locomotives	39%	31%	25%	6%	2,0
Brake tests	28%	42%	31%	/	2,0

Comment: The greatest delays in railway freight transport occur due to the migrant crisis. After that follows border police procedures, customs procedures and organisation between rail carriers and RIMs.

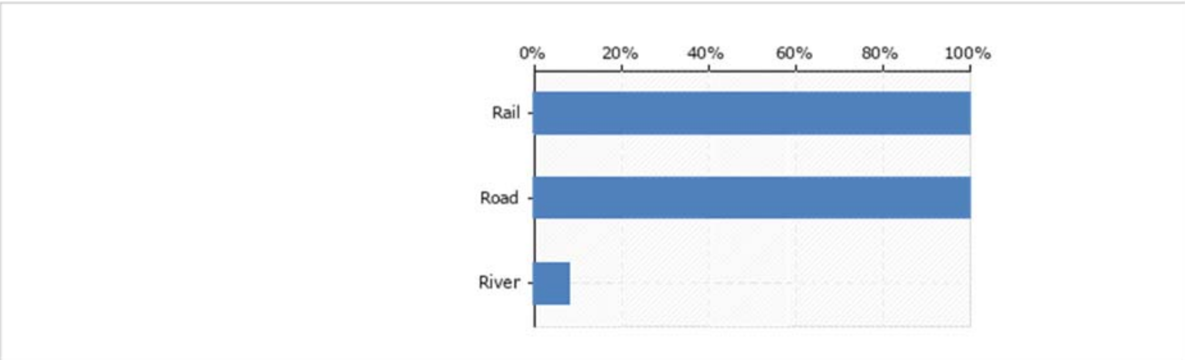
10.2 TERMINAL OPERATORS

Along the AWB RFC there are five member states with 21 intermodal terminals. Two of them (Spačva and Dragoman) have had no trains for the last few years. The anonymous survey with 18 questions was sent to terminal operators in April 2020, and 62% responded.

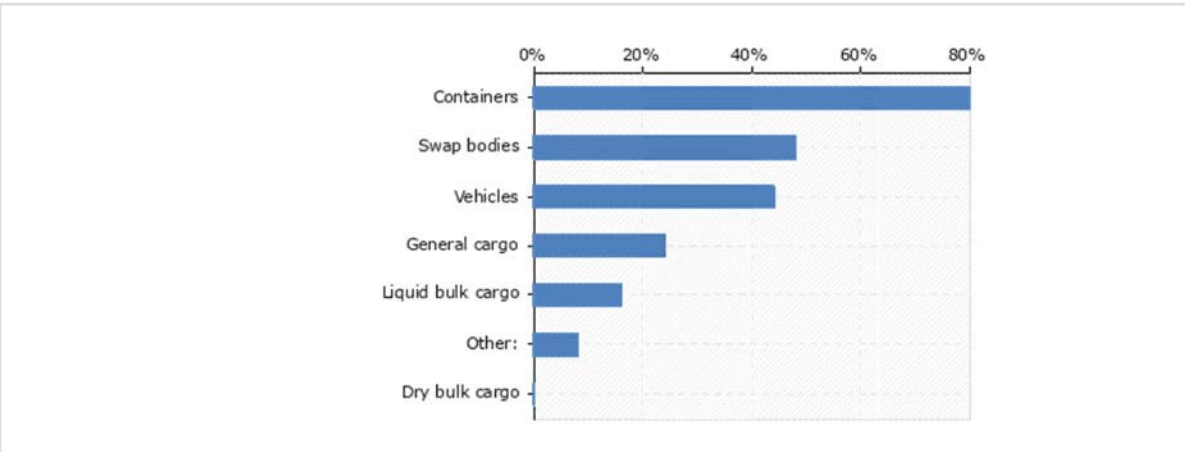
1) **The states in which the terminals are located.**



2) **Modes of transport** (more options).

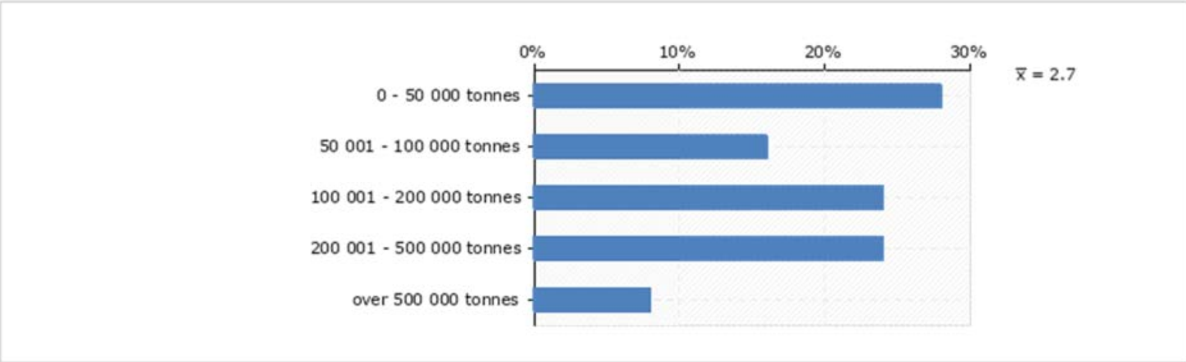


3) **Transhipment types of cargo** (more options).

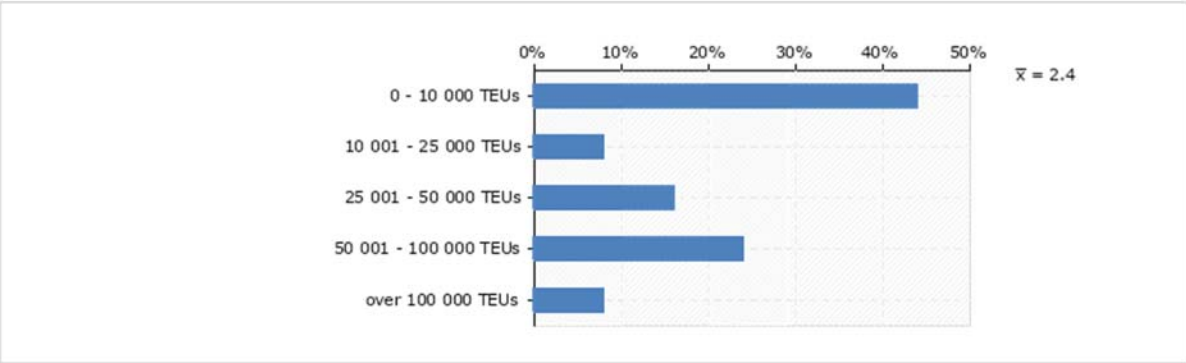


Other: semi-trailers

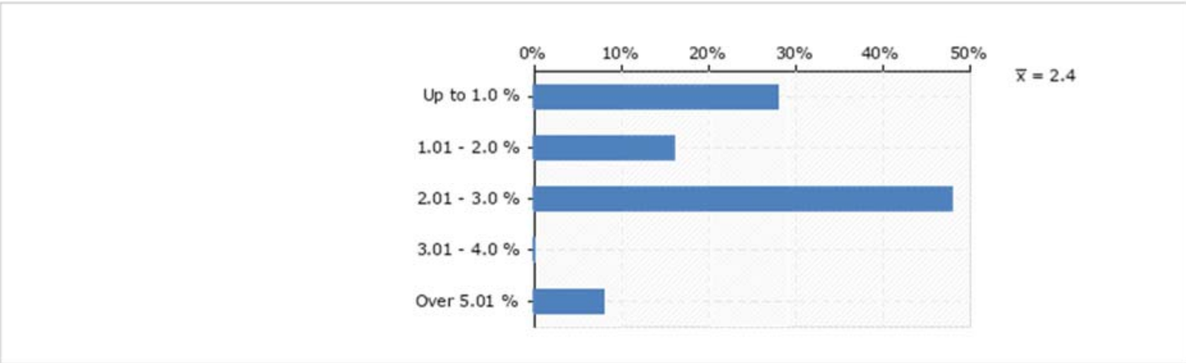
4) Estimated annual throughput (tonnes).



5) Estimated annual number of containers, swap bodies and semi-trailers (TEUs).

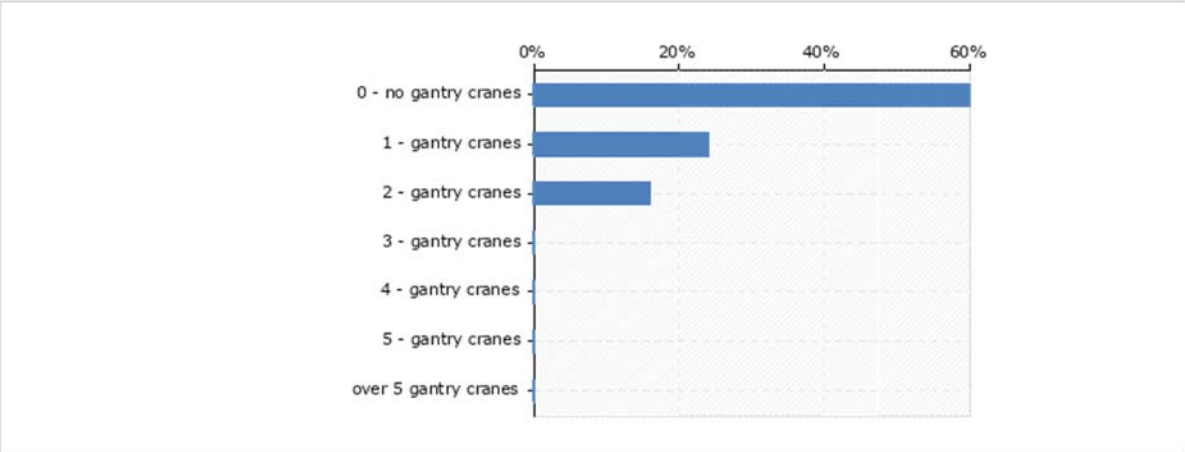


6) Estimated future annual growth of volume/services.

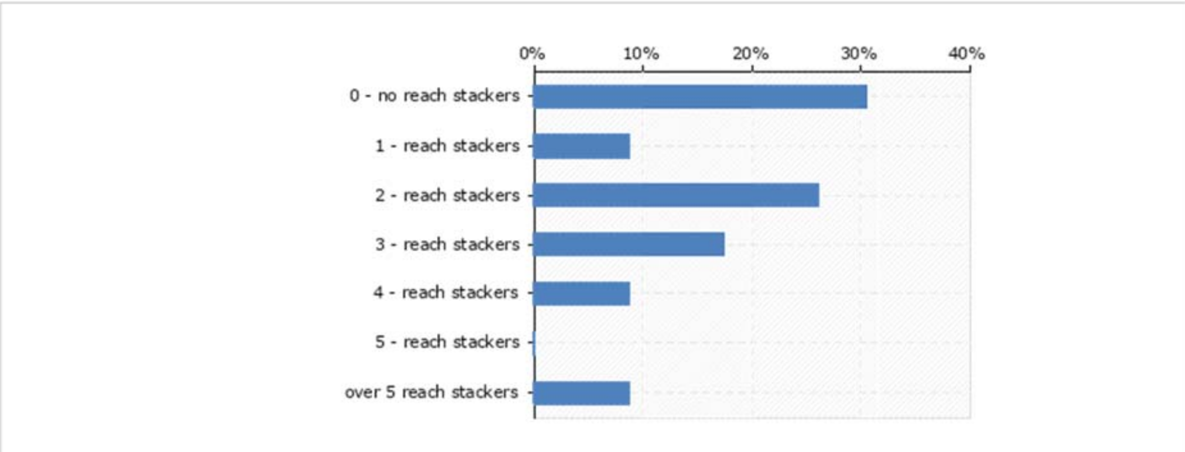


Comment: 48% of terminals predict the future annual growth of transport of between 2 – 3%.

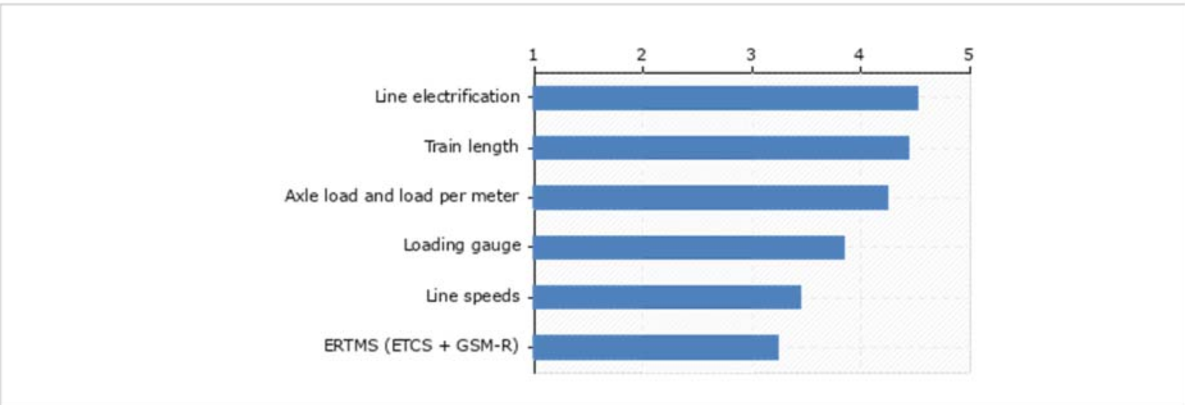
7) The amount of container transhipment machinery - gantry cranes.



8) The amount of container transhipment machinery - reach stackers.



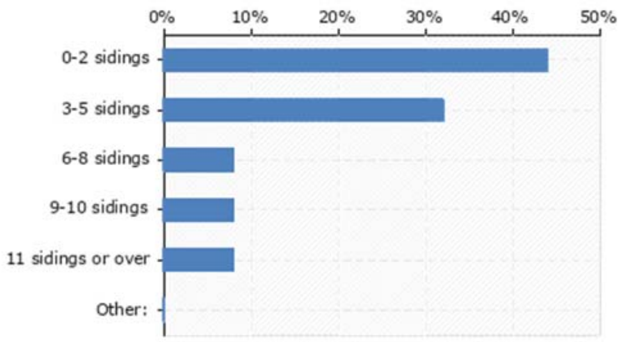
9) Classification of rail infrastructure parameters by importance (1-the least important, 5-the most important).



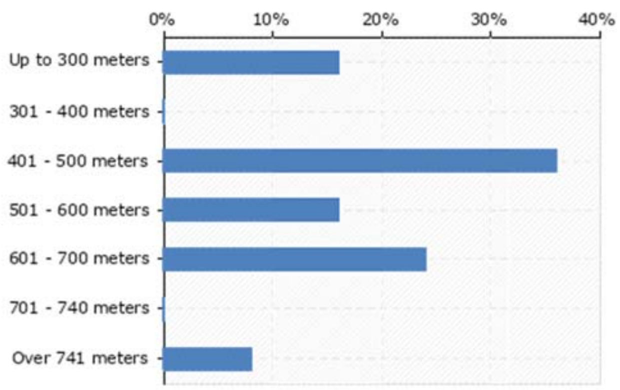
	1- least important	2	3-medium important	4	5-most important	Average
Line electrification	/	/	16%	16%	68%	4,5
Train length	/	/	16%	24%	60%	4,4
Axle load, load per metre	/	/	24%	28%	48%	4,2
Loading gauge	/	8%	24%	44%	24%	3,8
Line speeds	/	28%	32%	8%	32%	3,4
ERTMS	8%	8%	52%	16%	16%	3,2

Comment: The most important infrastructure parameters (over 50%) are line electrification (68%) and train length (60%), followed by axle load and load per metre with 48%. The ERTMS is medium important (52%).

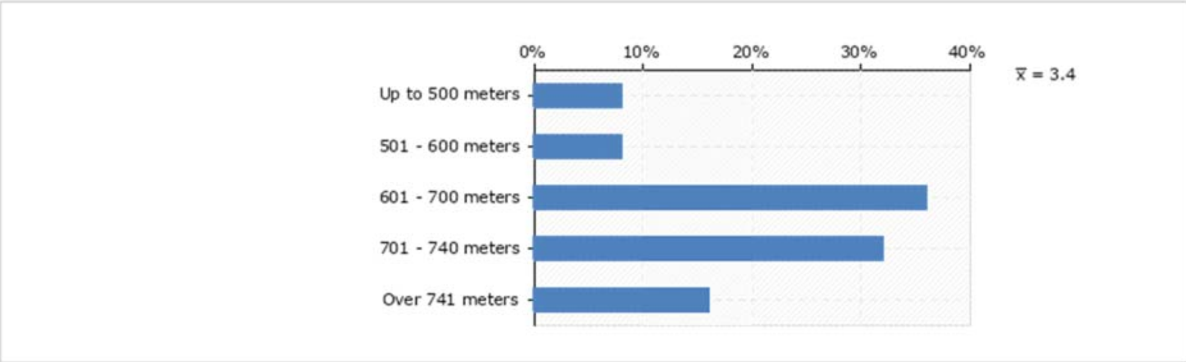
10) Number of sidings (rail tracks) in terminals.



11) Current (today) maximum available train length in terminals.

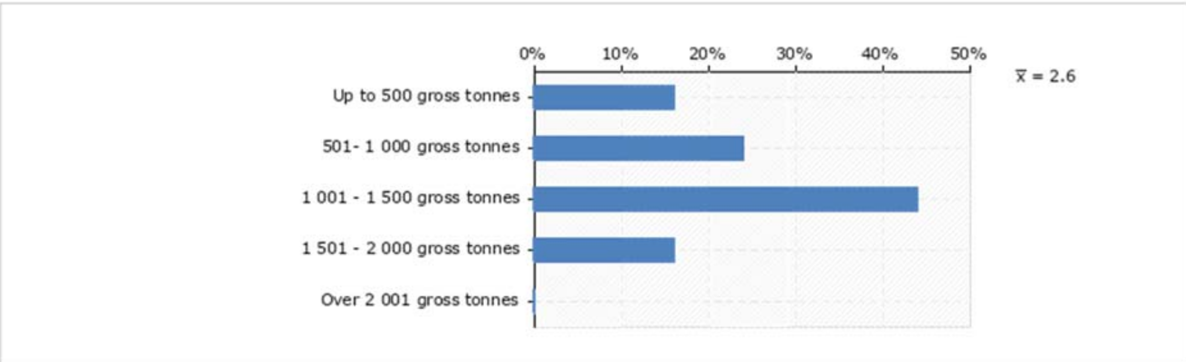


12) Future demand for maximum train length.

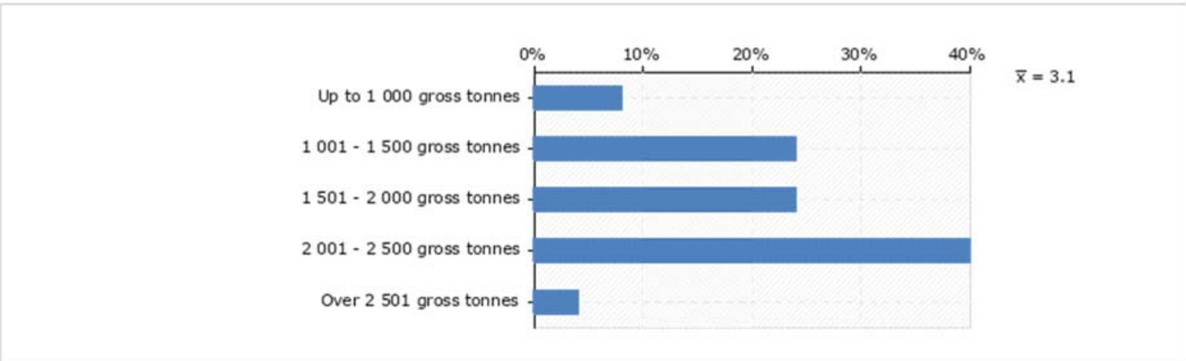


Comment: Future demand for maximum train length in terminals is mainly in two categories, 601-700 m with 36% and 701-740 m with 32%.

13) Current (today) maximum weight of freight trains.

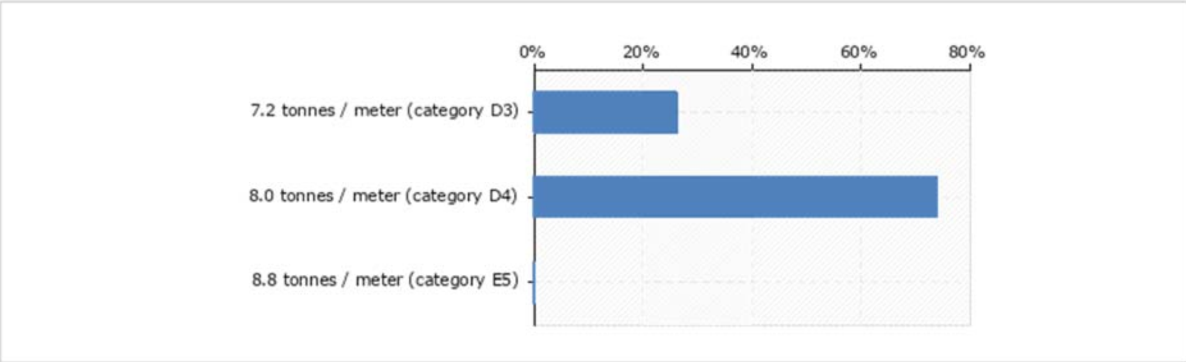


14) Future demand for maximum weight of freight trains.



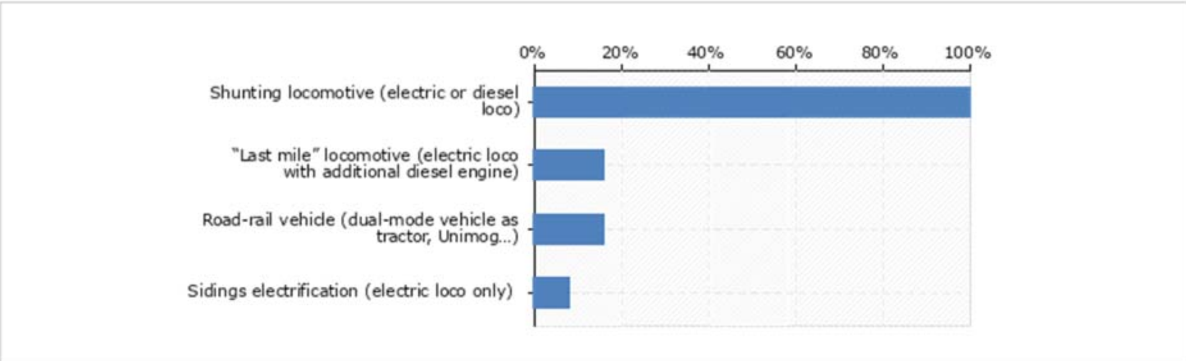
Comment: 40% of terminals have future demand for maximum weight of freight trains in a range between 2.001 – 2.500 gross tonnes.

15) Future demand for axle load per metre.



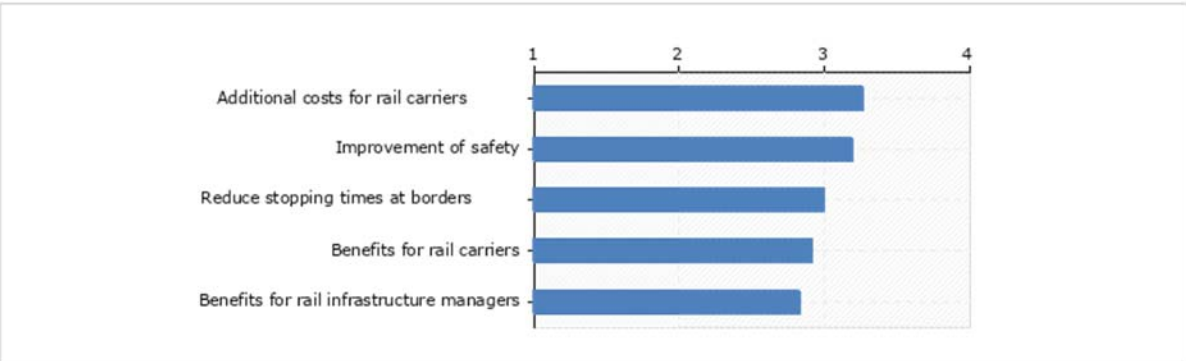
Comment: 74% of terminals have a future demand for axle load per metre of 8,0 tonnes/metre

16) Types of shunting movements at terminal (more options).



Comment: all terminals have their own shunting (diesel) locomotive.

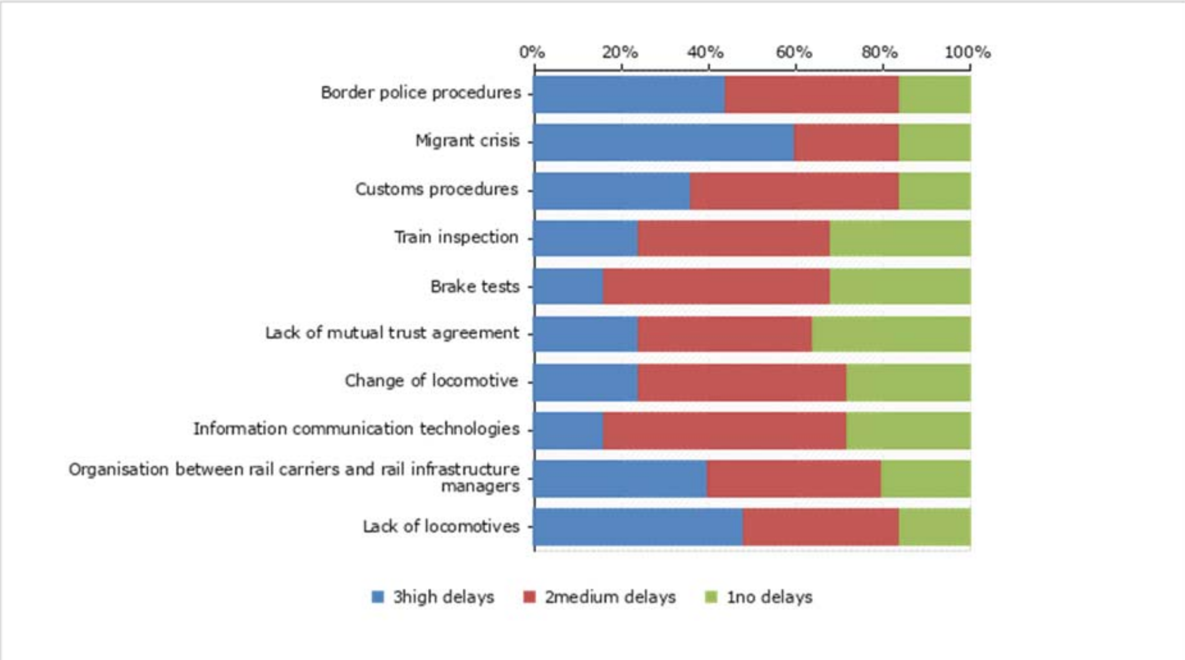
17) View of the interoperability (ETCS and GSM-R) in rail transport (1-disagree, 4-fully agree).



	1-disagree	2	3	4-fully agree	Average
Additional costs for rail carriers	9%	9%	30%	52%	3,3
Improvement of safety	/	19%	43%	38%	3,2
Reduce stopping times at borders	9%	17%	39%	35%	3,0
Benefits for rail carriers	/	35%	39%	26%	2,9
Benefits for RIMs	/	43%	30%	26%	2,8

Comment: 52% of terminals fully agree that ERTMS is an additional cost for rail carriers.

18) Procedures and delays in rail transport (1-no delays, 2-medium delays, 3-high delays).



	No delays	Medium delays	High delays
Border police procedures	16%	40%	44%
Migrant crisis	16%	24%	60%
Customs procedures	16%	48%	36%
Train inspection	32%	44%	24%
Brake tests	32%	52%	16%
Lack of mutual trust agreement	36%	40%	24%
Change of locomotive	28%	48%	24%
Information communication technologies	28%	56%	16%
Organisation between rail carriers and rail infrastructure managers	20%	40%	40%
Lack of locomotives	16%	36%	48%

Comment: according to the terminal survey, the greatest delays are due to the migrant crisis (60%) and lack of locomotives (48%).