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Riga Node Operation Optimisation Study

Final Report

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List of abbreviations

Abbreviation	Explanation
ALSN	Continuous automatic train signalling (Автоматическая Локомотивная Сигнализация Непрерывного действия)
ATD	Autotransporta Direkcija
CBA	Cost-Benefit-Analysis
CBI	Computer based interlocking
CTC	Centralized Traffic Control
CEF	Connecting Europe Facility
CIS	Commonwealth of Independent States
CSM	Common safety method
CPTD	Consolidated Preliminary Technical Design
DTD	Detailed Technical Design
EE	Estonia
EU	European Union
EV	Riga suburban passenger train (1520 mm)
FBS	Fahrplan Bearbeitungs System (timetabling software)
HST	High Speed Train
LDz	Latvijas dzelzceļš
LT	Lithuania
LV	Latvia
MD	Master Design
OCL	Overhead Catenary Line
OSShD	Organization for Cooperation of Railways
PL	Poland
PRM	Persons with Reduced Mobility
PV	Pasažieru vilciens – passenger train operator in Latvia
RB	Rail Baltica
RE	Regional Express
RIX	Riga airport
RV	Regional passenger train (1520 mm)
TP	Time Period
TSI	Technical Specification of Interoperability
TV	International fast train (1520 mm) – extension of existing national services
WG	Working group
WP	Work package

1. Introduction

1.1. Purpose and scope of this report

This report is to provide the final results of the Riga node operation optimisation study.

The key objective of this study is to prepare a detailed operational study for Riga railway node study core area, which does include the line sections parallel to rail Baltica (Šķirotava – Riga Central, Riga Central – Torņakalns – Zasulauks – Imanta) as well as the related branches inside Riga city area (Riga – Zemitāni, Zasulauks – Bolderaja - Daugavgrīva) for both railway gauges 1435 and 1520 mm. The corresponding planning time horizon is focused on short (2026), medium (2036) and long term (2046) and does also include 1520 mm infrastructure reconstruction in line with implementation of 1435 mm Rail Baltica (time period 2021 – 2026).

The initial work performed includes screening of available documents, providing additional research regarding network and traffic framework conditions from publicly available sources and stakeholder perspective. The results of this task are provided in chapters 2 and 3. The corresponding analysis of requirements and framework conditions is mainly focused on the current situation and the first ten years after proposed implementation of Rail Baltica. Additionally, an outlook on further development until 2046 is provided based on collected information and own views of the consultant based on international best practise.

On the grounds of the elaborated requirements and framework conditions the master timetable 2026/36 is developed. This will be the basis for assessment of proposed infrastructure and elaboration of potential infrastructure improvements. The features of the master timetable are described in chapter 5 together with the identified infrastructure improvement potential. Finally, the recommendations for proposed track layout upgrades in the railway core area are outlined in chapter 6. This work is based on the already existing plans for infrastructural changes required to implement Rail Baltica.

In chapter 7 the existing and planned maintenance and layover facilities in and around the city of Riga are analysed. Target is to identify the most suitable sites to cope with future maintenance and layover needs and to interlink existing and proposed passenger services.

Recommended changes to the infrastructure in the Latvian national 1520 mm network outside Riga node are elaborated in chapter 8 focusing on a long-term perspective to increase travel speeds of regional cross-country services to allow faster and more convenient travel on the longer cross-country distances.

The study also includes a complete check of possible train services during the individual construction phases of Riga Central station, which will be reconstructed starting in 2021 in stages. Construction works in adjacent line sections to implement Rail Baltica and to update existing infrastructure in the railway core area are. The results of this exercise are documented in chapter 9. This does include further development of already established service principles for passenger services and an estimate of considered freight train paths for the Latvian 1520 mm network.

1.2. Background of the study

Current and future situation on the 1520 mm network

The current structure of the existing rail network is the result of historical developments. Since the reinstating of Latvian independence in 1991 the structure of the core network, which was optimised to cater for the requirements of local suburban passenger transport around Riga and to provide long distance passenger and cargo transport links to the former Soviet Union, has not changed. However, due to a low demand, changing traffic flows and a bad condition of infrastructure closure of some of the branch lines, e.g. the (Riga-) Skulte – Rūjiena (-Pärnu) railway line or the Āraiši – Gulbene railway line left some of the more rural areas without rail connection. The cargo transport between CIS and Latvian ports continued to have the biggest share in overall freight volumes. With decline of the economy the network size was reduced by closure of several branch lines. However, the railway infrastructure was upgraded by modernizing signalling and communication infrastructure as well as track infrastructure to allow for a maximum speed of 120 km/h for passenger and 80 km/h for freight services. As a result of the current network and service structure regional and national passenger transport outside Riga suburban area is provided by bus services, leaving only a small market share to the railway. Despite this overall trend and the lower service frequencies compared to Central European standards rail still has a significant share in the public transport market on connections between major cities like Riga - Daugavpils and Riga - Rēzekne. As a result, from political processes after the independence of the Baltic states cross-border railway passenger traffic was reduced while bus services and air traffic increased since railway passenger traffic was not the development priority.

The current strategy is to establish the 1520 mm rail network as backbone of the national public transport infrastructure. To achieve this goal substantial passenger service improvements are proposed. A first step in service improvement will be the inauguration of a fixed interval timetable for Riga suburban services and the introduction of new rolling stock. To achieve this 32 new electrical multiple units have been ordered from Škoda. These new EMU's shall enter service in 2022/23 phasing out existing electrical multiple units, which were put into service beginning in 1966 and have reached the end of their economical service lifetime. Following this it is envisaged to improve regional and national passenger train services. This is also complemented by the introduction of new rolling stock (electric and bimodal trains or diesel trains).

To provide the required infrastructure for maintenance of rolling stock a new rolling stock maintenance facility has to be constructed in Riga area. Construction must commence as soon as possible to ensure that the new trains can be operated and maintained efficiently.

Current status of Rail Baltica implementation

Rail Baltica is a joint project of three EU Member States – Estonia, Latvia and Lithuania – and concerns the building of a fast-conventional double track 1435 mm gauge electrified railway line on the route from Tallinn via Pärnu (EE), Riga (LV), Riga International Airport (LV), Panevėžys (LT), Kaunas (LT) to the Lithuania/Poland state border (including the connection Kaunas - Vilnius). In the longer term, the railway line could potentially be extended to include a fixed link between Helsinki and Tallinn, as well as integrate the railway link to Warsaw and beyond.

The expected core outcome of the Rail Baltica project is a European gauge (1435 mm) double-track railway line of about 870 km in length and the required additional infrastructure (to ensure full operability of the railway); all of this is meant for both – passenger and freight transport. It will be interoperable with the TEN-T Network in the rest of Europe and competitive with other modes of transport in the region. According to current agreements between the member states involved and the EU, the line shall be fully operational until 2026. The delivery of the railway follows a three-phase model consisting of the planning phase, the design phase and the construction phase. The current status of planning, design and construction works in the core area is described in the following sections.

Planning Phase

During the **planning phase** operational and technical requirements are gathered and the routing of the railway is defined as a basis for related land procurement activities. The result of this phase will be the preliminary design.

Regarding Rail Baltica infrastructure in Latvia the draft alignment of the railway is settled, and spatial planning is completed, the preliminary design is completed and reviewed, the operational requirements for 1435 mm infrastructure are outlined in the RB operational plan. The proposed alignment of Rail Baltica in Latvia is indicated in Figure 1 (status – preliminary design).

Design Phase

During the **design phase** the detailed technical design of all railway facilities will be worked out. Design activities for railway core area include

- design of a new 1435 mm infrastructure and
- related relocation of existing 1520 mm as precondition for implementation of Rail Baltica.

Design works for 1435 mm and 1520 mm infrastructure in Riga Central station are carried out by BERERIX. Design works of adjacent line sections in the railway core area are carried out by IDOM. The detailed technical design (DTD) contract for these line sections includes the elaboration of 3 alternatives (Preliminary design, Consolidated Preliminary Technical Design (CPTD), Designer Proposal). After approval of one alternative provided by the designer, the designer proceeds with the Master Design (MD) and building permits and then later with the detailed technical design (DTD).

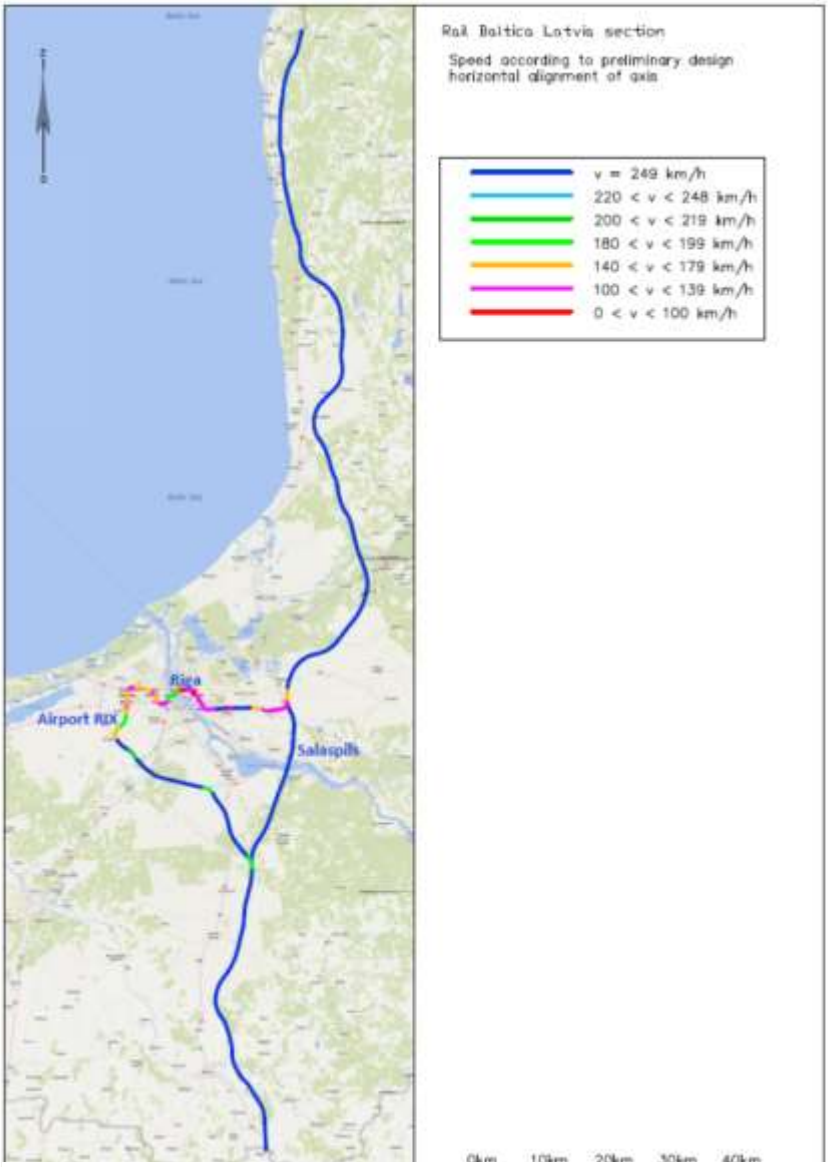


FIGURE 1: Proposed Rail Baltica alignment and maximum speeds in Latvia as per preliminary design

For Riga Central station BERERIX plans to approve MD for the 1st construction phase of Riga Central station (phasing of construction is described in chapter **Error! Reference source not found.**) by the end of March/beginning of April 2 020. This leaves little time to provide input for the assessment of the 1520 mm track layout, which should consider target stage and intermediate stages to ensure upwards compatibility of the layout and the stability and the quality of the operation during the different stages of the construction phase (2021-2026) as outlined in chapter 4.2.

Construction Phase

The subsequent **construction phase** will be dedicated to the implementation of the Rail Baltica infrastructure and related changes on other facilities affected by a Rail Baltica implementation. In Latvia construction will start with the reconstruction of Riga Central station and construction of Riga airport station. The construction of Riga Central station and the Daugava River bridge was awarded to the BERERIX consortium as a design and built contract. Procurement of RIX station construction is started with the first work to be undertaken in 2020[1]. The proposed staging for construction of Riga Central station is outlined in section **Error! Reference source not found.**. Assumptions regarding p hasing of construction works in the railway core area will be considered in this study, but still need to be clarified with RB Rail based on the current planning stage, before final recommendations are made.

Resulting from the proposed implementation timeline all phases are partly overlapping with the intention to speed up the overall implementation process.

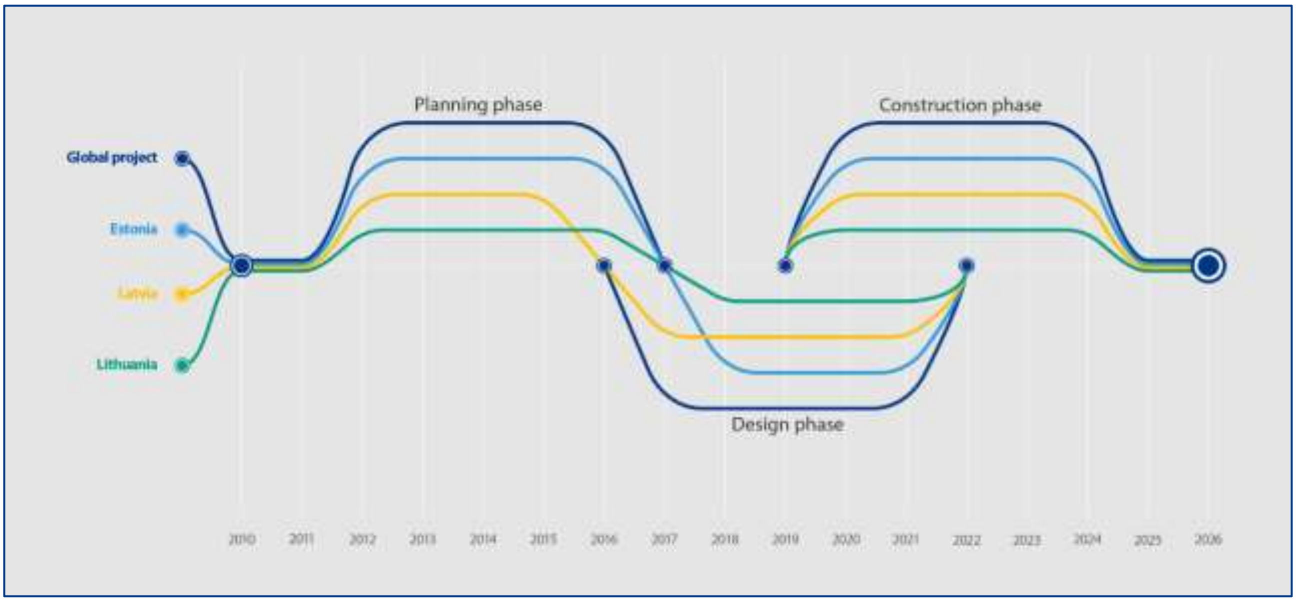


FIGURE 2: IMPLEMENTATION PHASES OF RAIL BALTICA INFRASTRUCTURE[2]

In Riga area the Rail Baltica infrastructure will consist of two railway lines:

- **Riga Loop:** The line section starting between Misa triangle and Upeslejas triangle in the north is dedicated to long distance passenger services calling at the international passenger stations Riga airport and Riga Central station. There are additional regional stations proposed in Saurieši, Acone, Slāvu tilts, Torņakalns, Imanta, Jaunmārupe, and Olaine, where the proposed Regional Express trains will stop. Further details about proposed passenger services are outlined in section 3. Between Imanta and Šķirotava the alignment runs parallel to the existing 1520 mm railway. In order to provide the required interconnectivity and to deal with

[1] Source: Ongoing construction procurement RIX station: https://www.eis.gov.lv/EKEIS/Supplier/Procurement/29274
[2] Source: RB Rail

spatial constraints the 1520 mm infrastructure in this area will be adapted, which also includes the redesign of over and underpasses, stations and the fencing on common line sections.

- **Riga Bypass:** This line section was originally dedicated to freight services, which shall avoid Riga City for technical and environmental reasons. According to the latest developments this line section shall also be used by passenger trains (regional express services Bauska – Salaspils – Riga Central station – Riga airport – Bauska) and long distance sprinter services (Tallinn – Vilnius), which shall not stop at Riga Central station and Riga airport station to provide more competitive travel times between Tallinn and Vilnius during the morning and the evening peak.

With the implementation of Rail Baltica, Riga Central station has to be reconstructed as multimodal transport hub facilitating the needs of the 1520 mm and the 1435 mm railway. Related activities include the integration of Rail Baltica with a minimum of four platform tracks and an upgrade of existing 1520 mm tracks and platforms. Opportunities for the development of the track layout in this central part of Riga city are limited by various spatial constraints. Thus, the complete track layout for Riga Central station has to be reworked.

1.3. Targets and scope of the study

Targets of the study are

- establishing operational requirements and the future track layout for both gauges in the core area covering Riga Central station and adjacent line sections as outlined in chapter 1.5 and
- elaborating requirements regarding the maintenance of passenger rolling stock and layover facilities for both gauges.

Therefore, a feasible and consistent plan for a staged development of the track layout for both gauges shall be developed considering a changing traffic demand and technical framework conditions in the timeframe 2026-2046. The establishment of related requirements shall be based on a synchronised timetable for both gauges to allow for an optimum interchange between both gauges to achieve a conjunct system combining the strength of both railway systems. Work will mainly be based on already existing plans and visions. Alterations may be necessary to fulfil operational goals (e.g. a highly synchronized cyclic timetable).

The focus in this study for the requirements is the establishment of future needs for the 1520 mm operation aiming at the increase of passenger traffic and taking into account specific technical constraints and operational requirements. Initially it was intended to relate them to a staged development of the proposed 25 kV AC electrification scheme. With the proposed electrification scheme for Latvian railway infrastructure on hold. Because of this this is no longer one of the main targets of the study.

Requirements and future services for Rail Baltica are mainly outlined in the RB operational plan, but need to be updated with subject to final decisions on maintenance and layover facilities, with subject to reflecting final decisions regarding a feasible track layout, and with subject to the inclusion of an updated service pattern (draft timetable, updated line concept for regional express trains, introduction of peak-hour sprinter trains Tallinn – Vilnius via Riga bypass) developed by RB Rail resulting from CPTD process and own market analysis conducted by RB Rail.

Operational requirements and the developed track layout resulting from this study will be the basis for further planning and procurement activities, which shall be started immediately after finishing the study to stick to the overall timeframe for the implementation of the infrastructure for Rail Baltica and the 1520 mm network. Given the advanced state of planning and design stage described in section 1.2 - there is already a defined track layout for all construction phases of Riga Central station and a preliminary design for the 1435 mm and 1520 mm infrastructure for the adaption of the adjacent line sections – main focus of the study in this regard will be to confirm the related needs and to provide necessary alterations to the planned track layout to ensure that future train services can be operated efficiently and at a high level of punctuality.

1.4. Forecasting horizons

The study shall cover a forecasting horizon of approx. 30 years after the inauguration of Rail Baltica to cover a suitable amortization cycle of the proposed infrastructure investments. To reflect expected changes in transport demand and the infrastructure, three specific years have been defined by the client, called Time Periods (TP), TP2026, TP2036, TP2046. In addition, the feasibility of 1520 mm services during the construction period of Riga Central Station has to be assessed (additional time period).

Based on the requirements outlined in the technical specification, the results of the kick-off meeting and the review of information provided by the stakeholders the initial assumption were set regarding traffic and infrastructure development which was summarized by the contractor as shown in Table 1.

This summary will be outlined and justified in the first interim report and finalised together with the stakeholders during successive activities. It is expected that these assumptions can be finalised after the review of the first interim report.

Feature	Gauge	Construction Period (2022-2026)	2026	2036	2046
Infrastructure	1520 mm	Reconstruction of line section Sarkandaugava – Mangaļi - Ziemeļblāzma completed Riga central station and upgrade of facilities in core area in the implementation Rolling stock maintenance depot to be completed, initial target: 2022/23	Janavarti – Imanta reconstruction completed	Changes of electrification system according to new strategy, including new line sections and upgrade to 25 kV AC (not yet fixed)	
	1435 mm	Under construction	Rail Baltica completed (all proposed sections operational)		
Long Distance Passenger Traffic	1435 mm	No 1435 mm traffic	Start of RB operation (HST and night trains from the beginning, regional traffic to follow as soon as possible)	Traffic as specified in RB Operational plan	Traffic as specified in RB Operational plan
	1520 mm	Service as in current situation (TT 2020)	Stepwise implementation of identified service improvements		
Regional Passenger Traffic	1520 mm	EV service, as far as feasible due to construction works Other services with slight increase as compared to the current situation (2020)[3]	Riga suburban and national train service	Stepwise implementation of further service improvements	
	1435 mm	No 1435 mm traffic	RB start of operation (incl. regional services)	Traffic as specified in RB Operational Plan (additional trains, same line concept)	Traffic as specified in RB Operational Plan (additional trains, same line concept)
Freight Traffic 1435 mm Freight Traffic	1520 mm	According to LDz forecast	According to LDz forecast, transfer of Riga port freight terminals to left bank of Daugava river completed		
	1435 mm	No 1435 mm traffic	No regular 1435 mm freight traffic in railway core area		

TABLE 1: TIME PERIODS AND RELATED ASSUMPTION SETS[4]

1.5. Study Area

The study areas are defined in order to allow proper investigation of relationships between passenger train services, which are the main market segment to be investigated at the required level of detail to ensure a consistent study

[3] light increase of services against the current timetable is targeted, e.g. to Sigulda and Bolderaja.
Realisation subject to technical and operational feasibility in Riga node area and provision of infrastructural measures on other line sections (e.g. platforms on the line section to Bolderaja).

[4] Source; own compilation based on results of project inception

result. The Study areas are defined as line sections (any gauge) located in concentric areas with Riga station as a centre:

- **Core area:** is defined as the quadrilateral Imanta – Torņakalns - Jāņavārti – Zemitāni with Riga Central station including potential locations of rolling stock maintenance depots. This will be the main focus of the study. Due to its location in the inner part of the city this is also the area with the most spatial constraints limiting possibilities to develop the track layout.

FIGURE 3: STUDY AREA – CORE AREA

Service areas relevant especially for 1520 mm traffic in the railway core area due to the functionality of Riga node as a central hub:

- **Riga suburban area:** currently electrified line sections up to Jelgava, Tukums, Aizkraukle, Skulte; currently non-electrified line sections up to Sigulda and Bolderāja. These lines are used by the suburban trains connecting surrounding municipalities to the city of Riga.

- **Regional area:** currently non-electrified line sections up to Daugavpils, Rēzekne, Ventspils, Liepaja, Madona-Gulbene, Valga-Tartu, Šiauliai – Klaipeda (incl. cross-border regional services).

- **International day train area** (Line sections up to Tartu, Šiauliai -Klaipeda, Kaliningrad, Minsk)

- **International night train area** (Line sections up to Minsk, Kiev, Moscow, St Petersburg)

In these areas, only principles and locations for track layout upgrades shall be defined in order to provide a consistent and future-proof train service model. To our understanding these areas are to be included mainly to ensure realistic and future-proof assumptions about future train services are made in order to study the traffic in the railway core area (demand, travel time, synchronized 1520/1435 mm train timetable) and to establish rolling stock maintenance requirements (fleet size and rolling stock types, expected fleet mileage). Furthermore, mirroring the service definition for these areas will contribute to establish market-oriented principles (line speed, travel times, service frequency) from an international best-practices perspective brought into the project by the consultant.

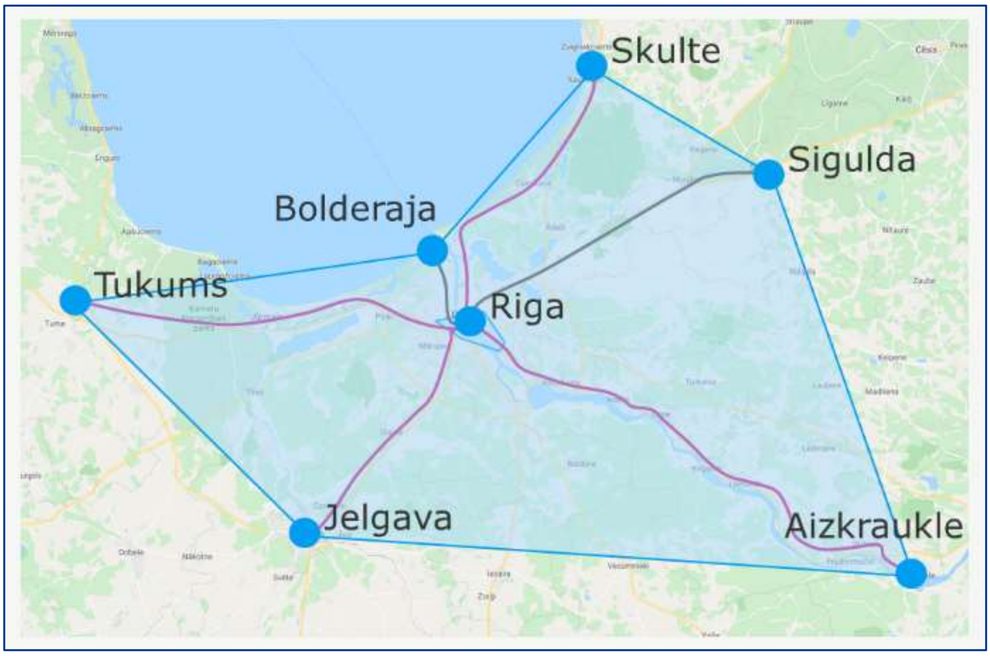


FIGURE 4: STUDY AREA – RIGA SUBURBAN AREA

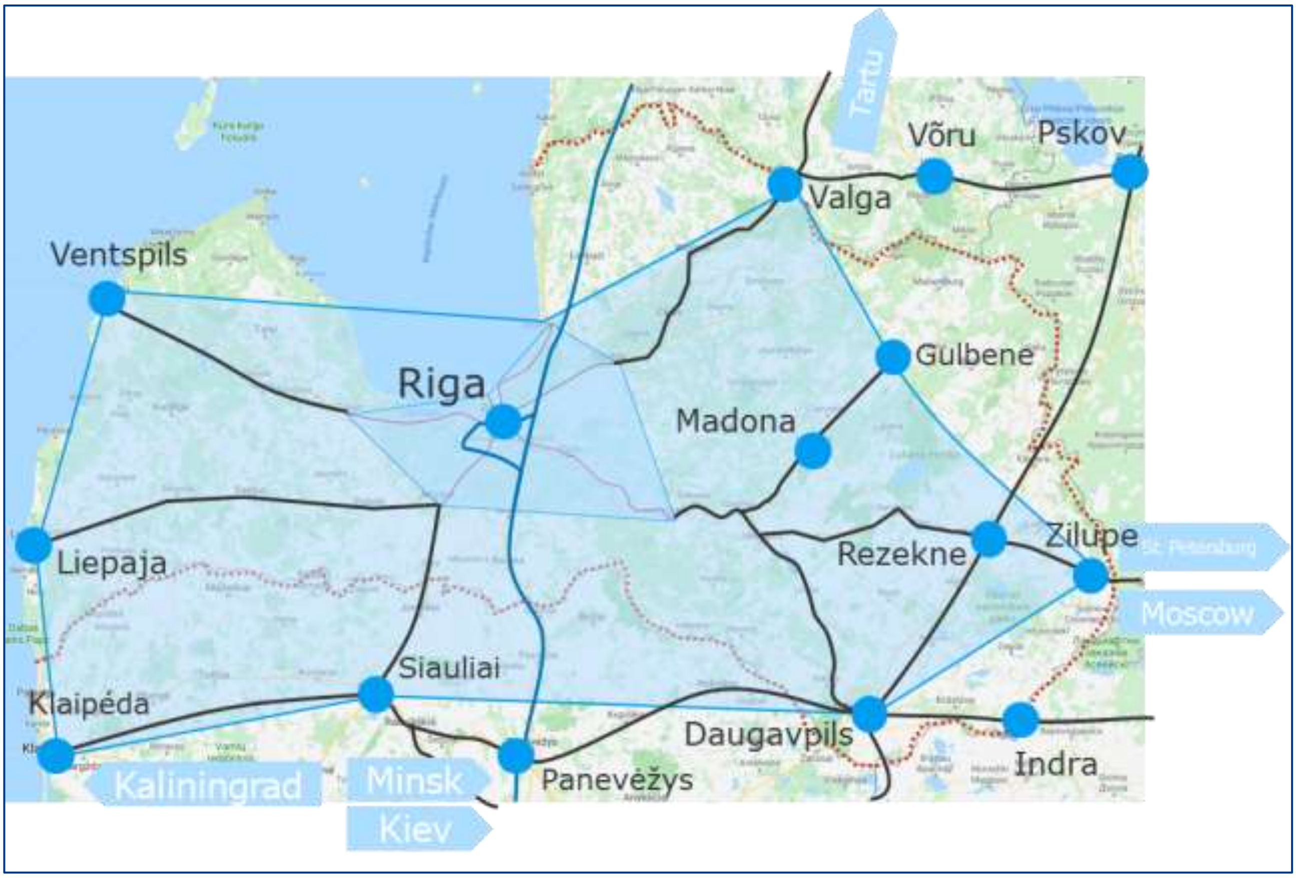


FIGURE 5: STUDY AREA – NATIONAL AND INTERNATIONAL SERVICE AREA

Reference to these definitions will be made throughout the study wherever needed.

2. 1520 mm / 1435 mm Operational Concept

2.1. Introduction

Findings regarding the development of passenger transport will be summarized, including information on future demand development trends, description of characteristics of already proposed services and related expectations (e.g. lines, service intervals). Special attention will be paid to the joint plans of ATD and Pasažieru vilciens. The consultant will also address intermodality between 1520 mm and 1435 mm services

In this chapter the current situation and the future development planned by the stakeholders regarding passenger and freight transport in Latvia will be outlined. The Riga region is currently affected by substantial changes regarding the service pattern, transport types and overall quantity structure of the freight and passenger transport.

To describe the major changes, the following aspects will be outlined and described in the following subchapters:

- Transformation of the service pattern for passenger transport in the Riga region and Latvia.
- Modernization of the rolling stock regarding electric suburban and diesel regional and national train service
- Current maintenance situation and requirements for procured future rolling stock regarding necessary functionalities and possible locations of new depots.

For each of these aspects the current situation and major changes for the future will be described and it will be assessed if the measurement suffices the future requirement regarding passenger demand and technical framework like rolling stock and maintenance capacities. In the next step the overall quantity structure can be derived and described in chapter 2.4.1.

2.2. Background

With overall 1.003 million inhabitants the city of Riga, which is the capital of Latvia and surrounding municipalities represented by the statistical region of Pie Riga and the Riga planning region represent more than half of the current population of Latvia. Characteristic for this region is a condensed city where most of the trips are done by foot, bicycle or public transport as well a less densely populated surrounding area with closed interrelationship of the city.

FIGURE 6: STATISTICAL PLANNING REGIONS OF LATVIA[5]

Municipalities close to Riga benefit from increasing income of parts of the population by the implementation of housing schemes allowing private land ownership and working in the city. Thus, the number of commuters from these municipalities is rising. Examples for this situation are municipalities in Marupe county, where the population increased from 3,200 inhabitants in 2000 to 20,000 inhabitants in 2019. While the total number of inhabitants in this area is comparable to other agglomerations, e.g. Copenhagen the population density is significantly lower. This leads to partly longer commuting distances and a significantly lower number of inhabitants living in the coverage area of a suburban train station.

Traditionally suburban train services play a major role in interconnecting the central parts of Riga city with municipalities around Riga. Today the average travel distance in this rail system is approx. 26 km. Overall a distance

[5] Central Statistical Bureau of Latvia - Central Statistical Bureau of Latvia, CC BY-SA 3.0, https://commons.wikimedia.org/w/index.php?curid=18527500

between 30…50 km is covered by suburban trains, which terminate in medium or small sized towns (Jelgava, Tukums and Dubulti, Aizkraukle and Ogre, Sigulda[6]). These lines also serve for leisure traffic since the coastal area north and southwest of Riga (Saulkrasti/Skulte, Tukums/Dubulti) can be easily reached by train. The network is designed as radial commuter network. Contrary to other suburban railway systems interconnectivity to other public transport modes was not in focus of the development.

The overall length of the electrified suburban lines is 251 km, which corresponds to 13.7 % of the Latvian 1520 mm railway network.[7] The related line section consists mainly of double track railway lines, which are used for passenger and freight services. There is no separation of traffic flows as in other suburban railway networks.

	2002	2010	2015	2018
Service offer [million train kilometres]	7.529	7.609	6.292	6.116
Transport performance [million passenger km]	643	670	545	584
Avg. train utilisation [passenger km/train km]	85	88	89	95

TABLE 2: KEY PERFORMANCE INDICATORS OF LATVIAN NATIONAL RAIL PASSENGER TRAFFIC[8]

This statistic indicates that the reduction of the service offer and the lack of modernisation of rolling stock resulted in a decline of transport performance. Due to service optimisation and reduction it was still possible to keep train utilisation at a relatively high level and even to increase train utilisation. However, the decreasing trend in ridership could not be stopped until 2018.

	2002	2010	2015	2018
Service offer [million train km]	604,7	633,6	663,2	689,4
Transport performance [billion passenger km]	38.000	48.000	55.000	55.000
Avg. train utilisation [passenger km/train km]	63	76	83	80

TABLE 3: KEY PERFORMANCE INDICATORS OF GERMAN RAIL PASSENGER TRAFFIC[9]

If we compare this development with the development in Germany on the same timeline we conclude that the opposite is possible. In the same time the public transport performance increased by 45% while the service offer was increased only by 14%. Reason for this are a variety of factors. Among these are:

[6] This relation is served by diesel trains, but meets more or less the same criteria as for the electrified suburban lines.
[7] Performance indicators of public rail network in Latvia – 2018. LDz 2019

[8] Source: Own compilation based on LDz basic performance indicators. https://www.ldz.lv/en/content/basic-performance-indicators
[9] Source: BAG SPNV. https://bag-spnv.de/zahlen-fakten. retrieved 01/03/2020.

- Introduction of integrated local tariff solutions allowing seamless travel on all modes of public transport at an attractive price
- Introduction of new rolling stock
- Introduction of offer-oriented service timetable serving most of the stations at least once per hour

Benchmarking example 1: Regional Rail Traffic in Estonia

Since 2013 The national passenger services in Estonia are operated by state owned passenger train operator AS East Liinirongid operating under the brand name Elron. These services include Tallinn suburban trains as well as national connections e.g. on the lines from Tallinn to Valga, Tartu, Narva. Since the implementation of the new public service contract which grants Elron the exclusive right to operate rail passenger services in Estonia until 2023, and the inauguration in 2013 of new rolling stock fleet consisting of Stadler EMU and DMU trains services improved significantly. While the service volume increased significantly – 64 % more trains were operated on the Estonian rail network in 2017 compared to 2013, passenger numbers also significantly increased making the new fleet and service pattern a success story. In 2019 8.3 million passengers used Elron trains. This is an increase by 43% compared to 2014 when approx. 5.8 million passengers used the services. The passenger train system is still not operated based on a fixed interval timetable.[10]

Benchmarking example 2: Dresden suburban railway services

The suburban railway system around the city of Dresden is serving an agglomeration with approx. 800,000 inhabitants. Population in the city of Dresden itself is 543,000 inhabitants. Current annual service volume is approx. 3.4 million train kilometres. Approx. 42,000 passengers are using the system daily. There are three lines serving 48 stations on a 127,7 km network. The city centre of Dresden itself is relatively compact. Most points of interest can be reached by tram or are within walking distance.

The base service interval on all three lines is 30 minutes off-peak and approx. 15 minutes during peak hours. Current punctuality level in the system is 98% due to investments in separate infrastructure on more heavily occupied central line sections. The system is typically used for daily commuting, but also for leisure traffic to Saxon Switzerland with significant seasonal morning and evening peaks requiring additional trains on the weekends during the spring, summer and autumn season.

As part of the infrastructure upgrades surroundings of all stations were significantly improved with park and ride and bike parking facilities. An important part of the success is also owed to the fact that the interconnectivity between urban public transport (tram and bus) was significantly improved. To achieve this, several stations have been rebuilt including relocation of platforms to provide optimum conditions for the interchange between road and city public transport. Two new stations have been introduced despite the dense tram and bus network to fully utilize the available market potential.

Most recent service improvement was the introduction of a 15 minutes peak hour interval on the section Dresden – Meissen. This resulted in approx. 1 million additional passengers per year.[11]

FIGURE 7: BENCHMARKING EXAMPLES SUBURBAN TRAIN SERVICE PATTERN

Currently the car ownership in Latvia is still the second lowest in the European union (356 passenger cars per 1,000 inhabitants in 2017)[12]. This is an indicator for a low-income situation but can also be interpreted as a chance to be of use for promoting the further use of public transport if the network is organised in the right way and brought to Central European standard. This process is under way with many investments made to improve the fleet and the

[10] Source; Elron statistics, Eurostat (amount of train movements),

[11] https://www.dnn.de/Dresden/Lokales/15-Millionen-Fahrgaeste-S-Bahn-verzeichnet-Rekord-in-Dresden, retrieved 01/03/2020

[12] https://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=road_eqs_carhab&lang=en, retrieved 01/03/2020

infrastructure as far as funding is available. The stagnation seen most recently can be partly related to the reached boundaries for further service improvement (high infrastructure utilisation, lack of operational staff, technical problems with newly introduced fleet).

Traditionally the more remote areas are served by a dense bus network since this is a result from the times when rail transport focused on suburban traffic and traffic on very long distances only. Due to its flexibility to adapt to changing demand and to modernise the fleet in short time intervals, and also benefiting from investments in the road network this mode of transport retained a high share in overall transport volumes. This is illustrated by the fact that the decline in transport performance was higher for rail than for bus. In the last ten years the annual amount of passenger kilometres travelled by bus decreased by 14 %. passenger kilometres travelled by rail decreased by 34 % in the same time period (2008-2018). Other benefits of the bus transport modes are the ability to provide more direct connections and the easier accessibility in many cases.

With the inauguration of Rail Baltica the area around Riga will benefit from significantly improved rail connections to the other Baltic states as well as to central Europe. Due to alignment of Rail Baltica in north-south direction via Riga the interconnectivity of the other parts of the country becomes even more important. Currently the average distance travelled by rail outside of Riga city is approx. 97 km. This is also due to the geographical structure of the country with low population density and large distances to cover between the five major cities (e. g. road distance Riga – Daugavpils 225 km, Riga – Liepaja 216 km, Riga – Ventspils 189 km, Riga – Jēkabpils 138 km, Riga – Valmiera 137 km).

As far as feasible it is planned to position the existing 1520 mm network as a backbone of public transportation. This strategic aim is reflected in the service procurement strategy of the local public transport authority ATD in local development plans and governmental budget related decision preparation.[13] Further details related to the recent state of plans for passenger transport are outlined in the following sections.

Passenger numbers for 2015 (passengers per station) are publicly available as part of the TSI PRM implementation plan for Latvia[14]. This data has been analysed by the consultant and will be used to check required and proposed service volumes and to set priorities for timetabling.

Publicly available transport statistics for Riga City (routes operated by Riga Satiksme) indicates a differentiated picture for most recent years. While annual passenger turnover increased after economic crises in 2012, numbers declined from 2015 to 2017.

Year	2012	2013	2014	2015	2017
Million annual passengers (tram, trolleybus, bus)	141.3	150.1	150.5	146.8	142.9
Annual public transport trips per inhabitant	217	233	234	229	223

[13] Information on the regional public transport service development 2021-2030 http://tap.mk.gov.lv/lv/mk/tap/?pid=40473219&mode=mk&date=2019-06-04
[14] https://ec.europa.eu/transport/sites/transport/files/rail-nip/nip-prm-tsi-latvia.pdf

Change compared to previous year	-	6.2%	0.3%	-2.5%	-2.7%

TABLE 4: RIGA CITY PUBLIC TRANSPORT – ANNUAL PASSENGER VOLUMES[15]

This recent development stays in contrast to the plans of the stakeholders for increasing demand in public transport. While the growing car ownership might contribute to this situation, these figures also indicate the need for further modernisation of the public transport system in Riga. This does include better interoperability between city and suburban public transport, especially by providing more attractive interchanges at stations, and integrated tariff solution. These development opportunities shall not be missed to ensure that the local public transport works as a feeder for the rail commuter network and therefore increases the number of passengers using the suburban and regional trains significantly.

This is supported by most recent developments in Western Europe. Here again, the city of Dresden shall serve as an example of what can be achieved by provision of an integrated public transport system and by according development of the public transport network, including all modes of transport. Between 2015 and 2018 the number of annual passengers as well as the annual number of trips per inhabitant continuously increased in recent years.

Year	2014	2015	2016	2017	2018
Million annual passengers (tram, bus)	152.9	153.4	157.1	160.4	163.2
Annual public transport trips per inhabitant	253	252	255	259	261
Change compared to previous year	-	0.3%	2.4%	2.1%	1.7%

TABLE 5: BENCHMARK DRESDEN CITY PUBLIC TRANSPORT – ANNUAL PASSENGER VOLUMES[16]

In order to gain a significantly higher demand potential, the public rail transport services shall be significantly improved by

- Stepwise introduction of modern rolling stock
- Increase of service frequencies

Overall envisaged goal is to increase passenger demand (number of annual trips) by 40% compared to today with following sub-targets for the main market segments

- Increase commuter traffic by 80% aiming at approx. 20% of overall market share
- Increase seasonal leisure trips by 20% (especially trips to coastal leisure areas from Riga area)

[15] Source: own compilation based on Riga City Economic Profile 2017 https://pasvaldiba.riga.lv/NR/rdonlyres/4531CDD6-9142-420F-8A6A-9BF3E424D894/66244/pdfR%C4%ABgasekonomikasprofils2017ENG.pdf and Riga City Economic profile 2019,

[16] Source: own compilation based on Riga City Economic Profile 2017 https://pasvaldiba.riga.lv/NR/rdonlyres/4531CDD6-9142-420F-8A6A-9BF3E424D894/66244/pdfR%C4%ABgasekonomikasprofils2017ENG.pdf and Riga City Economic profile 2019,

- Increase other trips by 20%.

The proposed changes to the service pattern and the rolling stock will be highlighted in the subsequent chapters 2.4 (Riga suburban services) and 2.5 (national and regional passenger services). Analysis will be complemented by other service types (freight services and international night trains).

2.3. Current service pattern for national passenger services

The current train services for regional and national passenger transport is marked by a demand-oriented service pattern (excerpt seen in Figure 8 below). That means that no structure for train services is clearly visible (types of services are only distinguished by train numbers) and in the end results into manually checking every train connection before making trips. Though for the peak hours in the morning and evening more train connections are available, the service can be seen as irregular and only few trains operate in the off-peak hours. This makes it even more challenging to plan trips outside the main operating time window unspoken by newly gained customers.

Flexible trips with a guaranty of a same day return within the operating hours (defined by from-to times for example between 6 am to 11 pm) are not always possible and not communicated clearly to the customer.

FIGURE 8: CURRENT PASSENGER SERVICE PATTERN (EXCERPT)

Also, a structure for possible products is only understandable for customers after intensive research. A typical service pattern is easy to understand and is divided into short and long-distance products combined with brandings which relates to the needs of the customers. To cover the typical customer needs the urban area service should have a sufficient frequency, should cover all available stations and should connect regional centres and subcentres including a guaranteed connection to local public transport services.

To meet these requirements regarding service and stopping pattern, product placement, rolling stock, and their maintenance are underway or are already carried out by the operators to transform the passenger services into a competitive network and to improve the modal split of rail transport significantly.

2.4. Future Riga suburban services and rolling stock

First of all, the focus will be placed on ongoing plans for a suburban network to improve the modal split of the rail transport and therefore making commuting more sustainable. It is planned to introduce a fixed interval service pattern on the electrified radial corridors from and to Riga backed up with new electric rolling stock.

2.4.1. Proposed service pattern

As seen in chapter 2.5, consultant proposes to introduce a state of the art commuter service which – when fully introduced – will met European standards regarding train frequency and could also meet other criteria like even distribution of trains per hour, fixed stopping pattern, connections to local and central mobility hubs and so on. This new service pattern is envisaged to start with arrival of the first new Škoda trains. For the first years of operation it is proposed to use a mixed fleet to operate the proposed service pattern. Following the original plan would mean that the cyclic timetabling principle and the proposed service frequencies would also be required during construction stage of Riga Central station. Therefore, this service pattern will be used as basis for capacity assessment during construction stage with the aim to check to which extent this is possible during the construction stages. Benefit of this approach is that the impact of each stage is comparable and that – subject to capacity check – advantages of newly procured rolling stock can be facilitated by an attractive service pattern as soon as possible.

Also, for every corridor and track section are target travel times defined. They allow an assessment if the concept is compatible with other services in the region. After first assessment of travel times by the consultant, it is assumed that they are only possible if the services will not be overtaken by other trains.

In principle, the frequency for train services is higher during the peak hour. For a usual working day, the typical peak our is planned to be between 7-9 am and 5 to 7 pm. Regarding the afternoon peak this time window is usually chosen if the majority of jobs is in the service sector with it´s typical 9 to 5 shift structure. Should the share of industrial jobs – with it´s typical three shift system – increase in the future, the afternoon rush hour will become longer, and the time window will be between 3 and 8 pm. This is also supported by the fact that afternoon and early evening hours are more and more used for leisure and further educational activities. Figure 9 shows the daily passenger demand distribution in Riga city area according to Rīgas Satiksme before and during first days of Corona virus restrictions. As can be seen the typical peaks still exist as described above. Notably, Corona crisis restrictions, which are mainly affecting service oriented and office jobs, the highest decrease of demand can be seen during peak hours and the curve generally flattens.

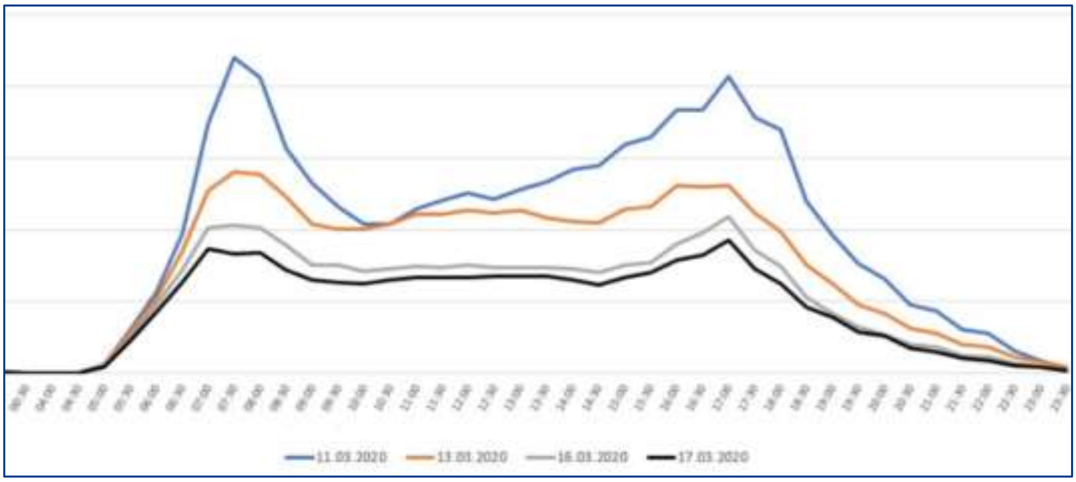


FIGURE 9: EXAMPLE: DAILY PASSENGER DEMAND DISTRIBUTION IN RIGA CITY PUBLIC TRANSPORT[17]

The typical service pattern with additional peak hour trains during weekdays is still applied on suburban commuter-rail-systems for medium sized cities, like for example Dresden S-Bahn and Nuremburg S-Bahn.

For bigger cities, where suburban system is the backbone of the public transport network, the timetables are more and more redesigned to operate a dense service pattern. One prominent example is the suburban rail system of Copenhagen, which used to operate with a 20 min peak service pattern and additional peak hour services until 2007, now trains are running every 10 minutes during daytime, thus providing a dense service pattern supporting for all types of individual traffic needs. Thus, a future-proof timetable and infrastructure shall allow extension of the peak service hours on short notice. Widened peak times also mean that it is more and more difficult to perform regular cleaning and maintenance within the "noon-break" between the morning and afternoon peaks.

To conclude, a future oriented conceptual timetable shall consider peak hour service frequencies to provide an attractive offer and the needed flexibility for passengers and shall allow flexible shifting and extension of peak hour service pattern, as needed.

Otherwise the rush hour is absent on weekends and will by enlarged over the whole day for the lines leading to the coastline like the track sections Carnikava – Riga and Dubulti – Riga.

Altogether, the frequency of suburban train services on the corridor is declining with larger distance from Riga Central station. The track sections being the closest to Riga Central station (Dubulti – Riga, Carnikava – Riga and Ogre – Riga) having between 4 and 3 trains per hour in the peak respective 1 to 2 trains in the off peak. The number of train services per hour is reduced with longer distance and travel time from Riga Central station down to 1 train per peak hour and only one train every two hours in the off-peak.

Comparison of the service volume of the planned suburban network with currently operated services indicates an increase in service volume between 22 % and 91 % on the section closest to Riga on the four suburban corridors and an overall increased volume in the whole network.

In the proposed service pattern, the service frequency in peak hours is adjusted to demand and train occupation with more frequent services on the line sections closer to Riga.

- 4 trains (15 mins interval) in the peak hours are planned on the inner sections of the network within a time distance boundary of approx. 45 min from Riga Central station
- 2 trains per hour (30 mins interval) are proposed on the less frequented outer sections of the network

This results in a reduction of train services on the corridor on the outer sections Dubulti – Sloka and Sloka – Tukums2, while train services on the corridor Aizkraukle- Riga for the further out sections Ogre-Lielvārde and Lielvārde-Aizkraukle are even slightly increased compared to the current train services in 2020. The corridor Skulte- Riga benefits the most from the proposed new service concept. On this corridor all the service volumes are increased on every corridor section, while on the corridor Tukums2 – Riga the volume will only be increased for the "inner" sections Dubulti - Riga (around 22 % more trains than today) but will be reduced for the other section Dubulti -Sloka and Sloka-Tukums2 (between -21 and -29 %).

2.4.2. Integration of services to Bolderāja

As part of the study the possibilities to integrate a new passenger service between Riga Central and Daugavgrīva should be studied. Regarding servicing Daugavgrīva by a rail-based means of public transport a separate tram-train study was carried out in 2019 by the Railway Transport Department of Riga Technical University.

Several variants for routing of tram-trains combining usage of existing railway in mixes operation with conventional freight trains and new have been studied from operational, technical and organizational viewpoint. A variety of alignment options combining tram and train line sections have been studied. Out of the six most promising alternatives the preferred variant foresees a separate tramway line section on the northern edge of the line parallel to Lēpju iela in Daugavgrīva in order to serve the densely populated housing estates west of the existing railway line. For serving passenger stops by means of separate platforms suitable for interoperable tram-train vehicles additional short tram line sections have been investigated (e.g. south of Buļļupe river to serve a stop closed to Silikatu iela and to serve Zasulauks station. Otherwise it was proposed to use the existing railway line Zasulauks – Daugavgrīva. According to the study, the line is proposed to interconnect to the tram network west of Riga Central station to provide a stop at 13. janvāra iela and to allow direct services to the city centre of Riga. Therefore, it was proposed in the study to introduce a dedicated track connection between rail network and tram network with a steep gradient of 8% (see figure Figure 10).

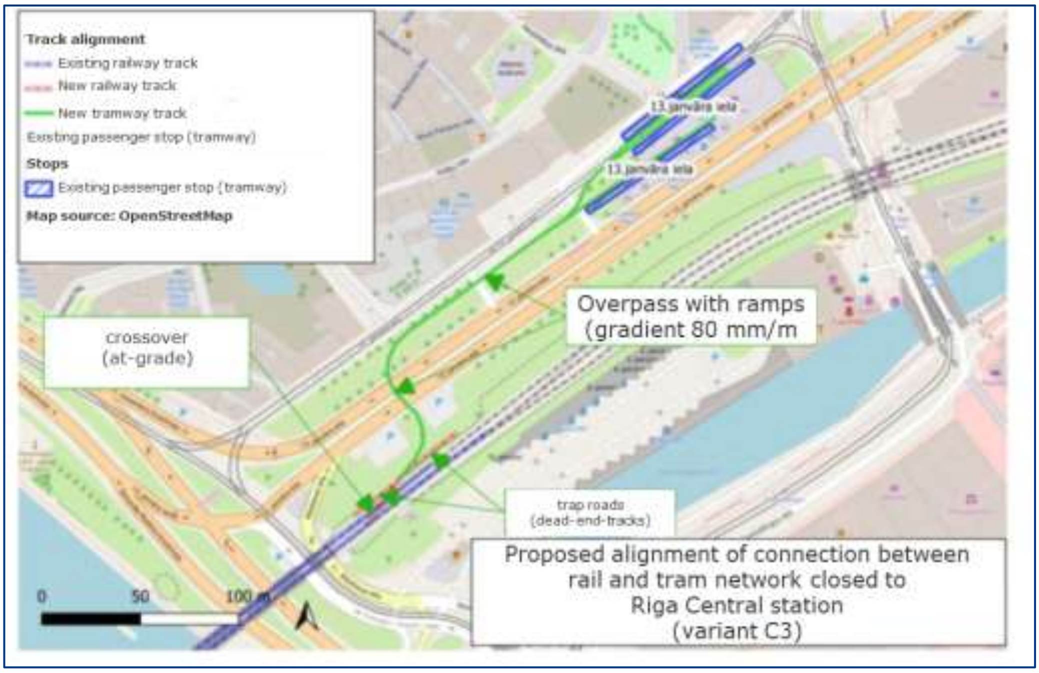


FIGURE 10: INTERCONNECTIVITY BETWEEN TRAM-TRAIN AND RAILWAY AT 13. JANVARA IELA[18]

Such a solution would provide a real improvement (approx. travel time 40 minutes between Daugavgrīvas D/P and Merkela Iela using bus route number 3 compared to approx. 26 mins travel time achievable by tram-train service and much improved coverage of the area by rail-based services. To ensure competitiveness to more frequent bus services it is concluded that the minimum service interval should be 30 minutes. Otherwise the bus is overall more attractive due to higher departure frequency. To cope with expected passenger demand in the peak hour (current demand for bus services is max. 750 passengers per hour) a peak time service interval of 15 minutes is necessary, if single tram-train vehicles with a maximum capacity of approx. 85 seats are to be used.

This solution was based on the following technical and operational main assumptions:

- To allow operation of tram-trains innovative rolling stock shall be introduced applying an individually developed wheel profile and autonomous operation without using overhead wires on the public railway network to overcome the different parameters of tram and rail systems. Autonomous power supply (batteries, hydrogen or diesel) is seen as preferred solution for operation on electrified line sections (3 kV and 25 kV AC).
- Passenger stops shall be realised on dedicated facilities allowing station and platform design with tramway parameters.

- Provision of a dedicated platform track for tram stop is not possible. This assumption is based on the currently operated timetable at the time of conducting the study (2019).
- To provide an attractive service the tram-train services should be designed for a 15 minutes interval in peak hours.

Contrary to the tram-train study a rail-based concept is proposed in this study. The idea of a rail-only service is supported by the following arguments:

- With the new service pattern, the limit of feasible line utilisation over Daugava river bridge will be reached.
- The originally proposed dedicated track connection to the tram network is based on at-grade junctions west of Riga station. Chances to realise will be lower compared to the originally service pattern assumed in the tram-train study since the capacity limit of the section over Daugava river bridge will be reached.
- An alternative to such concept avoiding the most heavily occupied track section could be realized by providing interconnection to the existing tram network in Zasulauks or Torņakalns. However, this will lead to significantly increased travel times preventing fast travel times between Daugavgrīva and Riga city centre. In both cases the effects of at-grade junctions and impact on station track layout need to be studied in detail.

Due to the high technical complexity and the limited capacity especially on the line section Torņakalns – Riga Central a rail-based concept is assumed for the purposes of the Riga node study. This solution is in line with the assumptions of the PV. It will also allow extension of Daugavgrīva services east of Riga Central station

Following the trade-off between available capacity (related bottlenecks are outlined in section of this report), interconnectivity of services and service interval it is proposed to study operation based on a 30-minute interval for trains operating Daugavgrīva and Riga Central station (to be operated for the complete day) as long term service vision. This is compatible with the proposed 15/30 minutes service intervals of the remaining Riga suburban network. Furthermore, the train-only option would allow in principle to apply through-running with extension of the services east of Riga Central station to cover a wider area of Riga city, e.g. by serving Zemitāni station.

The following stops are initially proposed in order to cover the demand potential: Daugavgrīva, Bolderāja, Lāčupe, Zasulauks, Stradiņi; Torņakalns, Riga Central station. To fully cover the expected demand potential two optional additional stations are proposed (Lāčupe South, Bolderāja South).

A map of initially proposed stops is shown in Figure 11 below.

Additional stops could be considered but this will likely require using one additional rolling stock to provide stable turnaround at Bolderāja. With the stopping pattern proposed above a travel time of approx. 22 minutes between Bolderāja and Riga could be achieved. This assumes, that a maximum line speed for passenger trains of 80 km/h between Zasulauks and Bolderāja can be realised. In any case the infrastructure must be upgraded to provided aimed capacity for freight and passenger services between Zasulauks and Bolderāja and Daugavgrīva.

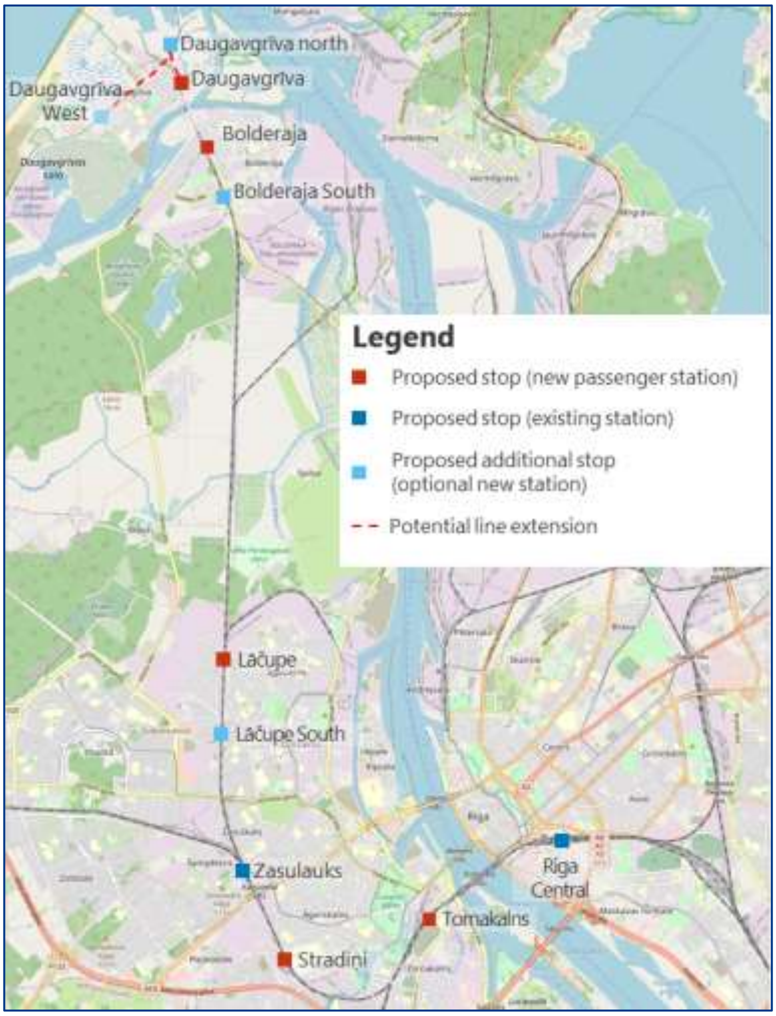


FIGURE 11: PROPOSED STOPS FOR PASSENGER RAIL SERVICES RIGA CENTRAL – DAUGAVGRĪVA

Based on the above justification it is clear that for a decent passenger service at least two trains per peak hour and one train per off-peak are necessary to form a sufficient service for future passenger and commuter demand (seen in Table 6 below). The number of trains over the whole day have been derived from trains services on the track section Sloka – Riga (seen in Table 6) and are let open for a discussion by the stakeholder.

Corridor	from-to	travel time [hh:mm:ss]	peak hour interval [trains/h]	off-peak interval [trains/h]
Daugavgrīva - Riga	Daugavgrīva - Riga	00:24:00	2	1
Riga - Sigulda	Riga - Sigulda	00:47:00	2	1

TABLE 6: ASSUMED PASSENGER SERVICE PATTERN BOLDERĀJA – RIGA

For better coverage of potential demand similar to the tram train concept an extension of services via a dedicated railway track parallel to Lēpju iela could be foreseen. Considering restrictions from existing buildings etc. and minimum curve radii for standard railway alignment a direction change north of the initially proposed station might be required to allow for a suitable alignment of the extension. This option will not be studied in more detail in the Riga node study.

2.4.3. Current and future rolling stock for suburban services

Required data for current and future rolling stock for suburban services was made available by PV to the consultant. (excerpt is provided in Table 7 below).

	Existing electric trains				New electric train
	ER2M		ER2T		Škoda
Number of wagons per rolling stock	4	6	4	6	4
Number of units	3	10	10	1	32
Mass [t]	226.58	340.48	239.98	360.28	
Length [m]	80	120	80	120	110
Traction engine or diesel engine power [kW]	200	200	240	240	
Number of propulsion engines or diesel engines	8	12	8	12	
Number of seats	318	530	318	530	400
Number of standing spaces					450
Passenger per square meter [p/m²]	4	4	4	4	
Brake coefficient, no less [m/s²]	0.6	0.6	0.6	0.6	

TABLE 7: DATA FOR CURRENT AND FUTURE ELECTRIC ROLLING STOCK

According to collected data and own additional research currently the electrified lines are mainly operated by two train types (with a variety of modifications and modernizations) the ER2 and ER2T with different train length and capacity additionally improving the complexity of rolling stock scheduling. Also, the current rolling stock is reaching their maximum lifespan making it more expensive to maintain it. Additionally, it reduces the availability for operations and costs. It is planned that suburban services should be operated entirely by the new Škoda rolling stock. For runtime calculation data for current and future rolling stock allow to calibrate the modelled infrastructure to be used for precise runtime calculation of new rolling stock and upgraded infrastructure in the next work packages.

FIGURE 12: CURRENT AND FUTURE ELECTRIC ROLLING STOCK

It will be part of further work packages to assess if the 32 Škoda rolling stock are enough to operate the suburban service pattern. This will depend on the detailed structure of the suburban service, the planned maintenance concept and the location of the depot and the assessed passenger demand as well. These factors and derived requirements will be summarized in chapter 3.4.2 on page 82.

2.4.4. Operational concept Timetable 2026/36

TheFigure 15 line concept for Riga suburban services is based on the principle of through-running in Riga Central station to optimize track occupation and to provide a more attractive service to the passengers (see also section 5.4). Overall, three lines are proposed:

- CT 1: Tukums 2 – Riga Central – Skulte
- CT 2: Jelgava – Riga Central – Aizkraukle
- CT12: Daugavgrīva – Riga Central - Sigulda

Lines CT1 and CT2 cover the services on the currently electrified lines with intervals and service volumes as described above. The difference in services frequencies between Tukums branch (up to four trains per hour in peak time) and Skulte branch (only three train pairs per hour in peak time) is solved by termination of selected services from Tukums in Riga Central station.

CT12 is a new line which is proposed as upgrade and extension of existing services on the Riga - Sigulda line. CT12 also includes the line section Riga Central – Daugavgrīva. Rolling stock to be used on the line CT12 will depend on future electrification status of the network. In the beginning these services could be operated by diesel traction. With electrification of the Riga – Sigulda line the services could be bimodal (diesel-electric on non-electrified line sections / electric on electric line sections or accumulator-based power supply on non-electrified sections). With electrification of the line to Bolderāja (also important for freight services Šķirotava – Riga port area) single mode EMUs could be used for majority of the services.

In line with service targets for Riga – Daugavgrīva line which are described above services on the line section Riga – Daugavgrīva shall be operated every 30 minutes during the daytime. The proposed concept for integration of this services into Riga node requires avoidance of terminating trains in Riga due to platform occupation issues. Therefore, the line is proposed as new fast cross-city link towards Zemitāni, Jugla and Sigulda. This will allow more frequent services to the new stops of Alfa and Teika (minimum 30-minute interval during peak time). Outside of the peak hours one of the two hourly trains could be terminated in Jugla. Compared to terminating of services in Zemitāni or empty runs to Vagonu parks this service can be achieved without additional rolling stock.

For line CT 1 extension of services to a common station with Rail Baltica (Skulte RB) is suggested. This station would require an extension of the existing 1520 mm line of approx. 3.5 km beyond the current end of the railway line at Skulte. This common station is proposed in the Rail Baltica operational plan. Provision of a station at Skulte area is an integral part of the regional train service concept for Rail Baltica. Proposed services in line CT 1 would benefit from interchange possibility to Rail Baltica trains towards Salacgrīva, Pärnu and Tallinn. Also interface to local public transport, which is crucial for success of proposed regional services on Rail Baltica could be more efficiently provided at a common location for 1520 mm and 1435 mm.

Since the proposed CT1 service offer to Jūrmala destinations (corridor Riga – Tukums) is higher (more trains) following the expected demand structure, some of the services from western direction will terminate in Riga Central station. Further details are described in chapters 5.5.2. and 5.5.4.

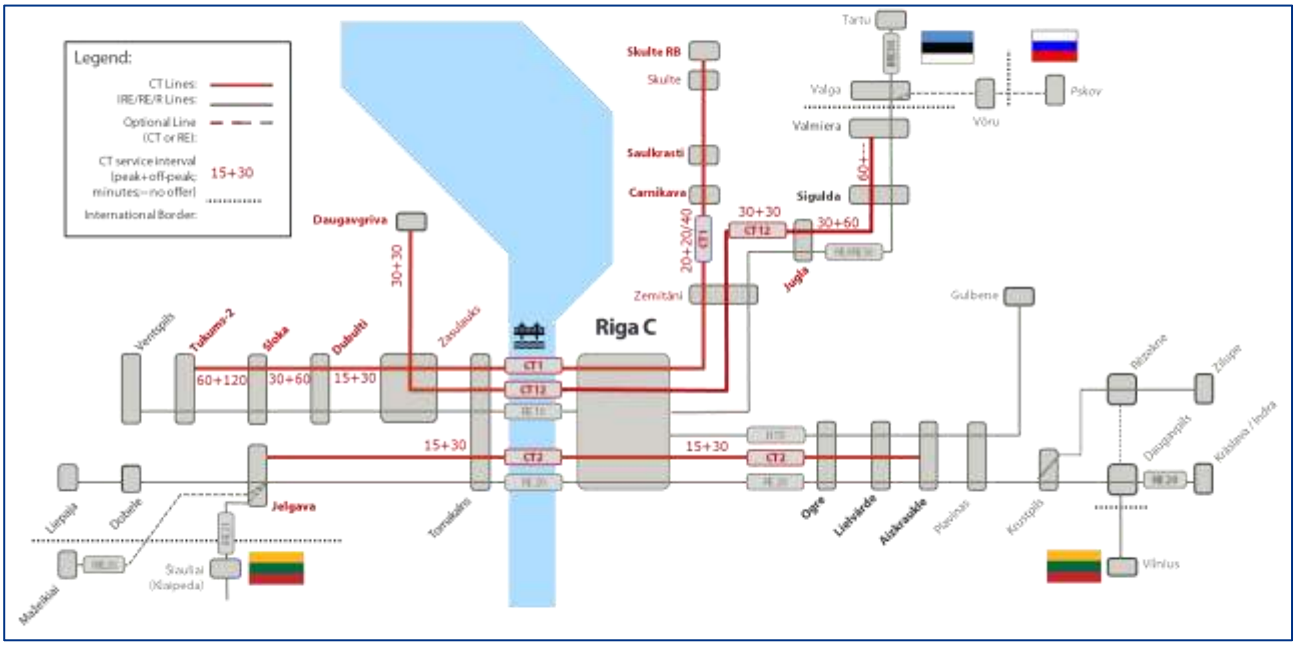


FIGURE 13: PROPOSED RIGA SUBURBAN PASSENGER SERVICES – PROPOSED LINE CONCEPT

The detailed timetable concept for the master timetable 2026 is described in section 5 of this report.

The proposed stopping pattern for national services is based on the PV proposals. This does include serving additional stops Alfa and Taika in Jugla area on the Riga Sigulda line, serving Stradiņi station (on the line section Torņakalns - Zasulauks) and omitting the stop at Cena station (Riga – Jelgava line), which is proposed to be closed.

2.4.5. Long-term outlook

As described above the newly introduced service pattern will provide for a state-of-the-art commuter service with attractive intervals during peak-hours allowing flexible travel in the areas closed to Riga. In theory it could be discussed to operate a 10-minute interval in peak times and 20 minutes off-peak interval. This would be compatible with proposed interval for Rail Baltica RE services between Riga Central station and Riga airport providing 3 RE train paths per hour (approx. 20 minutes interval). Current analysis shows that in this case the capacity limit in the section Riga Central station – Torņakalns will be reached. To overcome this, additional infrastructural measures it would be required to increase line and station capacity. Targets would be separation of suburban services from other services (e.g. for instance freight and regional express trains) and to exploit the available capacity by improvements to the signalling system. This might include

- a second bridge over the Daugava river, including integration of the additional tracks
- a further redesign of Riga Central station (for instance resolving at-grade-crossings, integrate additional approaching tracks into station track layout)
- provision of third and/or fourth tracks (e.g. Torņakalns – Zasulauks)

Same applies to potential introduction of a 15-minutes service interval for train services Riga Central – Daugavgrīva.

On the other hand, the analysis conducted in this study shows that provision of a 15-minute interval for line CT1 and CT2 as proposed will most likely cover the demand to be expected. It should be also considered that Rail Baltica regional express trains will provide additional relief on certain relations (e. g. Skulte – Riga Central, Salaspils – Riga Central).

However, the infrastructure should allow roll-out of 15 minutes interval on most occupied sections during the full day time to provide space for future growth and to allow more flexible travel arrangements for commuting and leisure purposes in the future.

In case train capacity limit is reached in peak times with proposed 15-minute service intervals lengthening of trains shall be the preferred option due to the large investments required for above mentioned infrastructure upgrades. This might require upgrading of passenger platforms to accommodate two train portions (220 m instead of 110 m train length for regional and suburban trains). This option should be considered in the design of the 1520 mm stations in railway core area.

In addition to the above-mentioned alterations, CT services on the line section Riga – Sloka - Tukums should be further increased to provide at least a regular one hourly through service between Riga and Tukums to fully cover the expected demand potential.

2.5. Regional and national passenger transport

After summarizing the situation for the suburban services, the proposed developments for regional and national passenger services will be analysed.

The future service model is based on four elements:

- Definition of regional and national passenger service types with line concepts including extended international cross-border services out of selected national services, rough service pattern for service types including target travel times, quantity structure in form of daily services and trains frequency in peak and off-peak hour.

- Expected change of daily passengers from public bus services to the new train services and expected proportion in the modal split of public transport. For most assessed O-D relations between central settlements with passenger stations rail shall have a modal split in public transport of more than 70%. For some relations with high attractiveness of rail transport mode more than 90% are envisaged in the future.

- Definition of regional, national and international service types including stopping pattern and required capacity for rolling stock for each service type.

- Rollout plan for new rolling stock to operate the new services, consisting of old rolling stock and introducing new diesel and bimodal rolling stock until 2035.

First the planned service pattern will be summarized and analysed. It allows for an integrated picture of suburban and regional train services.

2.5.1. Proposed service pattern for regional traffic

For future passenger service outside the Riga suburban area three different service types are defined having different stopping patterns to focus on important, highly frequented and demanded stations to reduce the travel time as much as possible, which again are divided into low and high capacity services. Low (~100 seats) and high (200-240 seats) capacity “RV” regional train service has the denser stopping pattern but still will not stop at stations which are already served by suburban trains. The “RE” train services will only stop at important regional stations and stations with connections to local public services. This type will function as a regional express service to connect regional main and sub-centres. It is assumed by the consultant that selected regional express “RE” services will also be extended for cross-border international passenger services called “TV”. With this concept it is possible to use existing rolling stock optimizing rolling stock schedules within existing service pattern, avoid occupation of additional train paths in Riga Central station.

High capacity regional (RV) and regional express (RE) services will expand the suburban electric passenger services and will cover all lines and corridors starting from Riga Central station. This results in new services on railway lines which are currently only used for freight trains. International “TV” services are planned to Estonia from Valga, to Lithuania from Jelgava and to Belarus from Daugavpils. The potential of additional international day services in case of reduction of travel time will be checked in chapter 2.5.3. No regional services are planned on the suburban corridor Riga-Skulte.

Overall, in the off-peak train services are planned every two hours and 60 min in the peak hours. On the corridor Riga-Aizkraukle - Plavinas - Jēkabpils and the diverging lines to Madona, Rēzekne and Daugavpils services could form a combined service that results in trains every 30 minutes in the peak hour. They would consist of a 30 min service formed by the train services every 60 minutes to Daugavpils and Rēzekne.

On less frequented lines RV services could operate as separated lines or coupled to regional trains. Combined with probably longer regional RE trains in the peak hour, these RV services could work as capacity extender on highly frequented main lines and service extender for branch lines like Plavinas - Gulbene.

There is a possible conflict regarding the target travel times of suburban and regional services. For regional services from Riga to Jēkabpils a travel time of 1:22 h is requested. For suburban services between Riga and Aizkraukle – which is only a part of the corridor of Riga - Aizkraukle - Jēkabpils – the target travel time is 1:30 h, if the train is not overtaken by other presumably faster regional services. Therefore, it is possible that regional services will be slowed down by suburban services, unless they will be overtaken. This would extend their travel time making them longer than assumed and also reduce the competitiveness of the passenger service to road traffic. Induction of compatible passenger service and types fulfilling the recommended requirements for quantity structure and travel time and additional requirements will be the part of further work packages.

2.5.2. Current and future rolling stock for regional services

The current rolling stock for regional services outside the Riga suburban area in the lack of electrification consist only of diesel passenger trains. It is proposed to phase out current old rolling stock like DR1A and DR1AM until 2030 but keeping modernized DR1AC diesel rolling stock in service until 2035. It is planned to procure new diesel and bimodal rolling stock with capacity of up to 100 seats as well as low capacity diesel rolling stock (up to 100 seats). Altogether the combined rolling stock fleet will in the end consist of 41 vehicles. The proposed rollout plan for the introduction of new rolling stock is not provided here for confidentiality reasons.

The biggest advantage of bimodal rolling stock from passenger service perspective seen by the consultant is the possibility of offering direct services with partly more comfortable electric services at least for parts of the trip. From overall perspective, replacing of diesel traction multiple units by using innovative rolling stock (either battery-operated or hydrogen powered unimodal or bimodal trains would contribute to reach climate-change-goals aiming at reduction of green-house gases and local emissions. Related solutions are already available on the railway market and first public transport authorities are forcing the use of available solutions as part of their transport service procurement strategies. First use cases for daily operation can be expected soon (e.g. operation of battery electric trains on Ortenau network in Baden-Wurttemberg, placed orders for hydrogen powered trains in Hessen and Lower Saxony).

At the end of the current planning period (approx. 2035) the fleet shall have the following structure:

- 32 electric trains with 440 seats each (Škoda 16EV; already procured)
- 27 bimodal trains with seating capacity in the range 200 - 240 seats (BEMU or diesel-electric)
- 5 low capacity diesel multiple units (targeted seating capacity 100 - 130 seats; currently planned as diesel trains, use of alternative propulsion subject to further decisions)

At this point in time all currently existing PV rolling stock will be replaced by new state-of the art rolling stock.

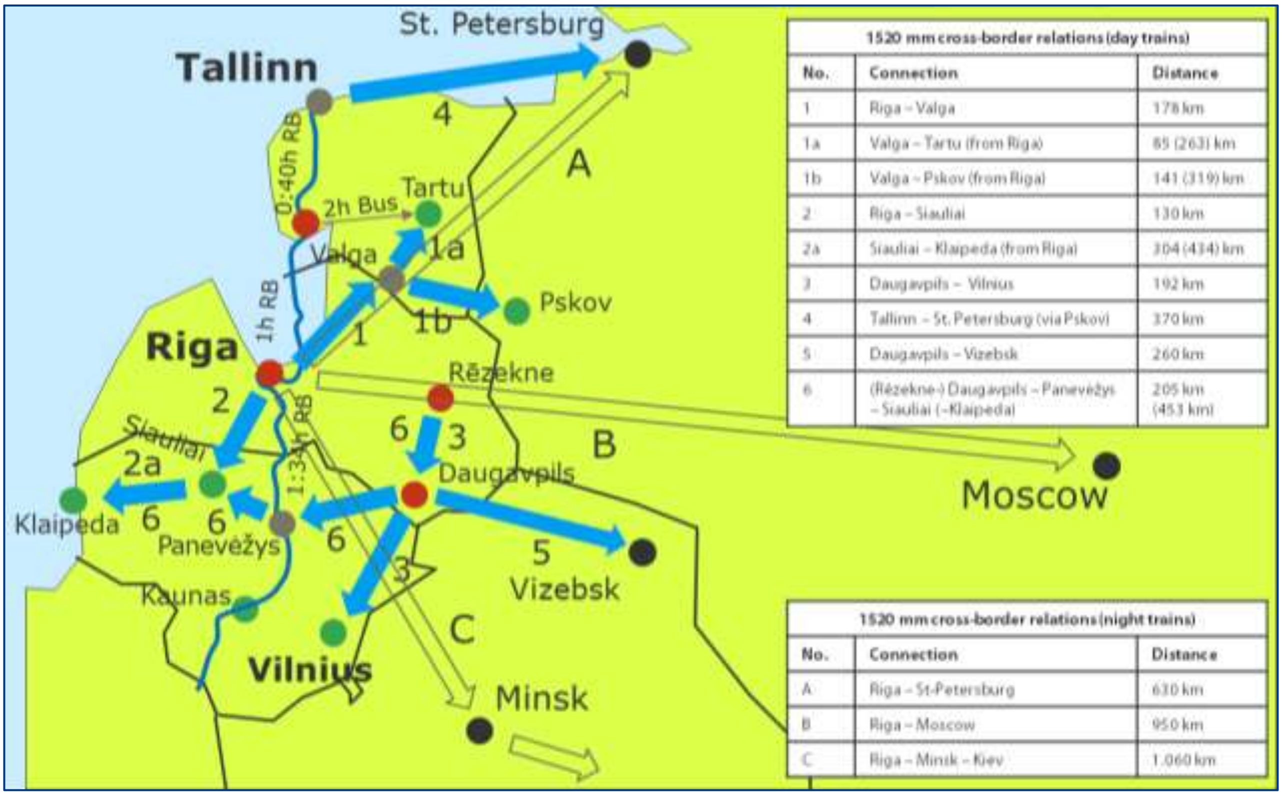
2.5.3. Outlook on 1520 mm international day and night services

As already described in chapter 2.4.4 it is planned to introduce an international passenger service type. Therefore, in this chapter the potential for more international 1520 mm passenger services shall be assessed. Possible international day and night services seen by the contractor are shown in Figure 14. The consultant checked the region for potential destinations for long distance international cross border day and night services. To filter the connection for day services the distance for the destinations was roughly assessed and a limit of approximately 600 km was set. The distance is seen too far for future 1520 mm day services to Moscow, Kiev. A connection to St. Petersburg lies within the parameter but can be served better with Rail Baltica Riga - Tallinn HST lines in combination with connections and improved 1520 mm services from Tallinn to St. Petersburg. The connection would still have potential as night service via Pskov.

Other cross border destinations around Rēzekne and Daugavpils are too far away from Riga and more suitable for overnight services. Otherwise the population doesn't reach the critical size to justify largely extended international cross border services.

However, long-distance international cross border services from Daugavpils, Rēzekne, Valga and Jelgava have potential but would have no influence of the overall quantity structure of Riga Node. The quantity structure of long-distance trains in Riga Central station would stay the same because international services would be extending selected faster regional services.

Possible long-distance international connections are indicated in Figure 14 below (relations 1 to 6). To the north international day services could be implemented to Pskov and Tartu and maybe as long-distance service all the way to Tallinn.



1520 mm cross-border relations (day trains)		
No.	**Connection**	**Distance**
1	Riga – Valga	178 km
1a	Valga – Tartu (from Riga)	85 (263) km
1b	Valga – Pskov (from Riga)	141 (319) km
2	Riga – Siauliai	130 km
2a	Siauliai – Klaipeda (from Riga)	304 (434) km
3	Daugavpils – Vilnius	192 km
4	Tallinn – St. Petersburg (via Pskov)	370 km
5	Daugavpils – Vizebsk	260 km
6	(Rēzekne-) Daugavpils – Panevėžys – Siauliai (-Klaipeda)	205 km (453 km)

1520 mm cross-border relations (night trains)		
No.	**Connection**	**Distance**
A	Riga – St-Petersburg	630 km
B	Riga – Moscow	950 km
C	Riga – Minsk – Kiev	1.060 km

FIGURE 14: PROPOSED INTERNATIONAL 1520 MM DAY AND NIGHT CONNECTIONS OVERVIEW

To the south international services from Daugavpils to Šiauliai and Klaipeda have potential as they work as direct connections and could still be faster and more comfortable. A direct and faster connection from Daugavpils to Vilnius has potential and is faster than a detour via Riga and Rail Baltica. Provision of passenger services between Daugavpils and Panevėžys would strengthen the role of Panevėžys as regional interchange to Rail Baltica. These services could be optionally extended from Daugavpils to Rēzekne as part of reintroduction of train services between Rēzekne and Daugavpils.

To check the potential of travel time improvements and the competitiveness with road traffic distance and travel time of current services have been summarized in Table 8 and the average speed has been calculated. To compete with road traffic and to check the potential for track improvements the travel time has been calculated for average higher speeds of 80 km/h and 120 km/h.

For the corridor in the north to Valga and Tartu the travel time is already seen as competitive to road traffic even if the average speed is already 80 km/h. An effect on the travel time would be achieved if the average speed would be increased to 120 km/h which would mean that the top speed to Valga needs to be upgraded to 160 km/h. Otherwise it would be faster to use a combination of Rail Baltica HST services with connections to bus services from Pärnu to Tartu. Realizing a competitive service from Valga to Pskov – with its 200,000 citizens – would require an upgrade to 160 km/h top speed as well as to reduce travel time below the three-hour mark. To improve top speed for 160 km/h measures regarding level crossings and signalling must be implemented.

For the corridor south of Riga via Jelgava to Klaipeda the service between Riga and Klaipeda only has an average travel speed of 65 km/h. With faster services between Šiauliai and Klaipeda the average travel speed is improved to competitive 81 km/h and a travel time of 3:45 h between Riga and Klaipeda. Here a potential travel time reduction is envisaged by the consultant especially for the first section. An upgrade to an average speed of 120 km/h, corresponding to a respective 160 km/h maximum speed would reduce the travel time Riga – Klaipeda below the three-hour mark to 2:32 h.

Checking above mentioned travel times against a scenario with usage of Rail Baltica and interchange in Panevėžys reveals that the connection via Panevėžys is more than 20 minutes slower, if 80 km/h travel speed and 5 minutes interchange time in Panevėžys are assumed. Nevertheless, the travel times are still attractive. This corresponds to the vision to establish an interchange hub between Rail Baltica and 1520 mm services in Panevėžys. Since a potential Panevėžys – Klaipeda service would stop in Šiauliai anyway, a direct service between Riga or Jelgava and Šiauliai should be considered even then, probably only running in selected peak hours.

If such principle is applied, the 1520 mm infrastructure and service pattern between Panevėžys, Šiauliai and Klaipeda shall be upgraded. This should also include the line section Daugavpils – Panevėžys. In that case Panevėžys would act as a rail gateway to the south for Daugavpils, which can be also justified by shorter travel times instead of using the route via Vilnius, e.g. to Kaunas.

The 192 km distance between Daugavpils and Vilnius already has at least an acceptable travel time below the three-hour mark and an average speed of 72 km/h. An improvement to average road speed of 80 km/h or better could reduce the travel time to around 90 minutes and is seen as a high potential connection for international day services in Latvia by the contractor.

A bit of an exception is the long-distance connection between Tallinn and St. Petersburg. This connection outlines the positive impact of the Rail Baltica project on 1520 mm operations in the area. If a reduction of travel time Tallinn - St. Petersburg to the important three-hour mark for passenger services could be achieved in combination with Rail Baltica HST services from Riga to Tallinn (1:40 h travel time) and moderate 1520 mm track improvement to 160 km/h top speed an overall travel time of 5-6 hours for Riga – St. Petersburg would be a realistic target subject to border crossing customs procedures.

No.	Connection	~ Distance	Travel time	Average speed	Target travel time for average 1520 mm speed of	
		[km]	[hh:mm]	[km/h]	(80 km/h)	(120 km/h)
1	Riga - Valga	178	02:00	89	02:13	01:29
1a	Valga - Tartu	85	01:15	68	01:03	00:42
	Riga-Valga - Tartu				**~ 03:15**	**~ 02:15**
1b	Valga - Pskov	141	-	-	01:45	01:10
	Riga - Valga - Pskov[19]				**~ 04:00**	**~ 02:40**
RB	Riga - Pärnu - Tartu *(Bus)*	-	03:00	-		
2	Riga - Šiauliai	130	02:00	65	01:37	01:05
RB+6	*Riga- (Rail Baltica) - Panevėžys- Šiauliai*	236			*01:55*	*01:37*
2b	Riga - Šiauliai - Klaipeda	304	03:45	81	03:48	02:32
RB+6	*Riga- (Rail Baltica) -* Panevėžys - *Klaipeda*	401			04:00	03:00
3	Daugavpils - Vilnius	192	02:41	72	02:24	01:36
4	Tallinn - St. Petersburg	370	06:20	58	04:37	03:05
6	Daugavpils - Klaipeda	358			04:29	02:59

TABLE 8: TRAVEL TIMES OF INTERNATIONAL 1520 MM SERVICES

In addition to the abovementioned cross border relations an optional service between Jelgava and Mažeikiai was considered when developing the train service pattern on the corridor Riga – Jelgava – Liepaja. This service could be operated as extension of the proposed Daugavpils – Riga – Jelgava regional express train services. Further details are described in chapter 2.5.4.

Regarding development of the service concept it is important to ensure that the national demand potentials on both side of the border is exploited in order to provide enough passenger using the proposed services.

Rolling stock for international services

Rolling stock used for international services could be the same used for regional services (described in chapter 2.4.4) in Latvia because most of the services could be integrated into the regional services. Therefore, regional services to Valga, Daugavpils and Jelgava could be extended to international destinations and using the same rolling stock and maintenance facilities. This has the big advantage that rolling stock management could be simplified and cost for repair and maintenance could be reduced. For that approach it is necessary to keep requirements regarding different voltages in mind which could be solved by using bimodal and diesel rolling stock.

[19] Additional time will be needed for border crossing since Pskov is a non-EU destination.

2.5.4. Operational concept 2026/36

The following line concept was developed by the consultant in this study: the principle of through running is applied to provide fast direct connections from the inland destinations to the Baltic Sea coast and to provide a service pattern which can be operated on the proposed platforms of Riga Central station. The developed line concept is depicted in Figure 15 below. Regional express trains are highlighted in green. As reference the CT services are indicated as well (grey lines) to mark the commonly used corridors.

For national services on the 1502 mm network within Latvia three RE lines are proposed forming the core network of regional services:

- **RE 10 Ventspils – Tukums – Riga.** This line will provide rail connection between the major station along the route and Riga. On the line section Riga – Tukums the offer is integrated with CT services. This line can be offered at a maximum two-hour service interval. For the master timetable 2026 the proposed service is developed to provide peak hour connection from/to Riga and to cover daytime travel for business and leisure traffic. The service pattern can be filled up in the long-term to provide at least a two-hour service interval during the complete day subject to removal of infrastructure upgrades on single-track section (Tukums - Sloka) as highlighted in section 5.5.2.

- **RE 20 Liepaja – Riga Central – Krustpils - Daugavpils / Rēzekne 2.** This line is intended to provide a fast east-west-connection throughout Latvia. This idea is supported by the benefits of through running on station track occupation in Riga (see section 5). Different service requirements (more traffic east of Riga) can be balance by beginning/terminating services in Riga. It is recommended to provide direct train connections between Rēzekne, Krustpils and Riga. To provide direct services in peak times, when path and station track capacity in Riga node is limited and to balance capacity train coupling and sharing in Jelgava is recommended. Possible alternatives are described in section 5.5.3. The same applies to services Riga – Rēzekne, for which train coupling and sharing at Krustpils might be considered to provide direct connections Riga – Rēzekne at the hours most attractive to passengers. On the line section Riga – Aizkraukle the trains operate as fast services stopping only at Salaspils, Lielvārde, Ogre and Aizkraukle. On the line sections east of Aizkraukle trains shall stop at every served station as long as there is no adequate slow train service provided. Target of this recommendation is to provide more regular departures on all intermediate stations since east of Aizkraukle since the RE20 is initially proposed to be the only service on the line. Results of the timetabling study confirm that one hourly path can be provided between Aizkraukle and Riga during peak hours. Thus, minimum possible service interval will be one hour. Timetable structure east of Krustpils is subject to passing loops on single track sections on the lines Krustpils – Daugavpils and Krustpils – Rēzekne which leads to variations in proposed travel times and. Where possible the faster services are provided in load direction (to Riga in the morning, from Riga in the evening). The lines could be extended further east (Rēzekne – Zilupe) and Daugavpils – Indra. An initial proposal is provided about the number of services is indicated in Table 9 below and illustrated in the tabular timetables in annex 9.

All three lines are proposed to be integrated in the 30-minute node in Riga to provide the best possible interconnectivity to Rail Baltica, between regional services serving different parts of Latvia and from and to the commuter network. Further details about the proposed interconnectivity at Riga Central are outlined in chapter 5 of this report.

- **RE 30/IRE 30 Riga – Sigulda – Valga – Tartu.** The regional express trains of line IRE30 are intended to provide fast connections from/to Riga with less frequent stops on the line section Sigulda – Riga. East of Sigulda all stopping places shall be served to provide a homogeneous service pattern with attractive departures from every location served. A faster service could be provided by omitting few less frequented stops by certain trains, but this will have no significant impact on travel time on the current infrastructure. Initial proposal for the master timetable 2026 is to provide a 2-hour regular service interval between Riga and Valmiera. Four trains per day are extended to Valga and Tartu calling in Strenči and Lugaži.

- **Line R70/71 Riga – Plavinas – Madona – Gulbene / – Krustpils.** A separate line Riga – Plavinas – Madona – Gulbene is proposed. Initial proposal is to provide 2 daily train pairs. These are outlined in the developed master timetable 2026/36. For these lines separate paths starting/terminating at the full-hour node at Riga Central are reserved. In Riga suburban area trains are only calling at the larger stations. In the future this service could be extended to provide a slow product on the Riga – Krustpils line. This would allow to accelerate the RE20 services Riga – Krustpils – Daugavpils by omitting less frequently used stops. Due to the long travel times this is recommended as the preferred option for development of a "slow" product east of Lielvārde calling at all intermediate stops. The additional benefit of this approach would be, that direct connections from communities like Aizkraukle, Plavinas towards Jēkabpils could be provided without slowing down RE services which would be interesting for leisure and commuter traffic from communities like Aizkraukle and Plavinas towards Jēkabpils. Services could be extended to Daugavpils providing additional opportunities for daily commuting from the smaller stops along the line and to accelerate RE trains Riga – Daugavpils (travel time improvement max. 6-8 minutes depending on location passing loops for RE trains). However, due to the limited number of intermediate stops and the overall low population density outside the bigger centres (Jēkabpils, Daugavpils) additional benefits will be limited. Provision of these additional services will be subject to required freight capacity in Riga node since introducing these services will cost one freight train path in each hour the services are operated.

All three lines are proposed to be integrated in the 30-minute node in Riga to provide the best possible interconnectivity to Rail Baltica, between regional services serving different parts of Latvia and from and to the commuter network. Further details are outlined in section 0.

For cross-border daytime destinations it is proposed to have either a through service or an interconnecting service. The proposal is developed in a way, that synergies with national traffic on both sides of the border can be achieved to support the business case. The related options are described as follows:

- **Riga - Valga - Tartu** services shall be operated as fast direct services. This is achieved with the proposed line RE30/IRE30 as described above. Cross border and national services are integrated into one service pattern to provide more frequent and more regular departures. North of Valmiera the cross-border train to Valga – Tartu are the only public passenger services on the line. Vice versa for line section Valga – Tartu the indicated cross-border trains can be integrated into the Estonian timetable to provide a more frequent and regular offer with Valga -Tartu – Tallinn services. Trains shall have connection to Tallinn in Tartu or could even be extended to Tallinn. With inauguration of Rail Baltica the main benefit would be to provide more frequent direct connections to Tallinn on the Estonian side (e.g. Valga – Tallinn). If train coupling and sharing in Valga is applied one train portion could also be extended to Võru. With possible travel time reduction on the line section Valga-Võru below 30 minutes the overall travel time between Riga and Võru would be approx. 2 hours.

- **(Riga-) Jelgava - Šiauliai** services (RE21) could be operated as extension of the RE20 services (Daugavpils – Riga – Jelgava – Dobele – Liepaja). Depending on the time of the day the spare hourly RE train slots on Riga – Jelgava line could be used. To provide the services during peak hours (business travel and long-distance commuting) train coupling and sharing in Jelgava would allow using the same RE slot by trains from/to Liepaja and from/to Šiauliai. If this is not feasible due to technical constraints (signalling), an interchange connection could be provided in Jelgava instead, if no spare slot Riga – Jelgava is suitable to meet the demand.

- Reintroduction of train services between Jelgava and Mažeikiai (approx. 40.500 inhabitants) is considered as an option. These train services would allow for cross-border commuting and leisure traffic utilising the re-introduced railway border crossing at Renge. Initial proposal is to run 2 daily train pairs. These services should be integrated into the RE 20 service pattern by applying train-coupling and sharing in Jelgava or by using spare paths not used by RE 20 Riga – Liepaja services. Introduction of such service should be supported by a detailed demand analysis to confirm cross-border demand.

- The **services from Daugavpils to Lithuania** shall be provided as separate services starting/terminating at Daugavpils. This would support easy integration of the services with services on Vilnius - Turmantas line. When possible through running to Vilnius should be provided as most attractive service. However, these trains shall be interconnected to Riga – Daugavpils services arriving/departing around the full hour node in Daugavpils as proposed in the developed master timetable. As outlined in section 5.4.4 of this document a future rail service to Panevėžys would be beneficial to interconnect Daugavpils to Rail Baltica services and to provide additional interconnections to Eastern Lithuania.

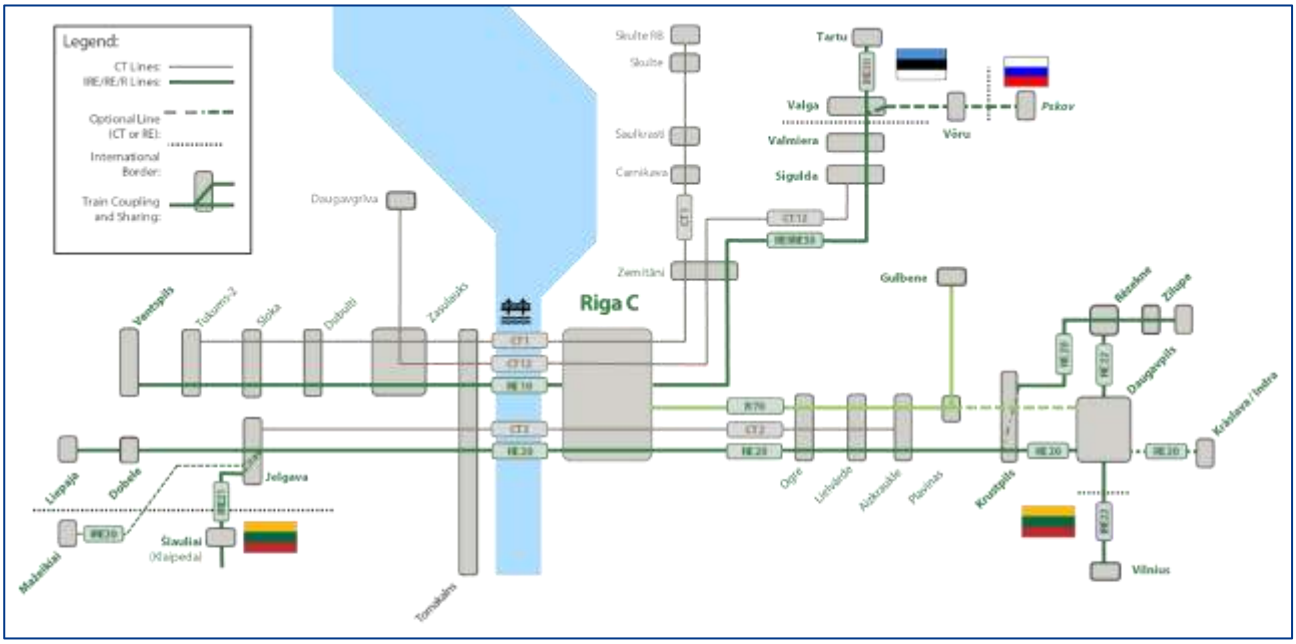


FIGURE 15: PROPOSED REGIONAL PASSENGER TRAIN SERVICES

In Table 9 the proposed service volume for the master timetable 2026/36 is indicated as train pairs per day. Where suitable the proposed service pattern was optimized to provide a better rolling stock utilisation and to include all required departures. The detailed tabular timetables for each line indicating all considered intermediate stops are outlined in annex 9. Specific operational features of the developed timetable are described in sections 5.4. and 5.5 of this report.

Line	From	To	Section	Daily train pairs	Remarks
RE10	Ventspils	Riga C	Ventspils – Riga C	4	
IRE20	Mažeikiai	Riga Central	Mažeikiai – Riga C	2	Train Coupling and Sharing with RE20 in Jelgava
RE20	Liepaja / Dobele	Daugavpils / Rēzekne - Zilupe	Liepaja - Dobele	4	
			Dobele – Jelgava	10	
			Jelgava – Riga C	10	
			Riga C – Krustpils	12	
			Krustpils – Daugavpils	11	
			Daugavpils – Krāslava	6	Recommended option, timetable not studied in detail
			Krāslava - Indra	3	
			Krustpils -Rēzekne	4	Train Coupling and sharing in Krustpils recommended providing through services Rēzekne – Riga C
			Rēzekne - Zilupe	2	
IRE21	Jelgava	Šiauliai	Jelgava - Šiauliai	2..3	Timetable not studied in detail, train coupling and sharing with RE20 in Jelgava or through running to Riga C using spare RE10 slots
IRE22	Daugavpils	Vilnius	Daugavpils - Vilnius	4	Timetable not studied in detail
RE23	Daugavpils	Rēzekne	Daugavpils – Rēzekne 2	6	Recommended option, timetable not studied in detail, through running towards Vilnius and/or Panevėžys could be introduced
RE30/ IRE30	Riga C	Valga-Tartu/Võru	Riga C – Sigulda	12	Incl. 4 trains Riga C – Sigulda as peak hour services Mon-Fri
			Riga C – Valmiera	8	
			Valmiera - Valga	4	
			Valga – Tartu/Võru	4	Optional portion operating to Võru with train coupling and sharing in Valga

TABLE 9: PROPOSED SERVICE OFFER TIMETABLE 2026/36 – REGIONAL TRAIN SERVICE

2.5.5. Long-term service development

To support the underlying idea of a fixed interval, offer oriented service pattern and to provide a basis for comparison two benchmarking examples from less densely populated areas are included here in the box below.

These two examples illustrate what can be achieved by provision of standard rail service with offer-oriented timetable. The outlined service frequencies mark the lower end of the service frequencies offered on German mainline network. Overall, a service interval of 120 minutes can be considered as the minimum standard to offer a convenient rail service. When comparing these figures, it must be considered that usually there are no parallel bus services competing with regional public transport and population density in areas covered by rail is higher than in Latvia (outside Riga suburban area).

Benchmarking example regional rail passenger services in less densely populated areas (East Germany, Brandenburg/Northern Saxony)

Regional express services – example RE 10 Leipzig – Cottbus

The cities of Leipzig (approx. 560,000 inhabitants) and Cottbus (approx. 100,00 inhabitants) are interlinked by a fast regional express train service covering a distance of 150 kilometres which is operating at a typical maximum line speed of 120 km/h. With the currently supplied infrastructure an average travel time of 1 hours 42 minutes and a travel speed of 88 kmph are reached. The service is offered based on a two-hour service interval. This relation is currently not served by long-distance trains of Deutsche Bahn, thus the subsided RE trains provide the only fast service, which also covers the significant over regional service potential (interconnectivity to long-distance trains in Leipzig, e.g. Berlin – Munich route and interconnectivity to Leipzig airport). The trains stop at regional centres along the line. In 2015 approx. 550,000 annual passengers used the services of RE10 which correspond to a service utilization of approx. 80[20]..100[21] passenger km per train km. The services are accompanied by additional regional train services. So altogether at least one hourly departure is offered on the larger stations for each direction.

Cottbus is currently only covered by a low amount of long-distance bus services. Thus, competition with bus services is low. While both cities are interconnected to the German federal motorway network there is no direct motorway connection between both cities.

Regional train services Cottbus – Goerlitz – Zittau

The city of Cottbus (100,000 inhabitants), the city of Goerlitz (56,000 inhabitants) and the town of Zittau (approx. 28.900 inhabitants) are interconnected by an hourly rail passenger service stopping at all intermediate stations. This line is running in north south direction parallel to the border between Poland and Germany and thus to be considered as tangential line. Trains cover 94 km distance between Goerlitz and Cottbus and 34 km between Goerlitz and Zittau. Despite shrinking population in rural areas, with partly unfavourable economic conditions overall more than 696,000 annual rail passengers were counted on the Saxon sections of the line in 2014[22], which corresponds to avg. 26 passenger kilometres per line kilometre occupy the trains on line sections between Cottbus and Goerlitz, which is also due to the influence of the regional centres along the line (e.g. Weisswasser – 19,900 inhabitants and Spremberg – 25,050 inhabitants).

The public transport services are supplied such, that there are either no competing parallel bus services or services are interconnected to rail or complementing rail services on parallel lines (additional offer Monday to Friday, more focus on serving additional destinations not reachable by rail, optimized for school traffic). This is supported by integrated tariff solutions (VBB tariff for line sections in Brandenburg and ZVON tariff for line sections in Saxony).

FIGURE 16: BENCHMARKING EXAMPLE: REGIONAL TRAIN SERVICES IN EAST GERMANY

It can be concluded that at least a two-hourly regional/national passenger service interval shall be supported on all lines and for most of the stations to provide an attractive and flexible service which can be efficiently interconnected

[20] Own estimate for lower occupied sections
[21] Basisgutachten ÖPNV Strategiekommission Sachsen, 2010
[22] Basisgutachten ÖPNV Strategiekommission Sachsen, 2010

to the local bus network. The examples clearly support the idea to provide more frequent rail services between Riga and the central locations in Latvia (Ventspils, Liepaja, Daugavpils, Jēkabpils, Rēzekne). While it is standard to offer fast and slow services on all lines,

Thus, the long-term focus shall be extending the proposed services train service on a more offer oriented basis, to improve competitiveness compared to bus services and to support the coverage of new market segments with additional travel needs (tourism, leisure, increased flexibility for business trips). This could include further shortening of travel times as well as provision of additional trains, mainly by filling up spare paths in the timetable such that no additional paths are required in the core area around Riga Central station.

The potential travel time improvements are outlined in the Table 10 below.

Train relation	Travel time comparison Current timetable vs. master timetable 2026			Runtime comparison 120 km/h vs. 160 km/h maximum speed[23]		
	Current timetable	Master timetable	Travel time difference	120 km/h Diesel	160 km/h Electric	Runtime difference
Riga – Liepaja	3:10	2:56 - 3:00	0:10	2:05	1:53	0:13
Riga - Ventspils	N/A	2:21 - 2:37	N/A	1:52	01:42	0:10
Riga – Sigulda - Valga	2:33-2:55	2:21 - 2:37	0:12 - 0:18	1:56	01:36	0:19
Riga – Krustpils - Daugavpils	3:18-3:43	2:25 - 2:47	0:53 – 0:56	2:14	01:52	0:23
Riga – Krustpils – Rēzekne - Zilupe	4:33	3:08	1:25	2:55	2:29	0:34

TABLE 10: POTENTIAL TRAVEL TIME IMPROVEMENTS FOR REGIONAL PASSENGER SERVICES

As can be seen introduction of the services according to the proposed master timetable would already lead to gains in overall travel time depending on corridor and stopping pattern of the proposed services. Further improvement of travel time can be achieved, if the line speed is upgraded from the current maximum 120 km/h to 160 km/h per hour. In principle these speed upgrades could be realized without expensive realignment of track sections due to the overall favourable geographical conditions and the already applied infrastructure parameters. Nevertheless, the question remains, how much additional investment is needed to provide required changes in the signalling system (signal distances and signalling principles) and to adapt level crossing protection system currently designed for 120km/h maximum speed. According to findings outlined in section 4.5 up to 160 km/h maximum speed the existing train protection system (ALSN) could be used. Rolling stock for regional passenger services available on the market is designed for this maximum speed as standard use case.

As outlined before the future service shall be developed as regular and flexible service with short travel times based on a 2-hourly service interval where required. Based on this principle, the long-term service requirements were estimated. These are summarised in Table 11 below. While overall number of train pairs per day and the general

[23] Unhindered runtime with considered optimized RE stopping pattern, without additional travel time within a complete service pattern (suburban services, freight trains, meeting with train on opposite direction in single track sections etc.)

service interval mainly impacts the operational cost of the railway undertaking the infrastructure must be designed to allow the minimum service interval in peak hours. It can be assumed that due to the overall structure of the network morning and evening peaks for the traffic to Riga will lead to a minimum 60-minute service interval in load direction while the service interval in the other direction can be longer with less frequent services. Such a service pattern is to be supported by the future infrastructure (passing loops at the suitable locations, partial double traction of line sections).

Line	From	To	Section	Service Interval (minutes)		Train pairs per day	Remarks
				Peak (standard for both directions/ minimum in load direction)	Off-Peak (Shortest interval possible in both directions)		
RE20	Liepaja / Dobele	Daugavpils / Rēzekne – Zilupe	Liepaja – Dobele	120 / 60	120	8	
			Dobele – Riga C	60 / 60	120	10	
			Riga C – Krustpils	60 / 60	120	12	
			Krustpils – Daugavpils	60 / 60	120	8	
			Daugavpils – Krāslava	120 / 60	120	8	
			Krustpils - Rēzekne	60 / 60	120	4	
			Rēzekne - Zilupe	120 / 120	120	4	Alternatively change to bus
IRE20	Mažeikiai	Riga C	Mažeikiai – Riga C	120 / 120	240	4	Train coupling and sharing with RE20 in Jelgava
IRE21	Jelgava	Šiauliai	Jelgava - Šiauliai	120 / 120	240	4	Recommended option, timetable not studied in detail
IRE22	Daugavpils	Vilnius	Daugavpils – Turmantas (-Vilnius)	120 / 120	240	6	Integrated offer Daugavpils – Turmantas - Vilnius
RE22	Daugavpils	Rēzekne	Daugavpils – Rēzekne	120 / 60	120	9	Partly Integrated offer with IRE 20 Vilnius-Daugavpils
RE10	Ventspils	Riga C	Ventspils – Riga C	120 / 60	120	9	

Line	From	To	Section	Service Interval (minutes)		Train pairs per day	Remarks
				Peak (standard for both directions/ minimum in load direction)	Off-Peak (Shortest interval possible in both directions)		
			Tukums – Riga C	120 / 120	120	9	Subject to future infrastructure Tukums – Sloka and passing regime
RE30/ IRE30	Riga C	Valga - Tartu	Riga C – Sigulda	60 / 60	120	12	
			Sigulda – Valmiera	120 / 60	120	12	
			Valmiera – Valga (–Tartu)	120 / 60	240	6	International services might be extended to Võru (optional train coupling and sharing in Valga)
R70/71	Riga C	Gulbene / Krustpils	Riga C – Plavinas	120 / 60	N/A	6	In case of electrification extension of CT services to Plavinas or Krustpils could be considered
			Plavinas – Gulbene	120 / 60	N/A	5	
			Plavinas - Krustpils	120 / 60	120	4	
			Krustpils – Daugavpils	120 / 60	120	4	
R72	Daugavpils	Rēzekne	Daugavpils – Rēzekne 2	60 / 60	120	8	optional

TABLE 11: PROPOSED LONG TERM OFFER (TIMETABLE 2046) FOR REGIONAL TRAIN SERVICES

2.6. International night passenger transport

2.6.1. Background and requirements

After summarizing the international 1520 mm day services the focus will be laid to long-distance night services to Moscow, Kiev and Minsk and potentially to St. Petersburg via Pskov (shown in Figure 17). Main operator for international night trains in Latvia is L-Ekspressis.

At the time of the writing of this part of the report no stakeholder meeting with L-Ekspressis could been held but is in coordination. This is not seen as a problem or stopping point by the consultant, because all necessary information was collected by own additional research or is provided by L-Ekspressis online. Until further crosscheck by L-Ekspressis the collected data is sufficient to define the operational principles of overnight passenger operation from and to Riga and to assume possible future expansion of the services.

FIGURE 17: OVERVIEW 1520 MM NIGHT TRAIN SERVICES

The collected data does include information about rolling stock, service pattern and the maintenance facility (see in Table 12 below).

Information	Current situation	Future plans and possibilities
Rolling stock	Current rolling stock is been maintained in the new facility, already very long trains	New Russian night train rolling stock, can be purchased and uses for the next 30 years, increase in demand only with more trainset or double stack rolling stock
Maintenance and depot	Can be checked online, modernized facility in 2012 for coaches only, locomotives in Daugavpils	Depot can be run at least for 30 years until 2043 after TP 3 and is therefore futureproof
Service pattern	Can be checked online, single trains daily or every second day in off-peak	Increase in demand can be solved trains every day (Riga-Minsk-Kiev) or an additional train one hour apart (Riga-Moscow).

TABLE 12: CURRENT AND FUTURE SITUATION OF L-EKSPRESIS

Current and Future service pattern

The current service pattern of L-Ekspressis can also be used to display the future service pattern as well. Since long-distance night trains are usually integrated in several international networks on their path, changes in the timetable are quite complex. Therefore, for the study it will be assumed that the time window for the night trains will not be altered and only minor changes will be made. Most of the current trains arrive in Riga between 7:30 and 8:30 am and at least the night train to Moscow is departing around 16:50 o'clock (depending on time-shift to Russia in summer/winter time) including longer dwell times at the platform for preparations and postprocessing occupying platforms rather long (shown in Figure 14). This means most of the night trains operate within the peak hour and occupy valuable platforms required for peak hour suburban and regional services.

FIGURE 18: SERVICE PATTERN OF L-EKSPRESIS (EXCERPT)

Rolling Stock and Maintenance Facility

Regarding rolling stock L-Ekspresis using rather old but modernized rolling stock and according to one statement is in good shape too. Even if new rolling stock is required in the future, procurement is possible either through purchasing of European 1435 mm rolling stock brought to 1520 mm Requirements or 1520 mm rolling stock from countries with 1520 mm infrastructure. Since L-Ekspresis owns a modernized maintenance facility for 1520 mm coaches the latter option will be assumed for the study by the consultant. Same assumptions were made for locomotives since the trains must be compatible with Russian and Belarusian infrastructure anyway.

FIGURE 19: L-EKSPRESIS OWNED DEPOT IN VAGONU PARKS[24]

Maintenance of coaches will be made in the depot in Riga in Vagonu parks. The facility has been modernized in 2012 and it is expected by the consultant to be active at least for the next 30 years within the 3 TP´s. Maintenance of locomotives will be assumed to be done near the border in Daugavpils since trains are switching locomotives within the operation pattern on a daily basis.

[24] http://l-ekspresis.eu/en/repair-of-coaches/who-are-we/who-are-we/

Integrating night train service operations into an integrated 1435/1520 mm service pattern should become challenging, as night trains currently operate inside the peak hours. A possible solution could be the reduction of travel times which would shift the night trains services out of the peak hour.

2.6.2. Operational concept

Based on the facts outlined above it is proposed that the existing two 1520 mm night train pairs:

- Riga – Krustpils – Rezekne-2 – LV/RU border Novosokolniki – Moscow/St. Petersburg and
- Riga – Krustpils – Daugavpils – Minsk

shall be assumed to continue operation in the future on a daily basis (one train per day per direction). The departure shall be assumed in the evening, the arrival in the morning. Due to uncertainties in development of travel times cannot be ruled out will arrive and depart during peak hours.

Based on rolling stock currently available on the market these trains will continue to be loco hauled with at least the current train length (also to provide for direct feeder services to additional connections). Trains shall be able to operate at maximum permitted line speed. To be on the safe side it is assumed for timetabling that current rolling stock will be used in the first years of operation under the regime of the master timetable 2026/36. This situation might change especially, if the line Riga - Daugavpils would be electrified at a later stage. Due to operational reasons and for the convenience of the passengers the trains shall have longer dwell time at Riga Central station. Layover of trains during daytime shall be performed in Vagonu parks (closed to L-Ekspresis depot/workshop).

Services in north-south direction will be likely covered by Rail Baltica (late/early day services or night trains). Thus, no additional train paths will be reserved for such trains.

2.7. Current and future freight transport

2.7.1. Background and requirements

Focus for summarizing the freight traffic will be the area around Riga Central station regarding the Riga Node Optimizations study with the core area around Riga Central station. Main operators of freight services are Baltijas tranzīta serviss, LDz Cargo and Baltijas Ekspresis. To access the current freight traffic data will be derived from timetable data of the Riga Central area, and information given by the network statement by LDz.

Main approach of the contractor is to reserve paths for freight trains as they don't follow a fixed service pattern but using left available capacity from passenger services not being restricted by strict requirements of passenger services like connections and turnaround times. For that reason the quantity structure and main line pattern will be summarized and extended with a hypothetically growth of freight volume for the future by the contractor to stay on the safe side left open for debate with the stakeholders as the volume of freight traffic is subject to external factors that are not being part of that study.

Freight traffic in Riga node is dominated by the necessity to serve the various terminals of the Freeport of Riga and to serve the Šķirotava shunting yard, where nearly all trains will be remarshalled, from various directions

The recent development of transhipment volumes as well as a future outlook is provided in the Freeport of Riga development program.[25] The expected development according to this masterplan is illustrated in Figure 20 below. The future outlook is based on two scenarios (minimum scenario with annual turnover of 27.4 million tonnes in 2028; optimistic scenario with cargo volumes slightly exceeding the level reached in 2016 41.1 million tonnes).

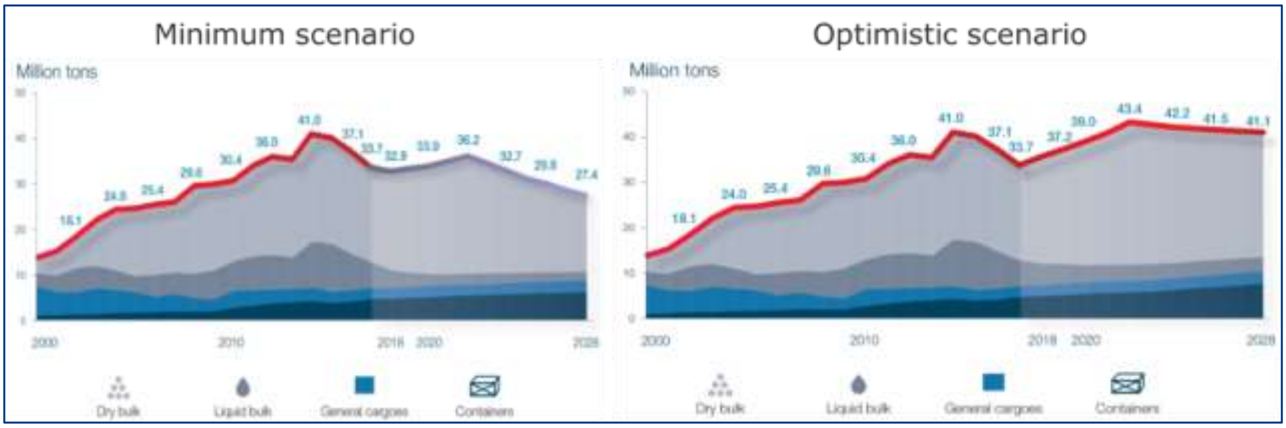


FIGURE 20: FREEPORT OF RIGA - FORECAST OF CARGO VOLUMES PER COMMODITY TYPE SCENARIO

Taking into account most recent developments with dropping of annual cargo turnover by 10% compared to the previous year the minimum scenario seems to be closer to current reality. Regarding cargo structure both scenarios foresee a decline of liquid bulk. In the minimum scenario, a significant decline of dry bulk (mainly coal and fertilizers) is expected. In both scenarios the share of intermodal traffic is rising.

Most recent port development and investment activities included shifting of facilities from Andrejsala and Eksportosta areas, which are located close to the city centre and shall be redeveloped, to the island of Krievu Sala on the left bank of Daugava River. To achieve this the railway line to Bolderaja and the railway access inside the terminal area were significantly improved, including new signalling facilities as well as construction of Bolderaja-2 station as reception yard for Krievu island and construction of new rail access to Krievu Sala island, including construction of an additional yard on the island. Shifting of facilities was completed in 2019 with the inauguration of the new coal terminal at Krievu Sala. Preparatory activities for redevelopment of the port area at the right bank of Daugava river have now started.[26]

[25] Freeport of Riga development program, Freeport of Riga, 2019
[26] Source: http://www.baltic-course.com/eng2/transport/?doc=153556, retrieved 01/03/2020

As shown in Figure 21 the main destinations in Riga from the Freight yard in Jāņavārti and Šķirotava are

- Bolderaja via Riga Central station and Torņakalns, serving the newly developed terminal areas at the island of Kundziņsala. In 2019 the new coal terminal was opened for public operation.
- Traffic to southern access to Riga Port area via Zemitāni - Brasa triangle to Riga Krasta
- Traffic to northern port terminals interconnected via sidings from Mangali and Ziemeļblāzma stations via Zemitāni and Brasa triangle.

Freight traffic to port facilities at right bank of Daugava river does not pass Riga Central station and uses the connection from Jāņavārti to Zemitāni directly. However, the path availability on the level junctions at Brasa triangle is to be considered.

Additionally, freight train paths have to be reserved for in and outgoing trains from and to the Riga freight yard coming from Valga, Aizkraukle Tukums and Jelgava.

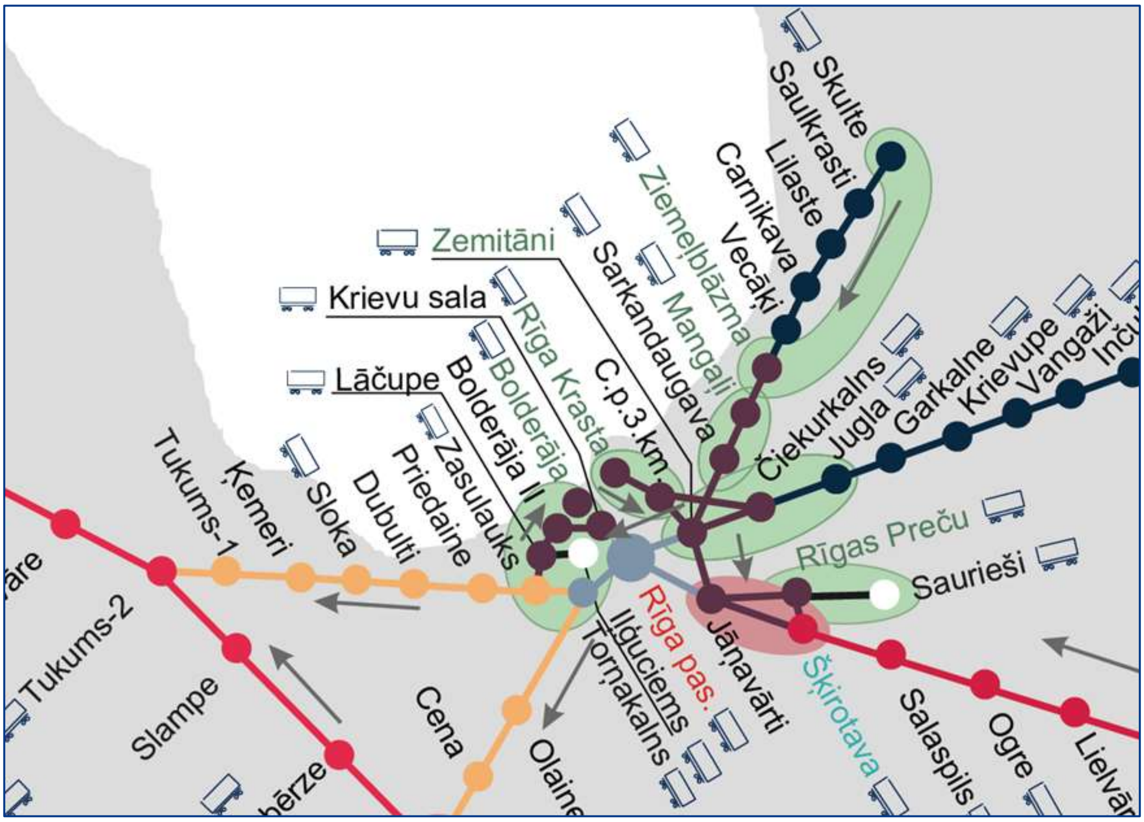


FIGURE 21: FREIGHT SIDING AROUND RIGA FROM LDZ NETWORK STATEMENT 2021

The quantity structure of the freight traffic is derived from the graphical timetable for the core area of Riga Central station delivered by LDz (excerpt shown in Figure 22). According to these data freight paths for the day are the following:

- One freight train path every 2 hours from the yard (Šķirotava/Jāņavārti) via bypass and Zemitāni to Brasa
- One freight train path every 2 hours from the yard (Šķirotava/Jāņavārti) via bypass and Zemitāni to Mangali
- One freight train path every 2 hours from the yard (Šķirotava/Jāņavārti) through Riga Central station, Torņakalns and Zasulauks to Bolderaja
- One In- and outgoing freight path every 2 hours from Ventspils-Tukmus2 via Torņakalns to the shunting yard (Šķirotava/Jāņavārti)
- One In- and outgoing freight path every 2 hours from Jelgava via Torņakalns to the shunting yard (Šķirotava/Jāņavārti)
- One In- and outgoing freight path from Aizkraukle to the shunting yard (Šķirotava/Jāņavārti) every hour.

Freight train paths around Riga Central station – as long as they do not influence the traffic through Riga Central station – will not be considered by the contractor.

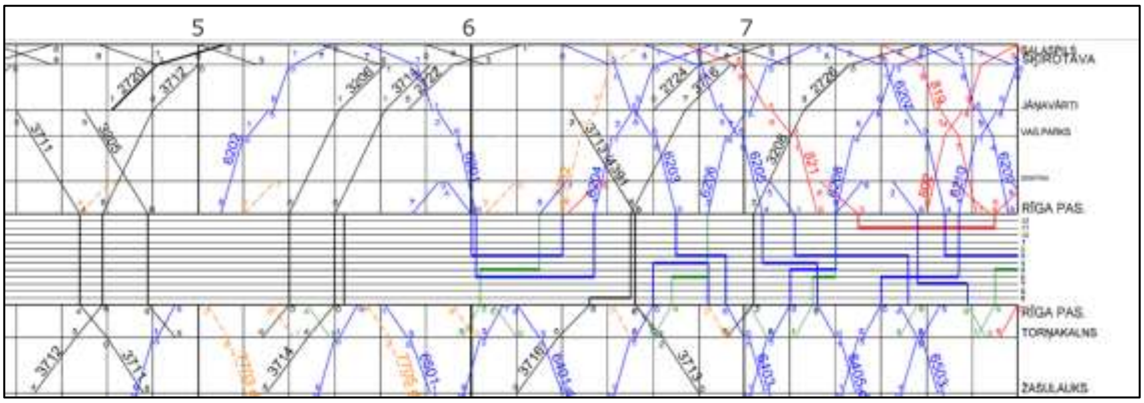


FIGURE 22: GRAPHICAL TIMETABLE 2020 WITH FREIGHT TRAFFIC (EXCERPT)

For run time calculation and to access the capacity allocation of the reserved freight trains path the typical characteristics of the trains are required. To ensure the usability of train paths for every freight train and to maximise the flexibility for the dispatcher, the longest, heaviest and slowest train available and allowed on the LDz network will be used for run-time calculation. The framework for freight trains is described in the network statement 2021 Annex 3.2.2.A. A freight train consists of up 57 – assumed by the contractor – 14 m long standard freight wagons with an altogether maximum length of 855 m and weighs up to 6,000 t. Also, the accelerations of the trains are depending on the number and engine power of used locomotives to haul the train (2M62UM, 2M62M, 2TE25KM, ER20CF and 2TE10M including double traction). Additionally, to ensure that the rolling stock is available over the whole period of investigation, the contractor will use only newer rolling stock for run-time calculation.

When developing the service pattern for freight train paths the maximum possible train length (850 m), weight (between 5,500 and 6,000 t) and required locomotive with the worst kW/t ratio according to the network statement was used for runtime calculations.

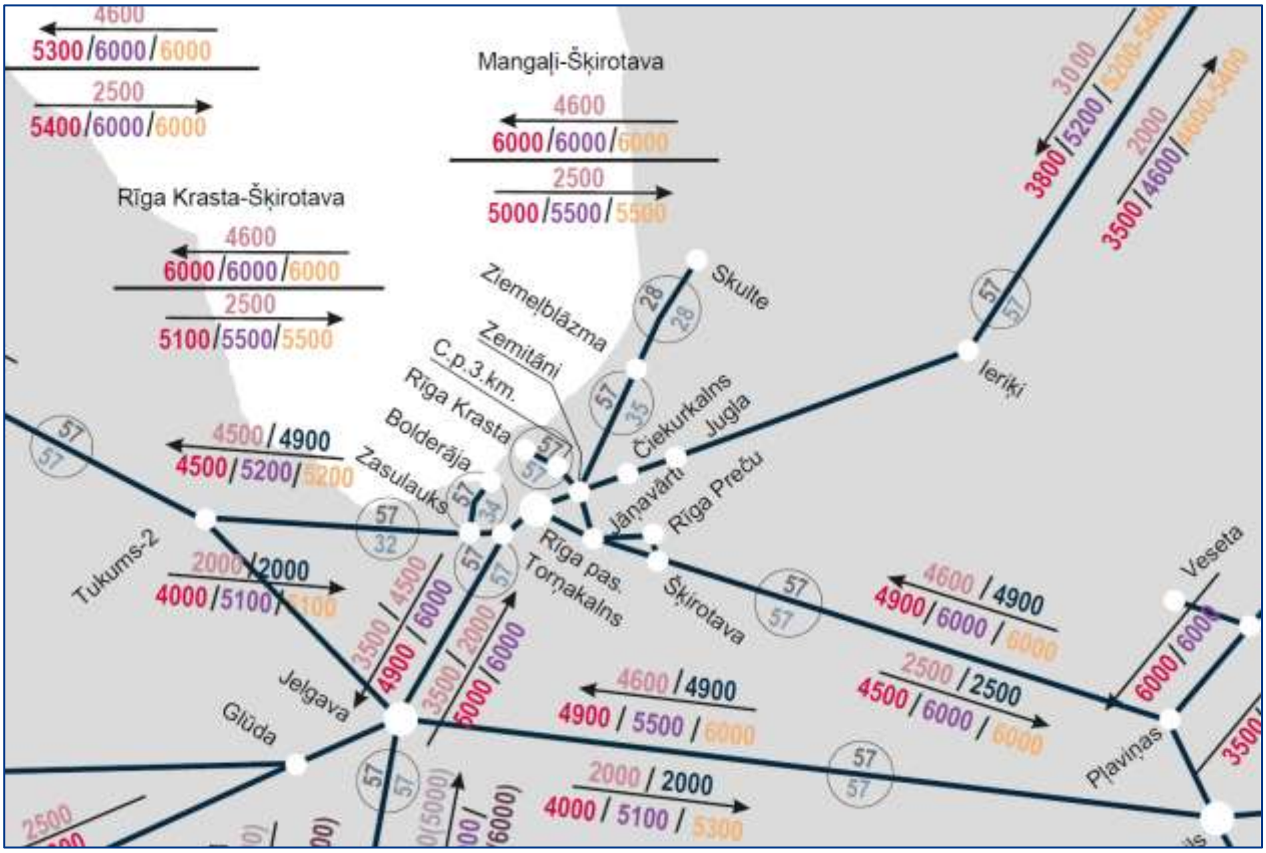


FIGURE 23: WEIGHT AND LENGTH OF LATVIAN FREIGHT TRAINS[27]

The freight capacity to be available is agreed between LDz and the government. The capacity which is to be provided by LDz on individual line section is outlined in annex 1 of the Indicative Infrastructure development plan 2018-2022. The related capacity requirements are outlined in the table below.

Further development of freight traffic is heavily dependent on the geopolitical situation and the resulting flows of Russian freight traffic through Latvian ports. Due to the high level of uncertainty at the moment it is suggested to use the current capacity requirements as outlined in Table 13 below as basis for the Riga node study (same assumption for all time horizons). However, finalising of transfer of major cargo terminals to West bank of Daugava river needs to be considered.

[27] Source: LDz network Statement 2021, Annex 3.3.2.A

Line section		Required freight capacity		Required total capacity	
Line No.	Section	even direction	odd direction	even direction	odd direction
6	Riga Pas. - Jāņavārti	38.5	38.5	82.5	81.5
6	Jāņavārti - Šķirotava	30.5	30.5	82.5	81.5
14	Riga pas. - Torņakalns	30	30	141	142
14	Torņakalns - Olaine	19	19	56	57
17	Riga Pas. - Zemitāni	1	1	55	56
17	Zemitāni - Jugla	10	10	25	24
18	Torņakalns - Zasulauks	11.5	11.5	85.5	85.5
18	Zasulauks - Priedaine	5.5	5.5	78.5	78.5
19	Zemitāni - C.p. Brasa	34	34	72	74
19	C.p. Brasa - Mangaļi	16	16	54	56
20	Čiekurkalns - Brasa	0	0	0	0
20	C.p. Brasa - Riga Krasta	18.5	18.5	18.5	18.5
22	Zasulauks - Bolderāja	6.5	6.5	6.5	6.5
25	Zemitāni - Jāņavārti	44	44	45	45

TABLE 13: REQUIRED FREIGHT CAPACITY (NUMBER OF DAILY TRAINS)[28]

Capacity requirements on other line sections not shown in Table 13 will be considered if needed for the development of the integrated 1435/1520 mm timetable. However, passenger traffic will be the main focus of study for line sections outside the core area.

2.7.2. Operational concept

To provide a basis for the study a "virtual" line concept has been developed. This is oriented on the amount of currently provided regularly timetabled train paths on the main relations relevant for the study Šķirotava – Bolderaja – Krievu sala, Šķirotava – Jelgava, Šķirotava – Sigulda, Šķirotava – Krustpils - Daugavpils / Rēzekne. In line with current operational principles it is assumed that all trains will start and terminate in Šķirotava freight stations (arrival and departure groups). The resulting assumed line concept is depicted in Figure 24 below. The individual line-based slot concept for the different main relations is described in the following paragraphs. This concept is used as basis to check pathing requirements in the railway core area and along the main corridors as part of the master timetable 2026/36. These paths are intended to check interrelationship between passenger and freight services and to show what is possible within the framework of the master timetable. The number of provided paths does not represent the maximum freight capacity of the individual line sections.

[28] Source: own compilation based on Par indikatīvo dzelzceļa infrastruktūras attīstības plānu 2018.-2022. gadam

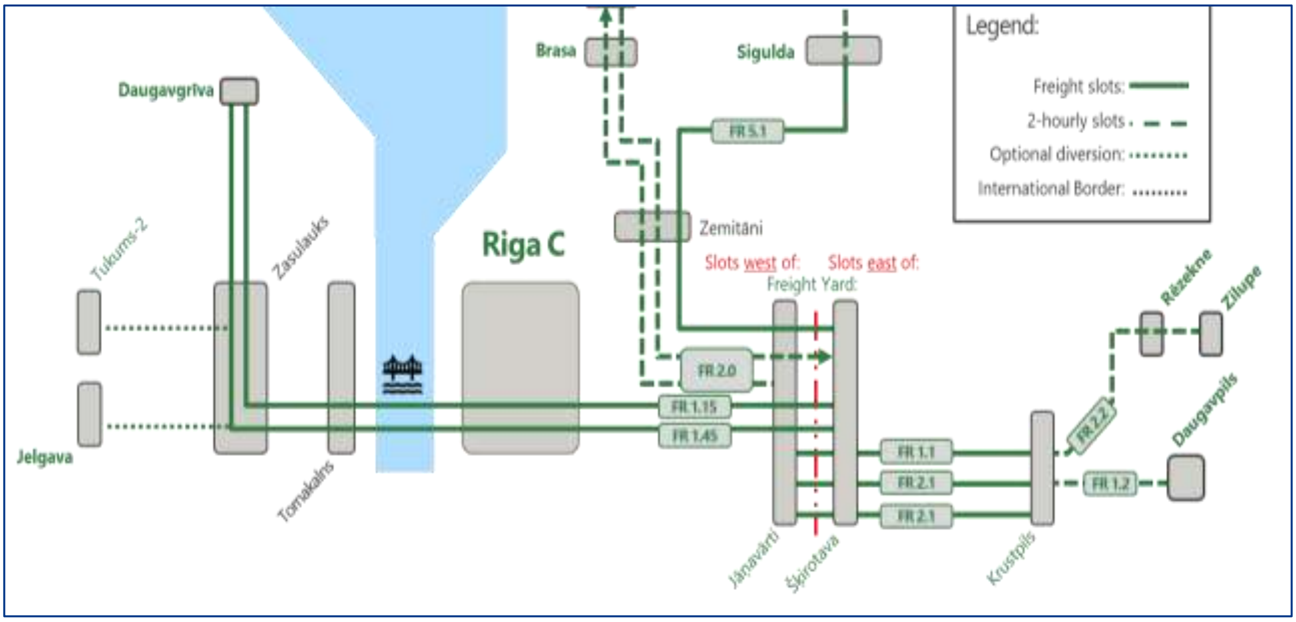


FIGURE 24: PROPOSED FREIGHT LINES/SLOTS FROM AND TO RIGA

Freight trains slots west of the central freight yard in Šķirotava:

- FR 1.45/1.15 slots between the harbour Bolderāja/Daugavgrīva and Šķirotava freight yard via Riga Central station. During peak-hour an hourly freight slot is available through Riga Central station alternately using the slot in 45-minute and 15-minute node 2-hourly in both directions. During off-peak both slots can be used hourly allowing 2 freight trains per hour and direction over the Daugava River bridge. During the peak-hours stop in Riga Central station on track 3 and 10/X can be necessary. The freight train in the slots can also be diverted to Jelgava and Tukums.

- FR 2.0 slots between Mangali and Brasa (through Zemitāni and the bypass) and the Freight Yard Šķirotava: Here an hourly slot with stop in Zemitāni in one direction is possible. The slot cannot be used in both directions at the same time. This allows for a 2-hourly freight train in both directions or alternating use of an hourly freight service in one direction.

- FR 5.1 between Valga-Sigulda (through Zemitāni) and the Freight Yard Šķirotava: Here on the double track section Riga-Sigulda hourly slots over the whole day are possible. On the single-track section between Sigulda and Valga roughly 2-hourly slots within the passenger service pattern are possible.

Freight train slots east of the central freight yard Šķirotava:

- FR 1.1 (also called FR 1.1, 2.1 and 3.1) slots between the Freight Yard Šķirotava and Krustpils and Daugavpils and Zilupe: In general, 3 slot per hour and direction are available over the day on the track section Riga - Krustpils. During peak-hours the number of slots can be reduced to 2 slots per hour due to single RE and R train pairs and night trains. Freight trains can operate no stop during off-peak but will have divers overtaking pattern during of peak-hours to allow the steady operation of three freight trains per hour. On the single-track sections to Daugavpils and Rēzekne-Zilupe the number of possible freight train slots is reduced to a 2-hourly service pattern. Also, trains will have longer to stop in Krustpils to synchronize with the slots to Daugavpils and Rēzekne.

In the result the following freight train slots in Table 14 are possible during the peak-hour, off-peak and during the night.

Line	From	To	Section	Service Interval (minutes)			Train slot pairs per day	Remarks
				Peak	Off-Peak	Night		
FR 1.45	Daugavgrīva	Šķirotava (Riga)	Daugavgrīva – Riga	120	60	-	17	During peak hour slots in 15 and 45-minute node in Riga will be used alternately in both directions. Paths provided by FR 1.45 and FR1.15 over Daugava River bridge are also shared by trains to Jelgava (11 train pairs per day). FR 1.45 and trains to Tukums (4 train pairs per day).
FR 1.15	Daugavgrīva	Šķirotava (Riga)	Daugavgrīva - Riga	120	60	20	29	
FR 1.1	Daugavpils/ Rēzekne - Zilupe	Šķirotava (Riga)	Krustpils - Riga	20-30	20	20	64	During peak-hour single RE and night service block 1 of 3 freight slots.
			Daugavpils - Riga	120	60	60	21	
			Zilupe - Rēzekne - Riga	120	60	60	21	
FR 2.0	Mangali/Brasa	Šķirotava (Riga)	Mangali/Brasa - Riga	60 or 120	60 or 120	20	32	Only one slot per direction can be used at a time, train can operate alternately in both directions every 120 min or in the same direction every 60 minutes.
FR 5.1	Valga	Šķirotava (Riga)	Valga - Sigulda	120	120	120	12	Irregular freight starting/ending in Sigulda possible with dwell time for synchronisation of both track sections.
			Sigulda - Riga	60	60		20	Hourly slot with stop in Zemitāni.

TABLE 14: FREIGHT SERVICES FROM AND TO RIGA DURING PEAK AND OFF-PEAK

2.8. Current and future maintenance and depot locations

Current maintenance facilities in Zasulauks and Vagonu parks

The current maintenance facility of L-Ekspressis in Vagonu Parks was already described in chapter 2.6.1 above. Another current maintenance facility is in Zasulauks and is used by PV to repair and maintain the electric suburban rolling stock fleet (shown in Figure 25 below).

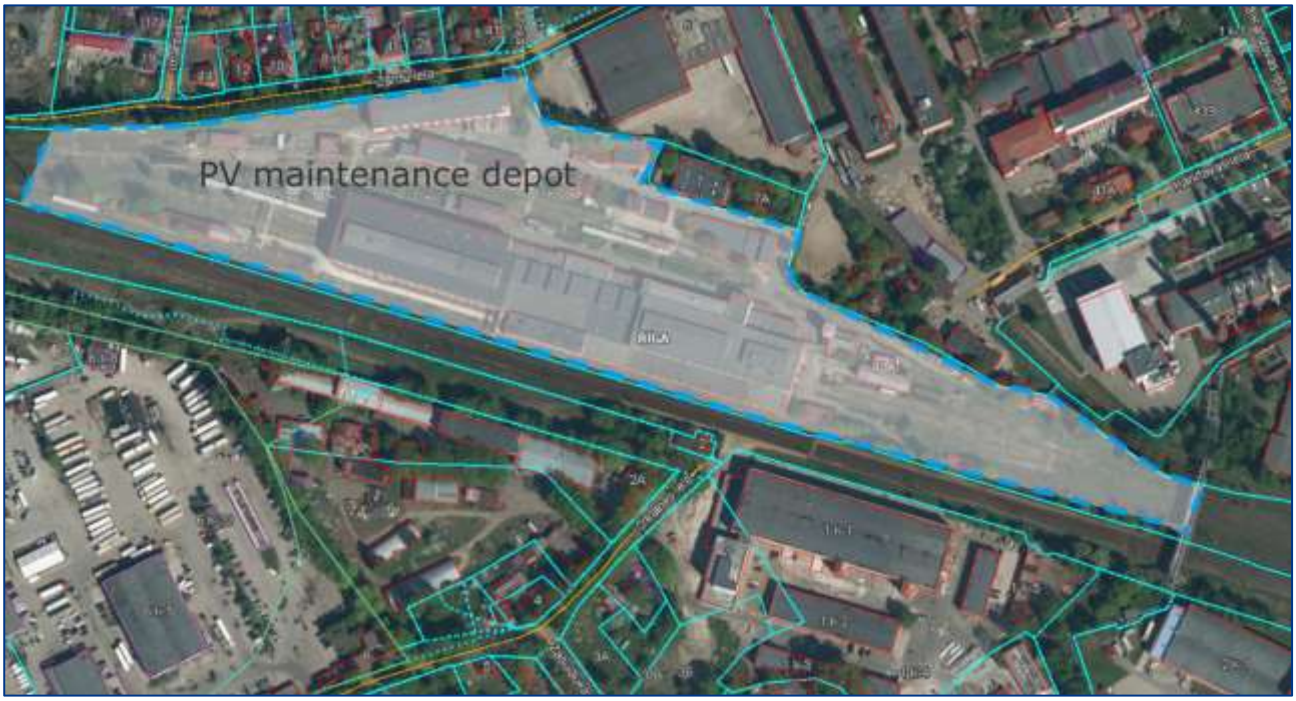


FIGURE 25: CURRENT ROLLING STOCK MAINTENANCE FACILITY IN ZASULAUKS

Future planned Maintenance Facility by PV

A feasibility study was carried out by E&Y on behalf of PV in order to find both strategically and economically advantageous sites for the construction of depots. There are 2 main areas of dislocation – the existing Depot in Zasulauks and Riga Passenger Station Vagonu Park C Parks, as well as the possibility of building a depot in Vagonu Park A Park.

In the current phase the Depot size is planned at ~ 18.500 m². The depot will have 6 tracks for maintenance of AC, DC and diesel/bimodal rolling stock. 3 tracks are reserved for the repair and maintenance of the suburban rolling stock and 3 tracks to ensure maintenance of diesel rolling/bimodal stock. The depot is planned to have a facility for exterior cleaning of rolling stock. For parking it is planned to use the existing parking tracks in Vagonu Park B parks and E parks (location of track groups is indicated in Figure 26 below). A larger version is provided in annex 13.

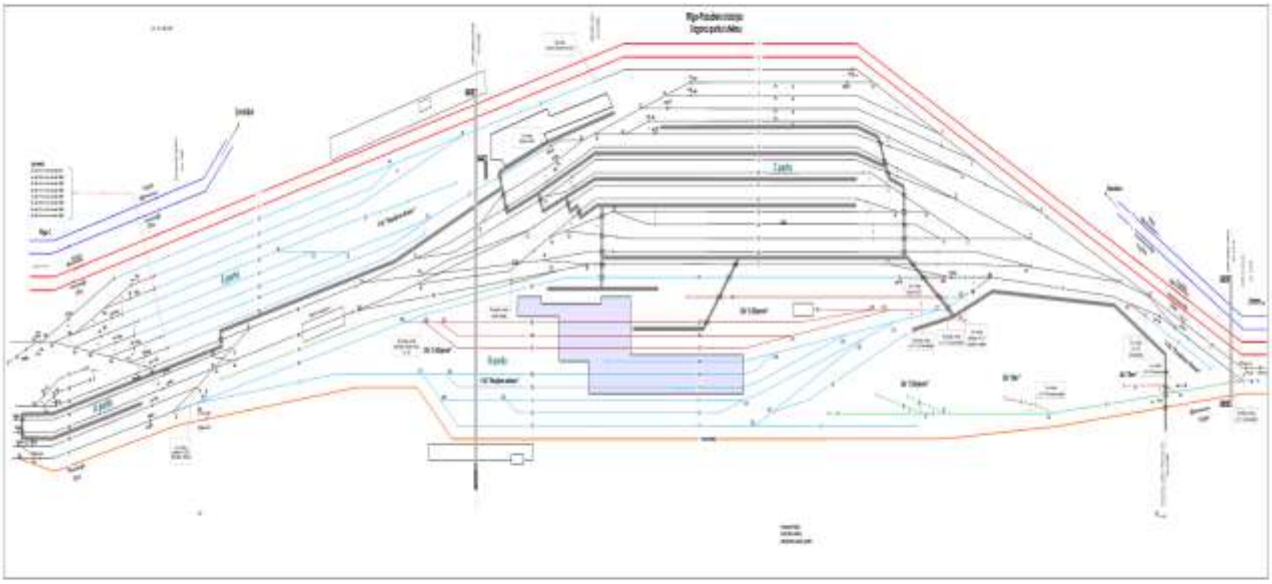


FIGURE 26: CURRENT LAYOVER TRACKS AND MAINTENANCE FACILITIES AT VAGONU PARKS[29]

However, the proposed maintenance facility is not planned to separate repairs of AC trains from DC train repairs. Even more so PV intends to construct (or retrofit the existing facilities) such that it should be able to maintain both existing rolling stock (diesel trains) and the new Škoda electric trains. The concept of maintenance facility is designed to provide both 3 kV DC electric trains and 25 kV AC electric trains as well as the planned diesel trains.

[29] Source: LDZ schematics provided by RB Rail

3. Operational Plan of Rail Baltica

Requirements and future services for Rail Baltica are mainly outlined in RB operational plan, but need to be updated subject to final decisions on maintenance and layover facilities, reflect final decisions regarding feasible track layout and to include an updated service pattern (draft timetable, updated line concept for regional express trains, introduction of peak-hour sprinter trains Tallinn – Vilnius via Riga bypass) developed by RB Rail resulting from CPTD process and own market analysis conducted by RB Rail.

3.1. Currently planned service pattern of Rail Baltica

The fundamental principles of the currently planned service pattern have been developed during elaboration of the operational plan. The service volumes for freight and long-distance traffic were developed based on the results of the Rail Baltica CBA. Additional research was undertaken to check the potential for additional regional train services and related regional stops. This research confirmed that there is a significant demand which should be served by introduction of an additional market segment. At the current stage the financing of the construction of regional passenger stations is not secured, but applications for financing of related planning and design activities were prepared.

The operational plan covers a timespan of more than 30 years of operation. The different demand over time is outlined based on so-called time periods (TP's), which are related to a time span of approx. ten years.

- TP 2026: Service volume in the first years of operation
- TP 2036 and TP 2046: Full market potential is reached. According to the CBA the full market potential can be gained within the first 10 years of operation.
- TP 2056: Reflecting potential additional growth of demand after implementation of the FinEst link.

As part of the elaboration of the operational plan a detailed timetable for passenger and freight services has been worked out. Therefore, the complete infrastructure was modelled using timetabling and simulation software RailSys. Based on the developed timetable the proposed railway infrastructure was adjusted to meet the elaborated requirements (additional passing loops, crossovers, the adjustment of the station layout).

This timetable was updated by RB Rail in 2019 to integrate the results from CPTD and to provide additional long distance and regional passenger services via Riga bypass.

3.2. Passenger services

3.2.1. Introduction

The passenger train service pattern outlined in the operational plan is developed from the consolidated demand forecast and forms the basis for the operational programme on Rail Baltica together with the freight train service pattern. For the evaluation of capacity limits of the line for passenger traffic the train service pattern required during peak hours – and not by the daily number of trains is important. Furthermore, the required train service in peak hours will determine the number of vehicles and required stabling capacity at depots and stations.

According to the updated operational plan there are three service types to be considered for the Riga node study:

- High-Speed Trains (HST) with a maximum speed of 249 km/h and few stops to realise a high travel speed. These trains will stop at the international passenger stations only as defined in an intergovernmental agreement between the three Baltic states.
- Night Trains (NT) for long-distance international overnight services with few stops (V_{max} = 200 km/h) and arrival in the final destinations in the early morning.
- Regional Express (RE) trains to connect regional centres with additional regional stops along the alignment (V_{max} =160/200 km/h).

In the train service pattern assumed for Rail Baltica CBA a dedicated shuttle was proposed to be operated between Riga Central station and Riga airport with up to 36 train pairs per day. This would correspond to a half hourly service over the complete day. Resulting from the preparation of the operational plan this shuttle service was replaced by the newly introduced Regional Express trains complementing each other to provide frequent departures. The currently proposed service pattern would allow for an operation of up to four RE trains per hour per direction between Riga Central station and Riga airport in peak hours.

For this study, the train services in 2036/46 shall be considered as basis for timetabling. According to the terms of reference TP 2056 is not in scope.

The realisation of regional passenger services (both the required infrastructure as stations + intermodal facilities and the PSC-based train operation) will depend of the political willingness and financial means of national and regional authorities. At the current stage there has been no decision by the authorities how and when to develop and introduce such services. Currently it is envisaged to start the operation of the first regional passenger services around Riga as soon as possible. This especially relates to services calling at Riga airport station to provide a link between the city centre and the airport as proposed. Thus, regional passenger train service is to be considered in this study beginning with TP 2026. It shall be assumed that services on all lines shall be operational.

3.2.2. Updated passenger train service pattern

Figure 27 shows the updated passenger train service pattern in 2036/46 considering the latest updates by RB Rail and the potential interconnectivity of 1435 mm services with 1520 mm train services as outlined in section 5.3. This line concept is the basis for the offered passenger trains in all three time-horizons. With growing demand, the number of daily trains will be adjusted over the years. According to Rail Baltica global CBA the full market potential of Rail Baltica shall be revealed within the first ten years of operation. Thus, an updated train service pattern for time horizons 2036 and 2046 will be identical in line with assumptions taken in the RB operational plan. A reduced train service pattern for 2026 could be derived based on the final timetable following service principles outlined in an operational plan and considering rolling stock circulation, stabling facilities and interconnectivity of services.

In the long term both HST and RE trains are operated in an hourly service (together 2 passenger trains per hour and direction) where in areas with a higher demand as on the section Kaunas – Vilnius or around Riga the number of trains is higher. Individual lines with a certain headway are combined on common sections to the half headway, e.g. HST lines Tallinn – Warszawa and Tallinn – Vilnius are both operated in a 120′ headway and combined to a 60′ headway on the section Tallinn – Panevėžys.

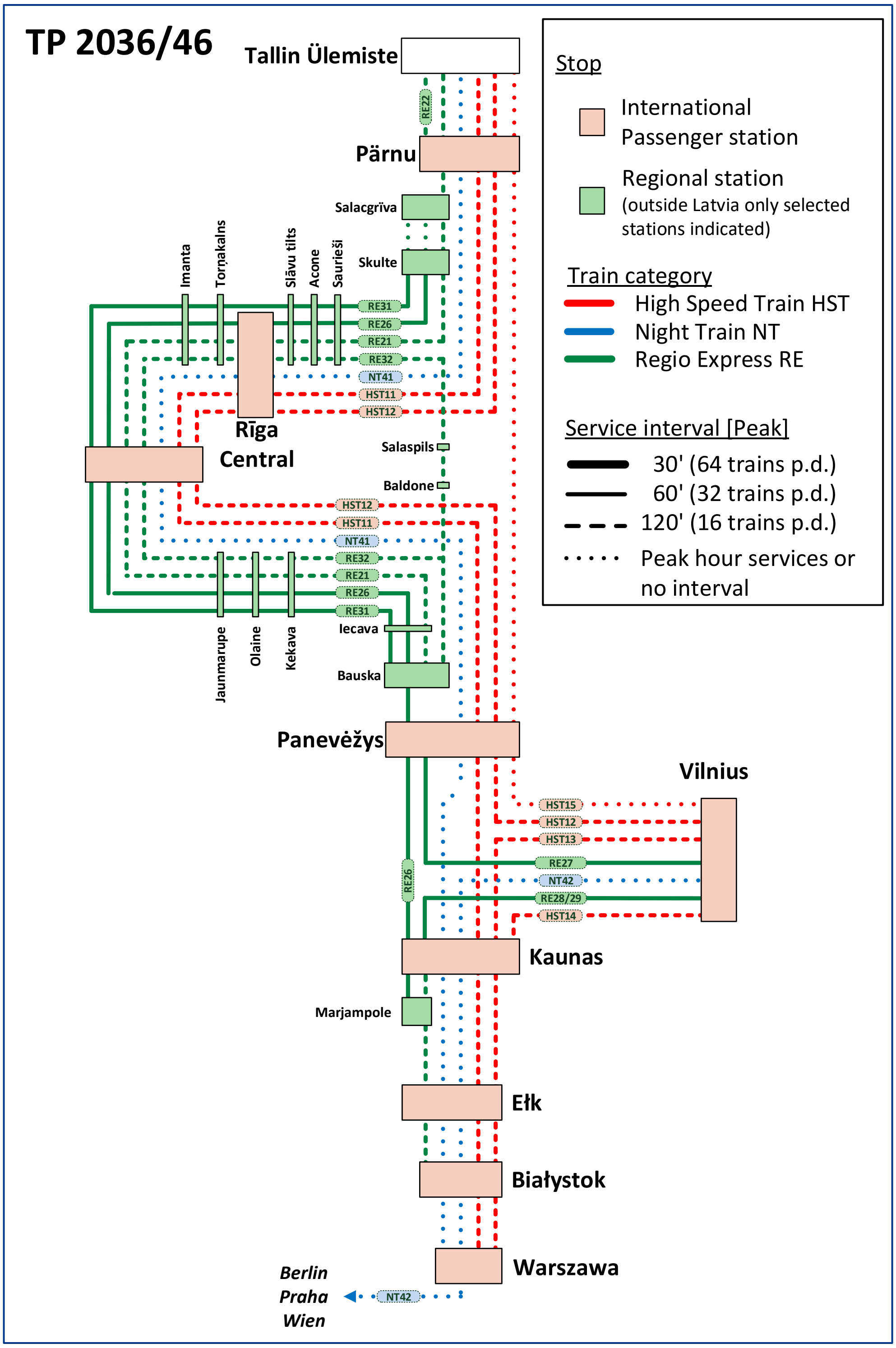


FIGURE 27: UPDATED PASSENGER TRAIN SERVICE PATTERN (LINES AND HEADWAYS IN 2036/46)[30]

[30] Source: own depiction based on RB Operational plan and timetable amendments in RailSys model by RB Rail

In 2056 on most sections both HST and RE trains are operated in an hourly service (together 2 trains per hour and direction) where in areas with a higher demand as on the section Kaunas – Vilnius or around Riga the number of trains is higher. Individual lines with a certain headway are combined on common sections to the half headway, e.g. HST lines Tallinn – Warszawa and Tallinn – Vilnius are both operated in a 120′ headway and combined to a 60′ headway on the section Tallinn – Panevėžys.

The routing and frequency of the individual lines can be taken from the following figure (forecast horizon 2056). This figure is based on the operational plan and was updated by the consultant to include the latest service pattern updates proposed by RB Rail (line concept, number of regional trains in Latvia and number of HST sprinter services via Riga bypass) to provide a basis for further discussion with RB Rail and the stakeholders.

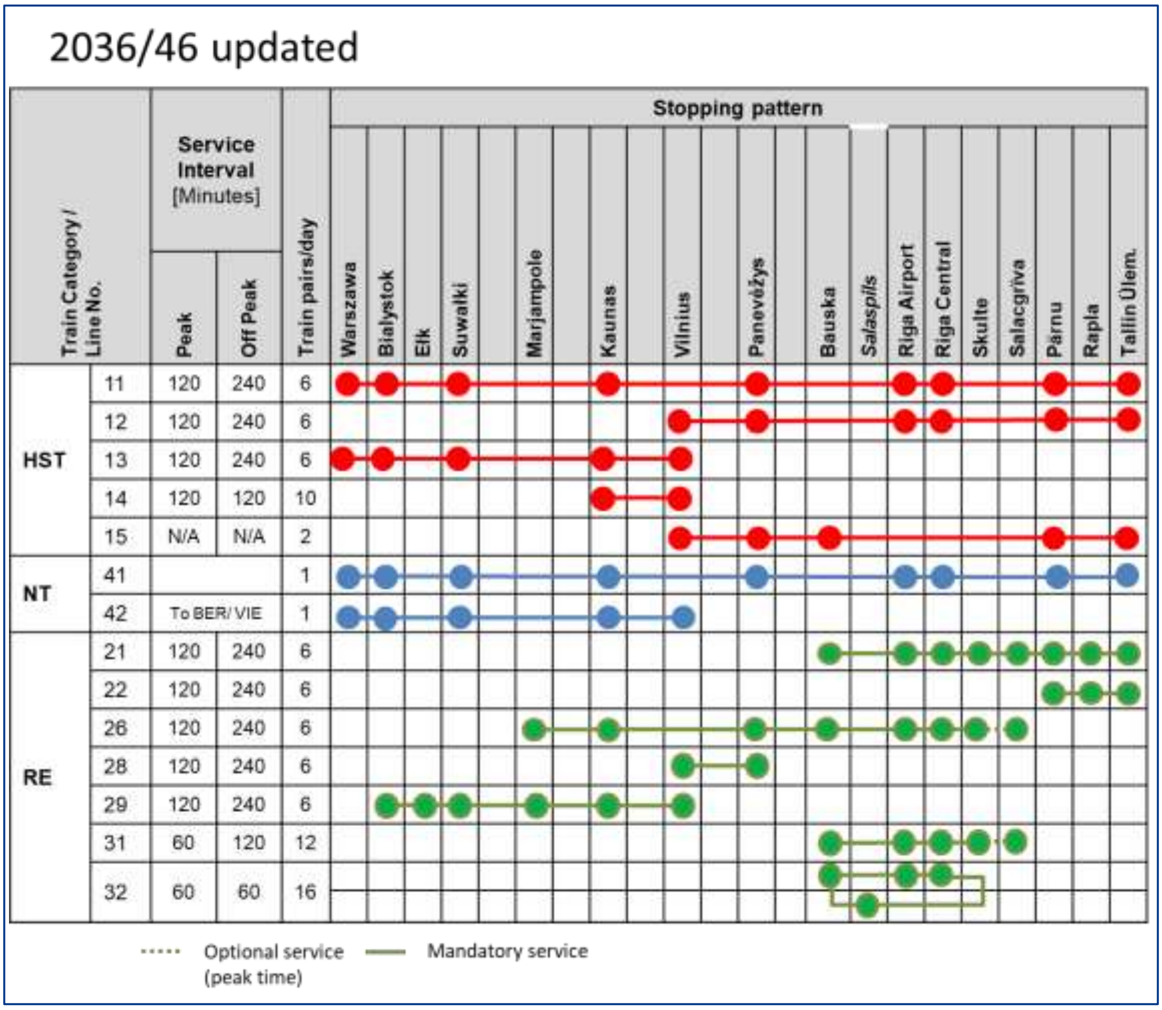


FIGURE 28: UPDATED PASSENGER TRAIN SERVICE PATTERN IN 2036/46[31]

[31] Source: own depiction based on RB Operational plan and timetable amandments in RailSys model by RB Rail

For the long-distance traffic next to the three HST lines Helsinki – Tallinn – Riga – Kaunas – Warszawa, Helsinki – Tallinn – Riga – Vilnius and Vilnius – Kaunas (– Warszawa) two night train pairs are included in the service pattern, one between Warszawa and Tallinn with a possible extension to Helsinki and one between Vilnius via Warszawa to another capital in Central Europe (e.g. Berlin, Praha or Vienna).

In Riga metropolitan area the vision to operate a dedicated airport shuttle service ("RIX shuttle" between Riga airport and Riga Central station has been replaced by a combination of several regional express lines, complementing each other. As a result, four trains per hour and direction are operated on the Riga loop in peak times. Off peak there are at least three trains per hour per direction. Main advantage of the concept is that the airport now can be reached without changing trains from all regional stations around Riga.

The 2019 service pattern update does also mean more frequent services on the outer sections of the Rail Baltica Riga suburban around Riga compared to the original version in the operational plan from 2018. Main new feature is the introduction of the circle line RE32 (Bauska – Salaspils – Riga Central station – Riga airport – Bauska). This line was introduced resulting from a discussion between RB Rail and local municipalities mainly to serve Baldone and Salaspils which are located close to Riga bypass.

The 2019 service pattern is implemented in the current version of the RailSys model, which shall be used as basis for this study and which covers the complete Rail Baltica corridor from the Polish/Lithuanian border to Tallinn at a microscopic level and the infrastructure in Poland on a macroscopic level.

The initial study of the provided model shows that the developed timetable is not entirely conflict free and the run time reserves implemented will not be sufficient to provide a stable operation. Also the station dwell times should be revised to provide necessary allowances to provide services for persons with reduced mobility (e.g. additional dwell time needed to allow establishment of a train-side or platform side wheelchair ramp) and to provide for loading and unloading of baggage for air passengers as proposed in the Rail Baltica Project Airport Integration Study which was finalised in 2019.[32]

Thus, the 1435 mm timetable needs to be revised to provide a stable and realistic basis for the development of the timetable.

In the operational plan it is proposed to provide an interchange between 1435 mm and 1520 mm at Skulte. This will be further studied during development of the integrated timetable.

3.2.3. Demand

Long distance services

[32] Rail Baltica Project Airport Integration Study (Passengers and Luggage services), 2019

Demand for long distance passenger trains is outlined in the RB operational plan. Consolidated figures are based on the Rail Baltica Global Cost Benefit analysis which was completed in 2017. The demand development until 2056 for the sections between international passenger stations is outlined in the table below. As can be seen the highest demand growth is expected in the first 10 years of operation. According to RB operational plan, the amount of passengers on section Riga Central station – Riga airport station would more than double between 2026 and 2036. Afterwards traffic is increasing at an annual average rate of approx. 1.3 %. This demand was considered for a development of a passenger service pattern.

	Tallinn-Pärnu	Pärnu-Riga	Riga-RIX	RIX-Panevėžys	Panevėžys-Kaunas	Kaunas-Vilnius	Kaunas-Poland
2026	1,115	923	2,071	1,022	1,775	2,315	934
2036	3,008	2,483	5,784	2,646	4,553	5,915	2,385
2046	3,251	2,685	6,507	2,777	4,736	6,136	2,476
2056	3,484	2,883	7,277	2,906	4,914	6,344	2,556

TABLE 15: LONG-DISTANCE PASSENGER TRIPS PER DAY (AADT ANNUAL AVERAGE DAILY TRAFFIC, BOTH DIRECTIONS) WITHOUT FINEST TUNNEL[33]

Regional express services

As part of the development of the RB Operational Plan, the demand at the various passenger stations was analysed based on a simple gravity model. The results of the analysis for the potential regional passenger stations in Latvia is outlined in Table 16 below. Where necessary, effects of parallel traffic of 1435 mm and 1520 mm trains were taken into account.

[33] Source: RB Operational Plan, 12/2018

Station name	Population					Trip generation	
	0-500 m	0.5-1 km	1-2.5 km	2.5-5 km	5-10 km	Total	1435 mm gauge
Salacgrīva	200	200	1,000	1,500	2,000	234	234
Skulte	200	200	1,000	2,000	2,000	254	64
Vangaži	200	3,400	5,000	5,000	0	906	227
Saurieši	500	1,000	3,000	500	0	390	98
Acone	500	1,000	3,000	500	0	390	98
Akropole	1,000	2,000	6,000	1,000	0	780	195
Riga Central station	Long-distance station with predominant trip attraction						
Torņakalns	20,000	20,000	60,000	0	0	9,000	2,250
Imanta	20,000	20,000	60,000	0	0	9,000	2,250
Riga Airport (RIX)	Long-distance station with predominant trip attraction						
Jaunmārupe	500	1,000	5,000	3,500	0	630	158
Olaine	1,000	1,000	3,000	5,000	10,000	950	238
Ķekava	100	200	1,700	5,000	5,000	490	123
Iecava	100	400	1,000	6,000	2,500	435	435
Bauska	100	400	1,000	6,000	2,500	435	435
Salaspils	100	100	1,000	18,000	10,000	1,107	277
Baldone	100	100	500	4,000	2,000	277	69

TABLE 16: EXPECTED TRIP GENERATION FOR 1435 MM REGIONAL PASSENGER STATIONS IN LATVIA[34]

As can be seen, the expected demand heavily depends on the ability of the system to attract passengers from a wider catchment area (2 - 10 km) in several cases. This can only be achieved if optimum interconnectivity with local bus services can be provided at the stations and if the timetable of the bus services is harmonized with the rail connections. (service interval, suitable arrival and departure times of the bus).

3.3. Freight services

The current version also contains a detailed proposal regarding required freight train paths for the peak weekday. Requirements are based on transport volumes outlined in the CBA. For determination of the number of train paths per day the needed flexibility was considered. That means, not every train path provided will be occupied.

Freight trains will be routed via Riga bypass to avoid passage of the city centre and to leave capacity on Riga loop for the freight trains with destination Riga. Some of the trains will have an intermediate stop. Due to the proposed steep gradients Riga loop cannot be used for freight trains with full length on a regular basis. However, it shall be possible

[34] Source: RB Operational Plan, 12/2018

to operate freight trains with reduced length and weight on Riga loop as emergency measure in case the operation on Riga bypass is not possible.

Line Section	Year			
	2026	2036	2046	2056
Year	Freight train paths per hour per direction			
Muuga – Salaspils	1	1	1.5	2
Salaspils - Kaunas triangle	1.5	1.5	1.5	2
Vaidotai - Kaunas triangle	1	1.5	1.5	1.5
Kaunas Triangle – Palemonas	1.5	2	2	3
Palemonas - border PL/LT	2	3	3	3

TABLE 17: RB OPERATIONAL PLAN: REQUIRED NUMBER OF FREIGHT TRAIN PATHS PER LINE SECTION[35]

Based on the mentioned requirements above a model timetable for freight trains was developed in the RB Operational Plan, mapping the demand on a line-based concept providing slots based on a fixed interval timetable. If necessary, this timetable will be considered and amended during development of integrated timetable to provide a conflict free solution. Basis for the work shall be the requirements for TP 2046.

3.4. Passenger Rolling stock fleet and maintenance facilities

In order to check the available base information for assessment of maintenance and layover facilities the main facts from the RB Operational Plan are summarised in the following chapter.

3.4.1. Rolling stock

As part of the preparation of the RB operational plan benchmarking regarding available rolling stock suitable for operation on Rail Baltica was performed. Based on that, the parameters of the trains for regional and long- distance passenger service were derived. The main parameters used for timetabling, capacity study, and assessment of required maintenance facilities are outlined in Table 18 below.

	Regional Express	HST
Seating capacity	300	400
Max. length over buffers	90 -110 m	200 m
Maximum operating speed	160 or 200 km/h	249 km/h (recommended)[36]
Deceleration (operational brake)	N/A	0.5 m/s^2
Starting acceleration	0.964 m/s^2	0,49 m m/s^2 (0-60 km/h)

TABLE 18: SUMMARY OF TECHNICAL TRAIN PARAMETERS FOR RAIL BALTICA SERVICES[37]

[35] Source: RB Operational Plan, 12/2018
[36] Assumed max. speed for the timetable modelling for RB Operational plan was 234 km/h, as required by RB Technical design guidelines
[37] Source: own depiction based on RB Operational plan, chapter 2 and chapter 4, December 2018

3.4.2. Rolling stock maintenance facilities

Potential locations for maintenance of passenger and freight rolling stock were analysed as part of elaboration of the RB Operational plan. In the Riga node area, the RB operational plan study focused on locations Acone as originally proposed resulting from spatial planning process and preliminary design and Jaunmarupe, which was introduced as option to provide relief to Riga airport station by provision of additional turning track for terminating tracks from locations north of Riga.

For maintenance of rolling stock for RE services a common or collocated facility with 1520 mm either Vagonu parks or Zasulauks is to be considered as an option. Technical feasibility, advantages and disadvantages of a common facility will be elaborated as part of this study (work packages 2 and 3).

HST trains

Main outcome of the performed studies related to HST train fleet was:

- Maintenance of long-distance trains (HST fleet) could be performed at Tallinn or Vilnius or in Riga area (Acone, Jaunmārupe).
- Tallinn and Vilnius will be the preferred option, since maintenance is to be synchronized with nightly layover of trains, where possible.
- Maintenance of HST trains should be concentrated on one location, if to be undertaken in a separate facility. However, it has to be ensured that check-up of running gear can be performed at least at one additional location.

From current state of affairs, maintenance of HST can be assumed to be performed outside Riga node area, most likely facilities will be related in Tallinn Rae depot since there is a space reserved already and planning of facilities shall start soon.

Regional trains

Main outcome of the analysis of maintenance locations and required facilities for maintenance of regional trains can be summarized as follows:

- For maintenance of regional trains, a solution with 2 depot locations is most beneficial since the saving of operational cost for the transfers of rolling stock in the long term outweighs the investment into a second maintenance facility. Preferred locations should be located in Riga area and in Vilnius area.
- Overall estimated fleet size for time horizon 2036/46: 22 EMU sets

Fleet size and maintenance requirements are to be updated to reflect the updated train service pattern.

3.4.3. Layover facilities

The required facilities for nightly layovers of trains were also highlighted in the RB Operational Plan. According to the RB operational plan, the nightly layover of trains in Riga node and suburban area is foreseen in Bauska, Jaunmarupe, Acone, Skulte and Salacgrīva. The numbers outlined in Table 19 are to be updated to reflect the updated train service pattern and the outcome of this study regarding future layover facilities in and around Riga node.

Type of Service	Free standing length, meters	EXTERNAL	Warszawa	Bialystok	Elk	Suwalki	Marijampole	Kaunas main	Palemonas	Karmelava	Vilnius	Valdotu	Panevezys	Bauska	Jaunmārupe	Riga Airport	Acone	Salaspils	Skulte	Salacgrieva	Pärnu	Rapla	Tallinn Rae	Muuga	Helsinki	Total Number
Operations Plan 2036/2046																										
Stabling, HST	210		4					3			8						5						5			25
Stabling, NT w/o DDm cars	210	1	1								1												1			4
Stabling, spare coaches	30	3	3								3												3			12
Stabling, DDm auto wagons	30		10								5												5			20
Stabling, EMU	95			1	1		4				8		2	1			10		1	1	1	1	4			35
Stabling, Locomotive (pass+freight)	25	X	3		8				15		2	24					2	6					2	24		86
Stabling tracks, meters total	12.225		1515	95	295	0	380	630	375	0	2940	600	190	95		0	2050	150	95	95	95	95	1930	600	0	
Shore power (1 kV train line pre-heating)			X								X						X						X			4
Shore power (230 V pedestal)			X		X				X		X	X				X	X	X					X	X		10
Interior Cleaning, partial			X				X				X						X						X			5
Exterior Cleaning (train washer)											X						X									2
Closed Toilet Service & water filling			X				X				X						X						X			5
Refilling sand			X				X		X		X	X					X	X					X	X		9
Diesel fuel refilling			X									X						X						X		4
Provisons for dining cars (kitchen)			X								X						X						X			4
Provisons for sleeper cars (laundry)		X	X								X												X			4

TABLE 19: RB OPERATIONAL PLAN: FACILITIES FOR NIGHTLY LAYOVER OF PASSENGER TRAINS[38]

[38] Source: RB Operational Plan,

4. Infrastructural framework conditions

In this chapter the infrastructural framework conditions are described. In line with the targets of the study this chapter is focused on the current situation and the proposed development due to implementation of Rail Baltica in the railway core area. Additionally, the overall framework conditions on the national network are highlighted as far as needed to elaborate the future service and track layout principles for the line sections outside the railway core area.

Infrastructural framework conditions are defined by the infrastructure operator LDz as responsible infrastructure manager for the 1520 mm network and by RB Rail as coordinator for the development of 1435 mm Rail Baltica infrastructure. EDZL as Latvian implementing body is responsible for coordinating planning and construction works related to reconstruction for Riga Central station and also for the related 1520 mm infrastructure in the railway core area. Therefore, required data for infrastructure modelling and the definition of operational principles are used from these three stakeholders.

In the following subchapters the infrastructural framework conditions relevant for the study will be outlined in more detail. This will cover current stage and planned alterations for both gauges (1520 mm LDz network and 1435 mm Rail Baltica).

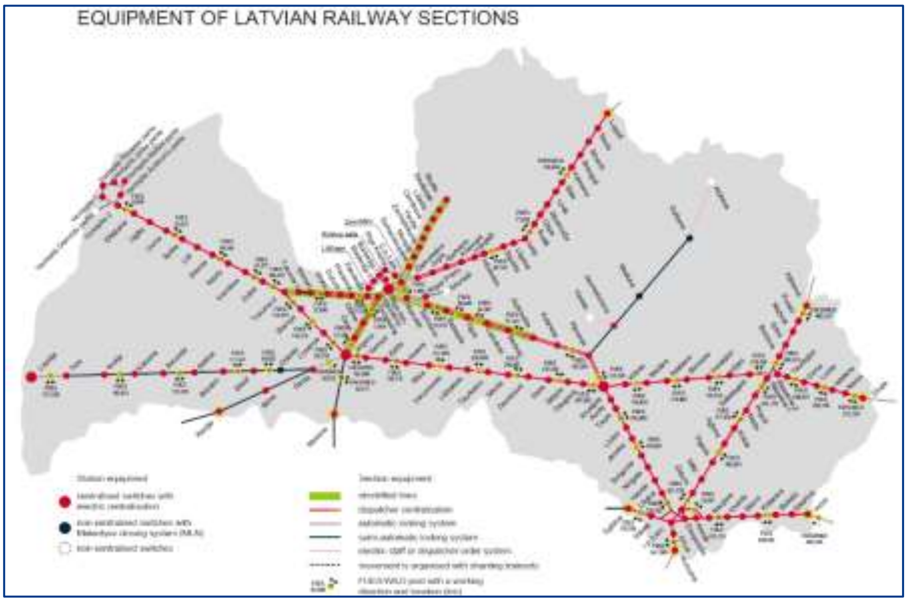


FIGURE 29: LDZ 1520 MM NETWORK[39]

[39] Source: LDz network statement 2021

4.1. Riga Central Station

4.1.1. Situation 1520 mm

The track layout for 1435 mm and 1520 mm parts of Riga Central station was developed prior to the study and is thus to be considered as freezed. That means any modifications are only possible within the boundaries of the existing track layout. This especially relates to the number of platforms and the platform and track axes since changing them means a complete redesign of Riga Central station.

The current track layout of Riga Central station does provide for 10 platform tracks (7 through platforms and 3 terminus platforms accessible from the east side). Additionally, two tracks are provided for freight train and shunting movements (tracks II and 9).

FIGURE 30: RIGA CENTRAL STATION – EXISTING SITUATION

The main target of the redesign of the track layout is to provide the necessary space to accommodate the 1435 mm tracks of Rail Baltica at the south side of Riga Central station.

In the final stage, Riga Central station itself will have 7 through platforms and 2 terminus platforms. The track layout is designed to allow for parallel movements of trains leaving and/or entering the station. Overall, the final layout is therefore flexible when it comes to changes in the service pattern or an increase in the quantity structure of train services (shown in Figure 31). Also, the platforms are rather long and would be suitable to provide for double occupation of platforms by regional passenger trains to allow easier transfer of passengers between 1520 mm trains on the same platform. But Riga Central station is in a cramped space when it comes to the planned extension with 1435 mm Rail Baltica infrastructure which leads to narrower platforms, which reduce the capacity for passengers and therefore will increase the required time for a transfer of passengers between train services.

The design speed for all tracks in Riga Central station is 50 km/h. For newly implemented turnouts within the construction boundaries the combination of diamond and rail type will allow a design speed on diverging track of 50 km/h.[40] This will also apply to the newly designed track sections where curved sections are aligned for 50 km/h design speed.[41] However, in some exceptional cases and for crossovers outside the construction boundaries for Riga Central

[40] Turnout angle at 1/11 as per drawing, Rail 60E1 as stated in Track, Document No.: RBDNB-LV_RCS_ZZZZ_TUC_ZZZZ_ZZ_ZZZZ_DN_RT_48_MAS_100508, 24/02/2020, chapter 6.1.1

[41] Basis of design – Track, Document No.: RBDNB-LV_RCS_ZZZZ_TUC_ZZZZ_ZZ_ZZZZ_DN_RT_48_MAS_100508, 24/02/2020

station turnout speeds on diverging track will be lower due to permitted speed as per Latvian railway technical and operational rules (related principles are outlined in chapter 4.5.1). Further details about the location of the affected turnouts and crossovers as well as an assessment of the resulting operational impact are addressed in chapter 6.6.1.

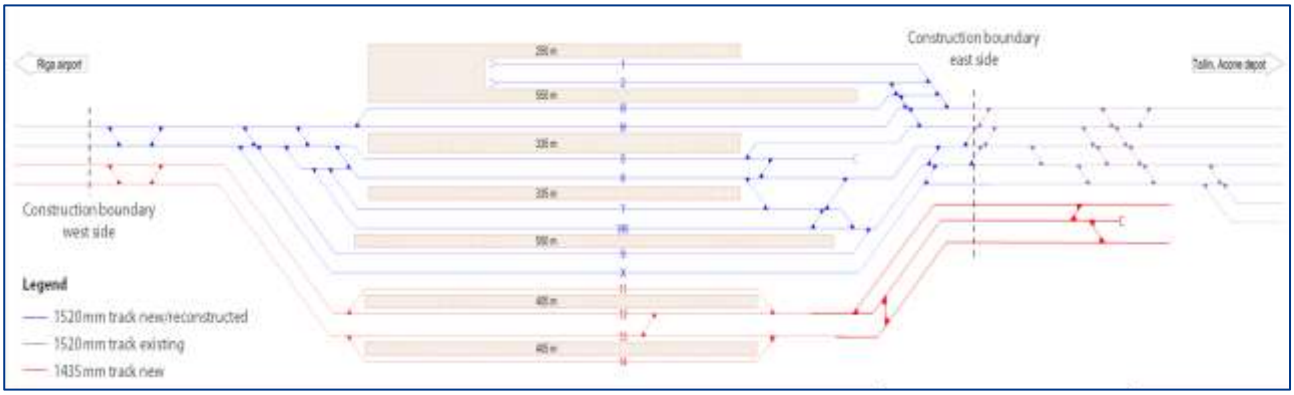


FIGURE 31: RIGA CENTRAL STATION – FUTURE SITUATION

When it comes to operations of trains from and to Riga, the station is differently connected to the LDz network. From the east Riga Central station is connected via two double track lines from Zemitāni and Vagonu parks and one single track line that is leading directly to the freight yard allowing flexible parallel freight and passenger train movements to and from Riga station from the east (shown in Figure 32).

For safe passage of freight trains without impacting the operation on passenger platforms, one separate track (track X) is provided in the current and future track layout of Riga Central station. This track is used in both directions. Currently, the freight track at Riga Central station is the only suitable station track in the core area, where freight trains with full length of 850 m can be held to wait on the next available slot to proceed towards Torņakalns or in case Šķirotava freight station cannot accept trains arriving from the west.

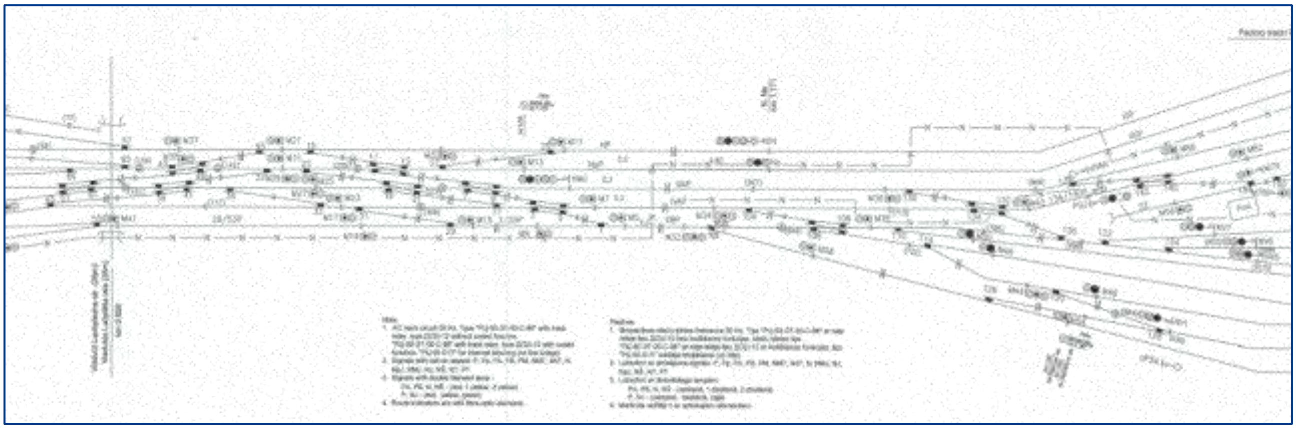


FIGURE 32: SWITCH AREA EAST OF RIGA CENTRAL STATION

From the west however the situation looks completely different. Here all trains must cross the double track Daugava river bridge. This means only half the tracks and half the capacity for train movements is available on the western approach to Riga Central station. The quantity structure of train traffic is roughly the same from both sides to Riga Central station. That means the bridge forms a natural bottleneck that limits the whole traffic through Riga Central station. While trains from the east can enter the station parallel via three corridors (between 6 and 8 trains per on each of the two corridors, in total max. 15) more trains have to share the same track from the west where up to 15 trains per hour per direction have to pass the Daugava river bridge (shown in Figure 33).

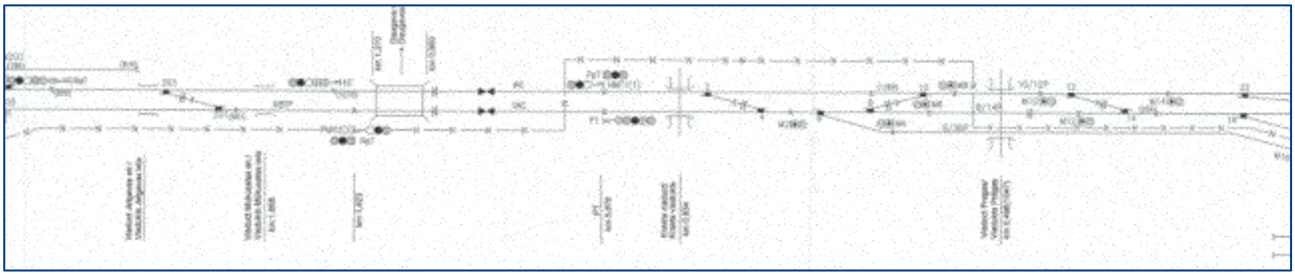


FIGURE 33: DAUGAVA RIVER BRIDGE WEST OF RIGA CENTRAL STATION

Also, there are other limitations regarding Zemitāni and Torņakalns (shown in Figure 34) next to Riga Central station. In all these stations train movements potentially interfere with traffic in contraflow direction when entering or leaving the station towards the corridors to Tukums-2 and Jelgava or to Skulte and Valga, since all crossovers and junctions are provided at grade. This could lead to a shifting of paths resulting in the loss of valuable connections in Riga Central station or could prevent running the train on the corridor at all.

FIGURE 34: TORŅAKALNS STATION WEST OF RIGA CENTRAL STATION

4.1.2. Situation 1435 mm

As outlined in Figure 31 above, the final layout of Riga Central station will provide for four 1435 mm platform tracks. These tracks will be accessible from all directions to allow maximum flexibility in case of degraded mode operation. A standard operational principle will be, that one platform is used for one direction. In addition to that the following facilities are provided:

- Additional crossover between tracks 12 and 13. This will allow to turn trains from/to direction Riga airport at Riga Central station without additional route conflicts.

- Additional parking and turning siding at the east side of Riga Central station. This siding is proposed to be located between the running lines. This allows for minimization of route conflicts with trains running in the opposite direction. The location of the crossovers is still under discussion due to the space constraints. Final operational requirements on track layout will be elaborated and checked during the further course of the study with the target to provide a feasible compromise within the given space constraints.

Within the construction boundaries of Riga Central station, the 1435 mm track layout is to be treated as fixed.

All tracks will be electrified with 25 kV AC catenary.

Generally, final 1435 mm track layout is designed for 80km/h maximum speed within station boundaries. On the west side speed for trains arriving/departing in tracks 12 and 14 is limited to 50 km/h due to the design parameters of diverging turnouts (turnout type 300-1/9) and the adjacent curved alignment on the diverging track. This design speed restriction also applies at the east side, crossovers between tracks 12 and 13 as well as access to the turning siding at the east side of Riga Central station (track 15).[42] Contrary to conventional signalling on 1520 mm, where speed limits must be applied to the complete entry and exit routes between station boundaries the speed limitations need to be applied only on the relevant short track sections due to flexibility of the ETCS level 2 signalling system.

After the final optimization of the track layout, which was finalized by RB Rail, EDZL and BERERIX in the beginning of 2020, the available track length for ETCS overlaps will provide for an arrival of trains on all platform tracks without impacting contraflow arrivals on adjacent platform tracks.

4.2. Proposed changes in the railway core area

In the railway core area 1435 mm tracks of Rail Baltica will be aligned parallel to existing 1520 mm line in the corridor Šķirotava – Riga Central station – Torņakalns – Jāņavārti – Zemitāni – Imanta. Currently, several alignment variants are under study as outlined in section 1.2. These variants differ in their impact on 1520 mm alignment to accommodate Rail Baltica within given space constraints. It has been agreed with RB Rail, to assume for the purpose of this study the most restricting alignment alternatives to be on the safe side and to study the impact:

- Alternative 1 for line section Torņakalns – Imanta
- Alternative 2 for line section Riga Central station – Vagonu parks – Šķirotava flyover

In the following sections the main features of the final rail alignment shall be described and the impact of implementation of 1435 mm track on 1520 mm track layout shall be highlighted.

Šķirotava flyover

[42] Basis of design – Track, Document Nr : RBDNB-LV_RCS_ZZZZ_TUC_ZZZZ_ZZ_ZZZZ_DN_RT_48_MAS_100508, 24/02/2020

Coming from the north the Rail Baltica tracks will overpass the existing tracks of Jāņavārti station and continue south of the main line Riga – Aizkraukle. Therefore, an overpass is proposed which shall be located adjacent to Jāņavārti passenger station. According to the current planning stage no realignment of 1520 mm tracks would be required in this area. However, construction of the overpass might affect the 1520 mm train operation in this area.

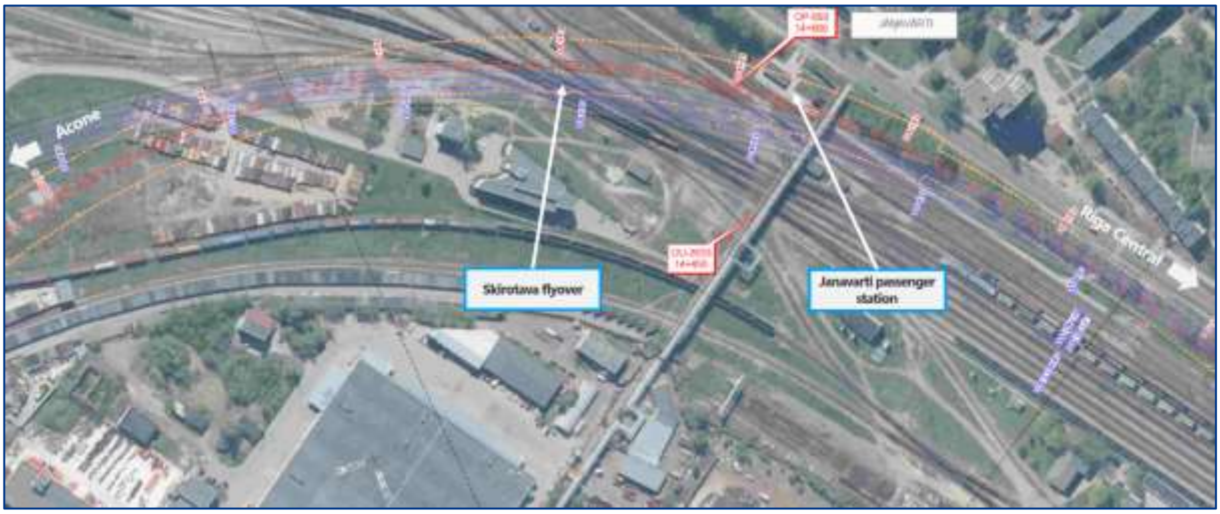


FIGURE 35: PROPOSED LOCATION OF ŠĶIROTAVA FLYOVER[43]

Slāvu tilts station

This station is proposed to be located between Jāņavārti station and Vagonu parks station and will be served by Rail Baltica RE trains. 1520 mm platforms are not foreseen for this station.

Vagonu parks stabling yard and passenger stop

To assure sufficient space for the Rail Baltica tracks, a realignment of the 1520 mmm bypass line south of Vagonu parks maintenance and stabling facilities is foreseen. This requires removal of the 1520 mm parking sidings south of the existing 1520 mm PV workshop and a realignment of the southern bypass. The number of tracks to be removed depends on the different alignment variants under discussion. For the purpose of this study the most restrictive case shall be checked, which assumes removal of 1520 mm parking sidings adjacent to the PV workshop and the relocation of the southern bypass platform of Vagonu parks passenger stop to the mainline north of Vagonu parks. According to the current planning stage this variant would also require a relocation of the platform for trains towards Jāņavārti, which is located at the south side of the area. The new platform is located east of the current location between the Rail Baltica main line and the rolling stock maintenance facilities. This means a new passenger access needs to be provided by means of a new pedestrian over- or underpass.

Initial results of the timetabling study indicated that the southern bypass would not be required from capacity viewpoint to cope with the expected traffic. Thus, the passenger platform could be also located on the main line north

[43] Source of the base drawing: project 2017/29, alignment alternative 1, IDOM 11/2019

of Vagonu parks depot area adjacent to the existing platform leaving the option to drop the bypass or to use the bypass as additional buffer exclusively for freight services. This would require changes to the track layout of the existing parking and cleaning sidings at the north side of the yard (see Figure 37). As an alternative the main line is to be relocated in order to provide an island platform or to allow space for the additional platform.

FIGURE 36 Vagonu Parks stabling yard and passenger station – proposed situation[44]

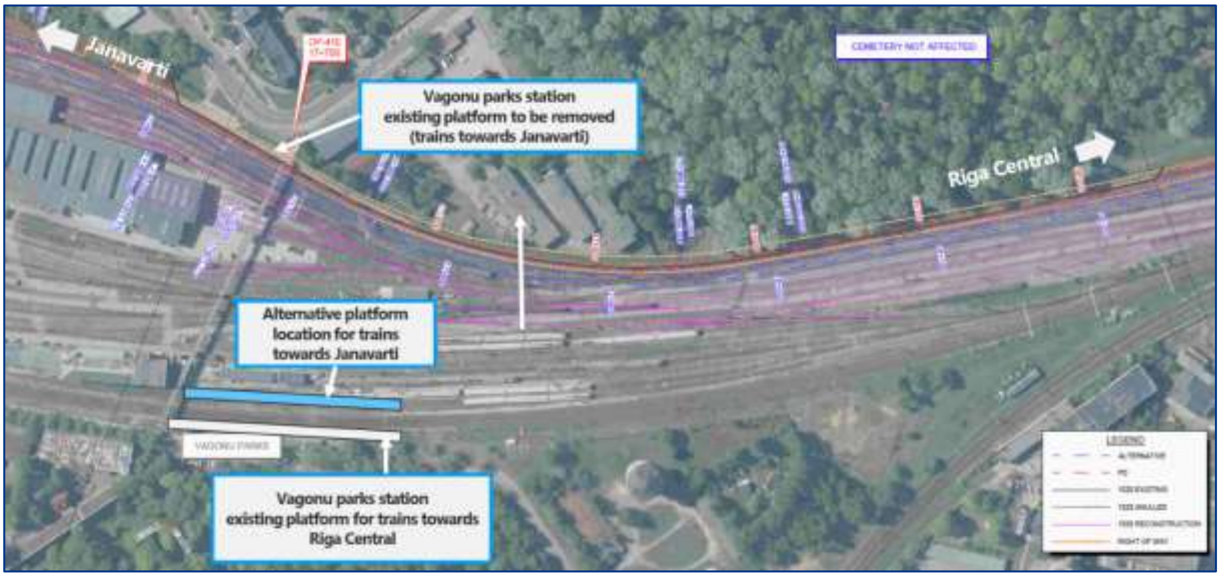


FIGURE 37 VAGONU PARKS STATION – ALTERNATIVE PLATFORM LOCATION[45]

Torņakalns station and Torņakalns cut and cover tunnel

It is foreseen that 1435 mm regional express trains and 1520 mm suburban and regional trains shall stop in Torņakalns. According to currently investigated alignment variants the new Torņakalns passenger platforms will be located further west to provide better access to Latvian University buildings and to cope with the required incline of the 1435 mm tracks for the cut and cover tunnel at the east side of the station. Existing 1520 mm platforms will therefore be replaced by new platforms further north. The proposed adjacent location of the platforms for 1435 mm and 1520 mm will allow for passengers to interchange to Rail Baltica trains from and to Riga airport. Overall, it is envisaged, that the track topology at the west side of Torņakalns station remains in the existing situation. At the south side of the station a redesign of the switch area is foreseen to adapt the track layout to the proposed cut and cover tunnel of Rail Baltica. The location of the tracks shall remain unchanged.

On the south side of the station, Rail Baltica tracks will underpass tracks of the Riga – Jelgava line. Therefore, a cut-and-cover tunnel with a length of approx. 180 m is foreseen. Ramps with gradients of 25 ‰ are proposed on both ends of the tunnel. This is possible, since no regular operation of heavy freight trains is foreseen on the Riga Loop.

[44] Source of the base drawing: project 2017/29, alignment alternative 2, IDOM 11/2019
[45] Source of the base drawing: project 2017/29, alignment alternative 2, IDOM 11/2019

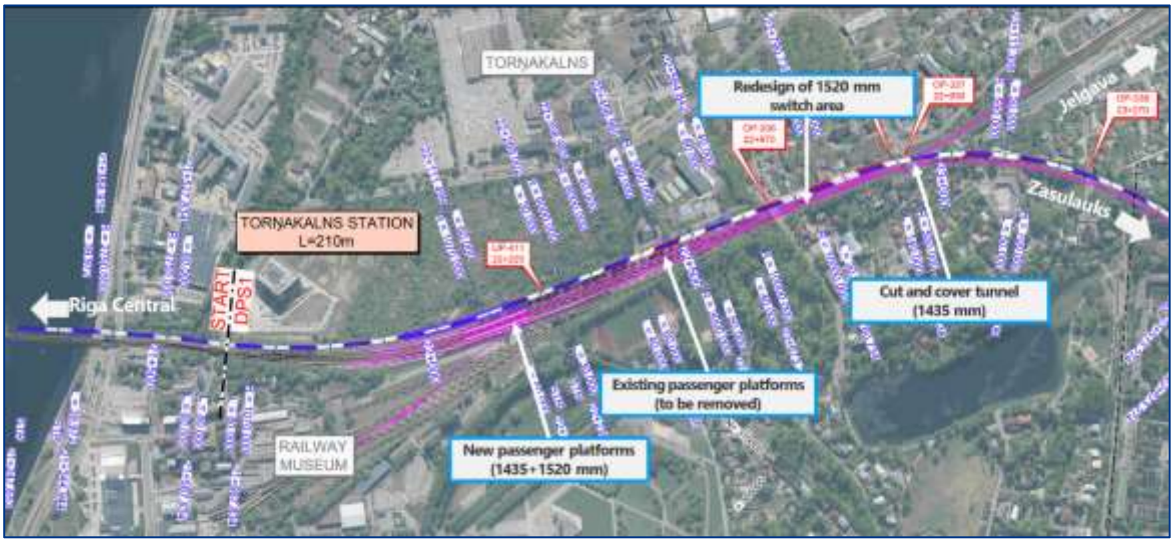


FIGURE 38: TORŅAKALNS STATION - PROPOSED CHANGES[46]

Zasulauks station

In the currently elaborated Rail Baltica alignment alternatives, no passenger platforms for Rail Baltica in Zasulauks are foreseen. Because of this the currently proposed modifications are targeting the provision of required space to accommodate Rail Baltica tracks. Therefore, the platform and station tracks will be relocated (shifting of track axis further north). The proposed alignment is shown in the figure below. The reception track for freight trains from/to Bolderāja (track 9 indicated in Figure 40 below) east of the passenger station shall remain. Currently this track has a usable length of approx. 724 m, which is not sufficient to allow for a stop of freight trains with the currently applicable maximum length of 850 m. The turnouts on both ends of the track are proposed to be relocated as part of the reconstruction works, but the usable length of the track still would not reach the required length to accommodate freight trains with maximum length of 850 m. To provide space for Rail Baltica track 10 east needs to be removed. This track is used as passing loop and connection to local railway siding (incl. LDz infrastructure maintenance facility near Krūzes iela) which will also be disconnected from the 1520 mm rail network.

[46] Source of the drawing: project 2017/29, alignment alternative 1, IDOM 11/2019

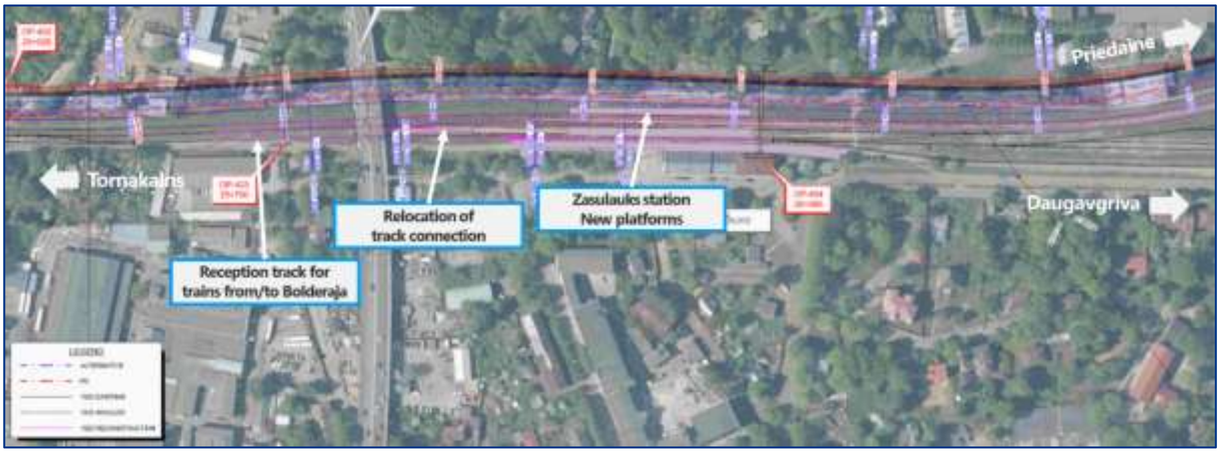


FIGURE 39: Zasulauks station - proposed changes[47]

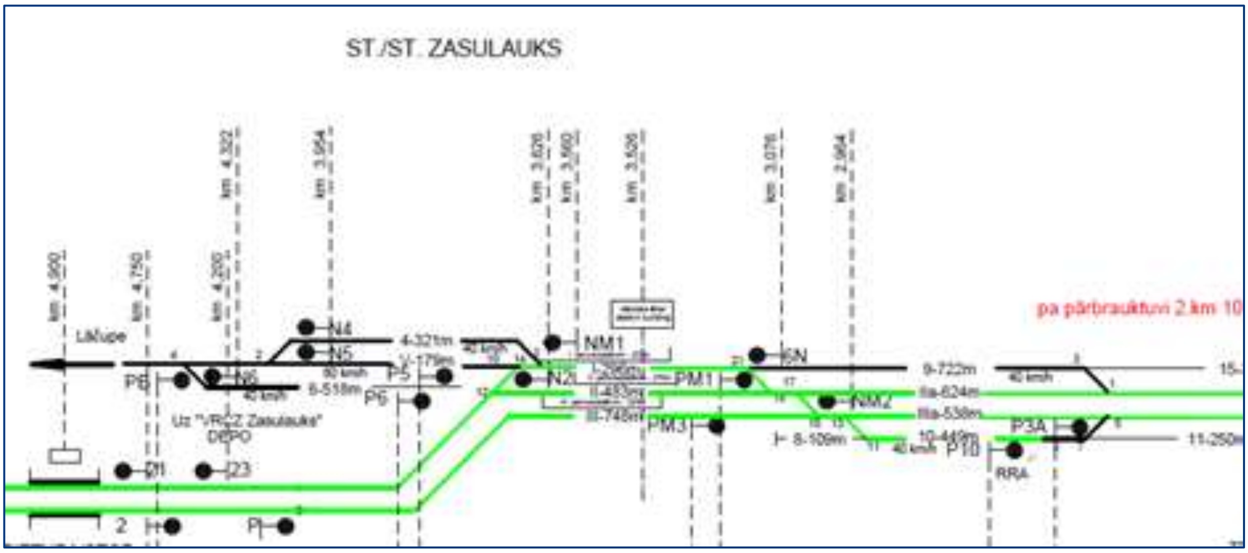


FIGURE 40: Zasulauks station – schematic track layout[48]

Zasulauks depot / Depo station

The main line Riga – Tukums is located south of the existing rolling stock maintenance facilities. To provide space for Rail Baltica, one track belonging to this facility needs to be removed according to the current planning stage. Also, the storage area adjacent to the rolling stock maintenance workshop building will be affected. Required relocation of the 1520 mm main line east of the depot also means that the storage sidings east of the rolling stock maintenance depot need to be changed (removal of two tracks to provide space for realigned 1520 mm main line, shortening of tracks).

[47] Source of the drawing: project 2017/29, alignment alternative 1, IDOM 11/2019
[48] Drawing provided by RB Rail

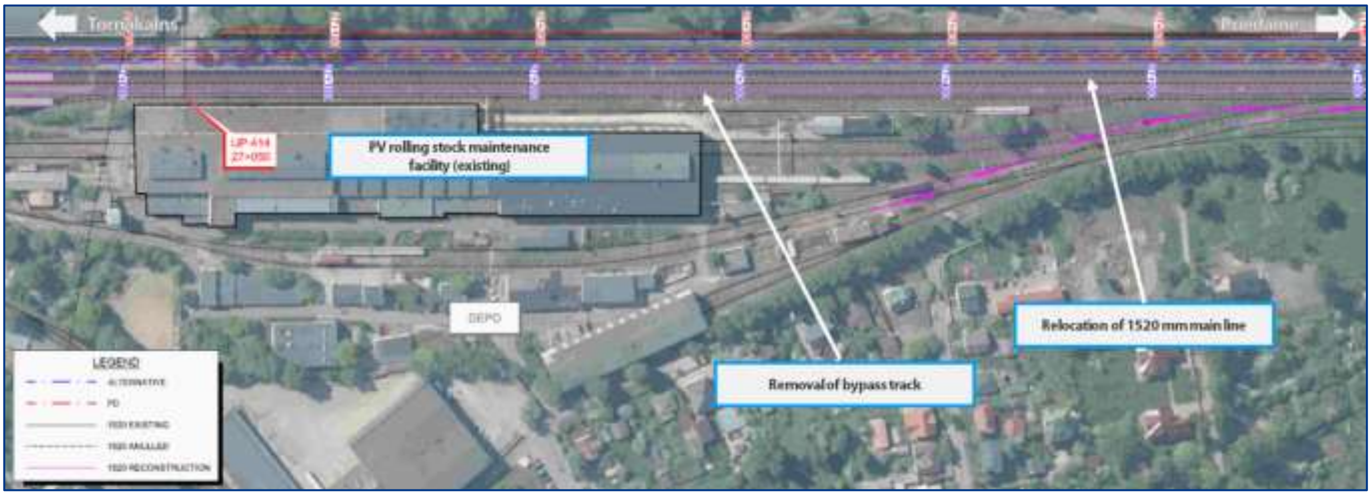


FIGURE 41: PV ROLLING STOCK MAINTENANCE DEPOT - PROPOSED CHANGES

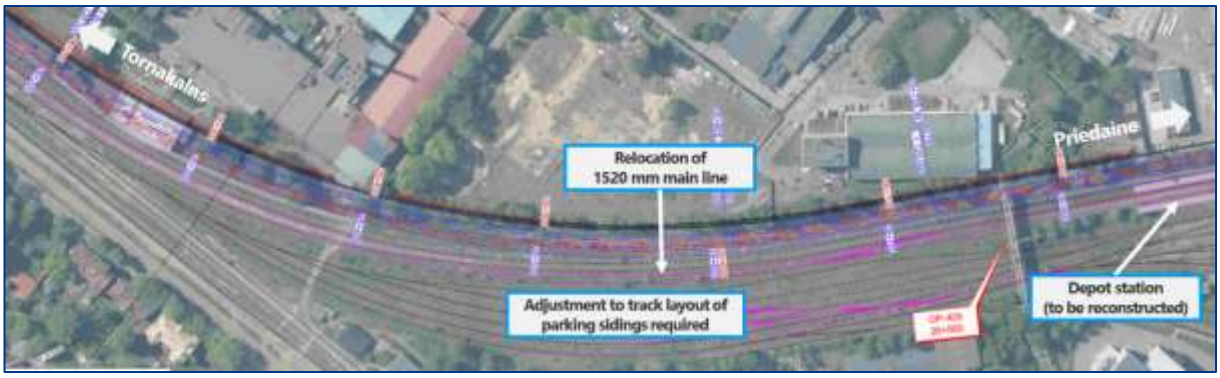


FIGURE 42: ADAPTION TO EXISTING PARKING TRACKS EAST OF ZASULAUKS DEPOT[49]

Zolitūde station

As in the existing situation Zolitūde station will be served by 1520 mm trains. It is planned to relocate the existing 1520 mm tracks and platforms to provide sufficient space for Rail Baltica.

Imanta station

Imanta station is proposed to be served by 1520 mm services (Riga – Tukums) and 1435 mm Regional Express services. This would allow an interchange between trains from/to Riga Airport - Bauska and from/to Priedaine – Dubulti – Tukums. To accommodate the two new platform tracks of Rail Baltica 1520 mm platforms the station tracks need to be realigned.

[49] Source of the drawing: project 2017/29, alignment alternative 1, IDOM 11/2019

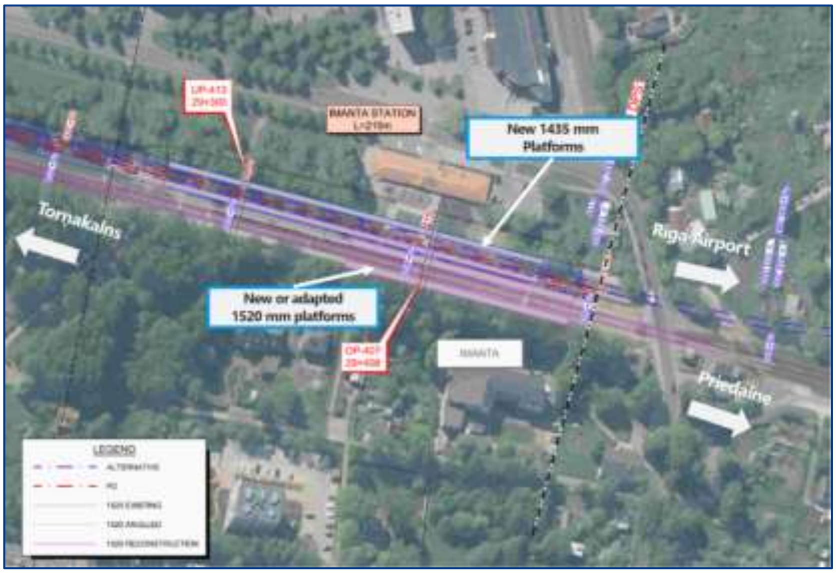


FIGURE 43: IMANTA STATION – PLANNED SITUATION[50]

4.3. Situation in other parts of the network

4.3.1. Overall network

The overall network is shown in Figure 44. The corridors in the suburban area around Riga to Skulte, Tukums2, Jelgava and Aizkraukle are electrified double-track lines (exceptions are the track section Sloka-Tukums2 and certain sections on the corridor Riga-Skulte which are electrified single track lines). This allows in combination with a rather efficient signalling to operate high frequency suburban commuter lines in a radial network around Riga. The rest of the network is however unelectrified and consists mainly of single-track lines. Even the suburban corridor Riga-Sigulda-Valga north of Riga is not electrified but partly double-track, allowing the operation of high frequency diesel commuter lines.

The general top speed for passenger trains is 120 km/h and 90 km/h for freight trains. Exceptions are the numerous speed reductions in stations and at level crossings (reduction to 100 or 80 km/h or less). This top speed is enough for commuter trains and medium speed regional trains which stop at every station anyway. But this prevents faster non-stop services between regional centres from reaching a decent average travel speed to compete with road traffic. The low top speed reduces the negative effect of capacity reduction on mixed traffic lines through different average speeds of freight and passenger trains.

[50] Source of the drawing: project 2017/29, alignment alternative 1, IDOM 11/2019

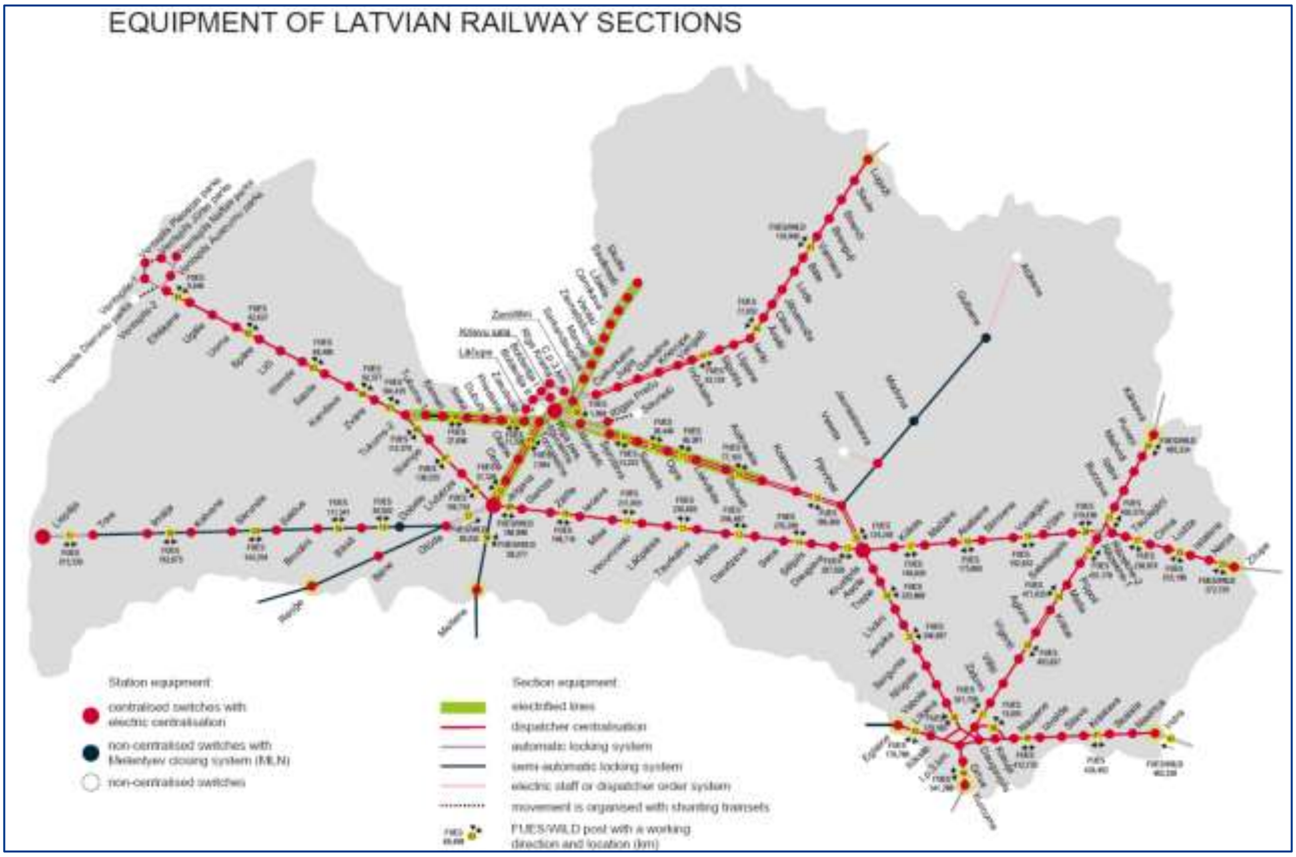


FIGURE 44: CURRENT 1520 MM LINE NETWORK OF LATVIA

4.3.2. Proposed infrastructure upgrades in other areas

Infrastructure upgrades are subject to an agreement between the infrastructure provider LDz and the Latvian government. Related to the most recent goals projects are outlined in the Indicative railway infrastructure development plan 2018 - 22. As part of ongoing modernisation of Latvian rail network several projects are realised with a funding by European Union Cohesion fonds. Besides the proposed 25 kV electrification of the 1520 mm core network, which is described in section 4.4, two major projects are of special interest for this study and have to be considered for the assessment of Riga node infrastructure and the development of an highly synchronized cyclic 1435/1520 mm timetable.

Modernisation of line section Sarkandaugava - Mangaļi- Ziemeļblāzma

This project aims to improve the security, quality and capacity on this line section, which is part of the TEN-T rail network. This section is part of the railway line Riga – Skulte. The project does include the following works:

- Construction of a second electrified track in the section Mangaļi – Ziemeļblāzma
- Rebuild of station tracks

- Modernisation of the signalling system
- Construction of two-tiered crossings for pedestrians.

According to the above-mentioned plan this project is a precondition for the introduction of a fixed interval timetable, which shall be implemented by the end of 2022.

After various attempts to ensure the quality and the market price by LDz the procurement of construction works for this project was finalised by end of 2019. The construction works will be carried out by the consortium "Belam-Leonhard Weiss".

Modernisation program for station infrastructure

According to the above-mentioned Indicative railway infrastructure development plan platforms have been already modernized at 27 of the 66 stations which are currently served on a regular basis by passenger trains.

This includes for example the following activities:[51]

- The modernisation of 21 stations on the corridor Riga – Krustpils in 2023
- The modernisation of 9 stations on the line section Riga – Jelgava, including platforms at Torņakalns in 2020
- The modernisation of 10 stations on the line section Riga – Tukums II, including Torņakalns, Zemitāni, Zasulauks and Zasulauks Depot, Priedaine station in 2020
- Implementation of platforms on the corridor Zasulauks – Bolderaja to allow passenger services on this section[52] as well as implementation of new passenger stop Alfa station east of Zemitāni on the Riga – Sigulda line

Most of the upgraded platforms will be designed for 125 m length, some for 160 m length. Proposed platform height is 55 cm in line with requirements of TSI INF. As part of related infrastructure optimisation closure of Cena station on the line Torņakalns – Jelgava is proposed. [53] Modernization of platforms in Torņakalns, Zasulauks, Zemitāni and Depot station shall be aligned with recommendations of this study and coordinated with the Rail Baltica project construction works, which will start from 2022 in order to avoid double works.

In Zemitāni LDz is planning to upgrade 3 of the 5 existing platforms as part of the station modernisation programs. The other 2 platforms can be kept if required and be modernized at a later stage.

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[51] Par indikatīvo dzelzceļa infrastruktūras attīstības plānu 2018.-2022. gadam, Ministru kabineta rīkojums Nr. 588, 06/11/2018
[52] https://www.ldz.lv/lv/izsludin%C4%81ts-iepirkums-dzelzce%C4%BCa-pasa%C5%BEieru-platformu-moderniz%C4%81cijai-un-jaunu-pieturvietu-0; retrieved 10/09/2020
[53] https://jauns.lv/raksts/zinas/367777-ozolnieki-prasa-ministra-skaidrojumu-par-planiem-slegt-dzelzcela-pieturu-cena

4.4. Electrification of 1520 mm network

Currently only 251 km of lines around Riga are electrified in 3 kV DC for suburban services. Under normal operating conditions electrification is only used by Riga suburban trains. All freight trains are diesel hauled. This does include all line sections in the core area, except branch lines to Bolderāja, Riga- Preču and Riga-Krasta as well as the railway line to Sigulda.

Currently the electrification of the Latvian main railway network is being prepared. This program was developed with special focus on heavy rail freight traffic in east-west-direction. According to LDz an electrification would allow to operate longer freight trains with gross weight of up to 9,000 tonnes. The traction power supply on the newly electrified sections shall be 25 kV AC 50 Hz which is in line with the newest technical standards.

This project should have been financed with support from European Cohesion fund. Procurement for electrification started in autumn 2019. Project costs are estimated at 441 million Euro.

In case of the usage of single voltage EMU's for passenger services this staging would result in the need to operate Riga Central station with two voltages (25 kV AC and 3 kV DC). The new suburban train fleet procured by PV was originally planned be delivered as single voltage trains in 3 kV DC. According to the latest information by PV EMU's could be optionally fitted as dual voltage trains allowing transition between traction power supply systems on the open line.

Results of stakeholder interviews with LDz and Ministry of Transport showed that the sequence of phasing and the scope of electrification is currently not certain due to the latest decline of transit cargo traffic from Russia to the Latvian Baltic sea ports of Riga, Ventspils and Liepaja and the Russian proposal to route even more traffic to Russian ports (especially Ust-Luga). According to BERERIX and EDzL statements, 25 kV electrification is currently not included in the ongoing Riga Central station redesign works. This situation conflicts with the target to provide 25 kV electrification for stage 1 of the electrification program until the end of 2025. Furthermore, it must be considered that currently no order of the passenger train operator is placed to get rolling stock for 25 kV traction power.

In March 2020 it was decided by LDz management board to cancel the electrification program. This decision was confirmed by the LDz supervisory board on 23rd March 2020.

This updated status means:

- Dual voltage Riga Central station is not to be considered for construction stages of Riga Central station.
- The further approach for later stages needs to be clarified. With the option to convert procured Škoda EMU's for Riga suburban services, advantage of a dual voltage fleet could be taken to provide a more flexible phasing without additional bottlenecks in Riga Central station and the railway core area. Furthermore, construction of Rail Baltica which will be electrified with 2x25 kV AC traction power supply would be easier (e.g. grounding and bonding measures).

At the time of writing this report future electrification plans were not finalized and were thus not considered in detail. However, it is assumed that dual voltage EMU will provide the solution for phased implementation of modernisation of traction power supply in railway core area. The developed service principles will be compatible with different traction concepts for the remaining diesel sections outside Riga node area (electric, bimodal, hydrogen power).

In neighbouring Baltic states Estonia and Lithuania 25 kV electrification is under way. Estonia is planning to electrify the core part of the existing network for 25 kV AC traction power supply. By end of 2024 the line section Tallinn-Tartu must be fully EMU compatible from the infrastructure side[54]. A procurement for 6+10 EMUs was just announced, the deadline for bids is 01/06/2020.[55] The line section Tartu – Valga is within the second stage of the Estonian electrification program and is expected to be completed by 2028. The catenary will be designed for an operational speed of 160km/h. Thus, it shall be assumed in the study, that passenger services Valga -Tartu can be operated with 160km/h maximum speed, subject to railway alignment restrictions.

In Lithuania, electrification of the line from Kaišiadorys to Klaipeda, which is the backbone of the national 1520 mm railway network is planned as one of the top priorities of Lithuanian Railways (LTG).[56] The proposed electrification scheme also includes an electrification of Vilnius bypass. There are also further upgrades planned, e. g. double tracking and modernisation of the bottleneck section Livintai – Gaižiūnai. This will result in a maximum speed of 160 km/h for passenger trains and 120 km/h for freight trains.[57]

4.5. Signalling

4.5.1. General signalling principles

Timetabling and capacity analysis depend on the applicable speed limits and braking curves and thus from the parameters of the signalling system. The features of the signalling system may also restrict the maximum line speed in the current situation and may limit future speed upgrades in the long term. Also, the applicable rules for the design of signalling system like required length of safety overlaps might interact with the track layout and may influence capacity due to conflicting routes or a restricted usable length of station tracks, e.g. length of overlaps.

Thus, a brief analysis of the current main features of the signalling system was performed to gain the basic understanding on the fundamentals to be considered in the further operational analysis that has to be performed.

Lineside signals and indication of maximum speeds

The Latvian railway network is entirely equipped with the OSShD colour light signalling system which is a multiple aspect speed signalling system. That means that

[54] Source: Confirmed information by Estonian Railways provided by RB Rail
[55] http://elron.ee/kuulutasime-valja-hanke-uute-taiendavate-rongide-ostmiseks/
[56] https://www.railjournal.com/financial/lithuanian-railways-rebrands-and-refocuses-strategic-direction/, retrieved 28/11/2020
[57] https://www.railwaygazette.com/infrastructure/vilnius-klaipedia-electrification-and-upgrading-contracts-awarded/55512.article, retrieved 01/03/2020

- only main signals and no distant signals are implemented,
- the main signal also indicates the aspect of the next main signal ahead,
- a main signal indicates the speed allowed in the section protected by the main signal,

Under normal operating conditions indication of a reduced speed by a main signal is applied in the following cases:

- in the route, containing a diverging turnout, protected by the respective main signal
- length of block section less than then braking distance to next main signal.

The maximum speed of the route over diverging turnouts is determined by the type of turnouts (angle of the switch diamond) as follows[58]:

- 25 km/h - for passenger trains with a deviation over a turnout with 1/9 diamond type
- 40 km/h - for trains with deviation over a turnout with 1/11 diamond type;
- 50 km/h - for trains with deviation over a turnout with 1/11 diamond type and rails types of R65 or 60E1
- 80 km/h - for trains with deviation over a turnout with 1/18 diamond type;

Aspects of signals for the above speeds, depending on various track layouts, are represented in the Annex 5 of Technical Operation Rules. The currently used lineside signalling system can only display three different speed steps for train routes:

- Proceed at reduced speed and readiness to stop;
- Proceed with reduced speed
- Proceed with line speed

The maximum speed of station tracks is part of the local operational rules and for LDz network outlined in annex 1 of the network statement. Thus, the driver will interpret the signal aspects correctly depending on his route knowledge.

[58] see Section 426 of Technical Operation Rules

Train protection (ALSN)

To limit risks of signal overruns at danger ALSN is used as train protection system and allows – depending on the block section length, which in a multiple aspect signalling system equals to the available maximum brake distance, and the brake equipment of the train – maximum speeds of up to 160 km/h.

The system is safety-related, not fail-safe since it is a supplement to track-side signals, but safe eno204ugh to supervise the driver.

The system consists of track circuits (TC) and on-board equipment.

- The track circuits are of rather conventional design with receivers based on relay or electronic technique.
- The on-board equipment consists of an electronic amplifier; a relay-based decoder; an electro-pneumatic valve for switching on/off the braking system; a light signal, representing aspects of track-side signals, and a vigilance handle for acknowledgement of received information by a loco driver and driver's vigilance monitoring.

The data transmission between coded track circuits and on-board equipment is via inductively coupled air coil pickup on-board antennae above the rails. The signal aspect indicated in the cab relates to the aspect shown by the lineside main signal ahead. The distance to the next signal cannot be indicated by ALSN. There are four cab signal aspects (see Figure 45):

- Green: next signal is clear
- Yellow: next signal ahead indicates a proceed aspect with necessity to stop, a static speed limit of defined value is continuously monitored by ALSN onboard equipment
- Yellow/Red: Next signal ahead is closed (red), static speed limit 50 km/h (freight trains) or 60 km/h (passenger trains) of defined value is continuously supervised by ALSN onboard equipment[59]
- Red: passing of red signal is detected, speed limit of 20 km/h is monitored, when this aspect is shown
- White: No signal received from the rails.

In Figure 45 the typical braking down of trains approaching a closed signal with 3-aspect signalling including surveillance by ALSN is displayed to illustrate the use of cab signalling. The resulting braking behaviour and the ALSN speed restrictions enforced by the ALSN on board equipment are to be considered when determining minimum train headways and performing operational simulation.

[59] Source: European Railway Traffic Management System (ERTMS) National Implementation Plan Latvia, 2017

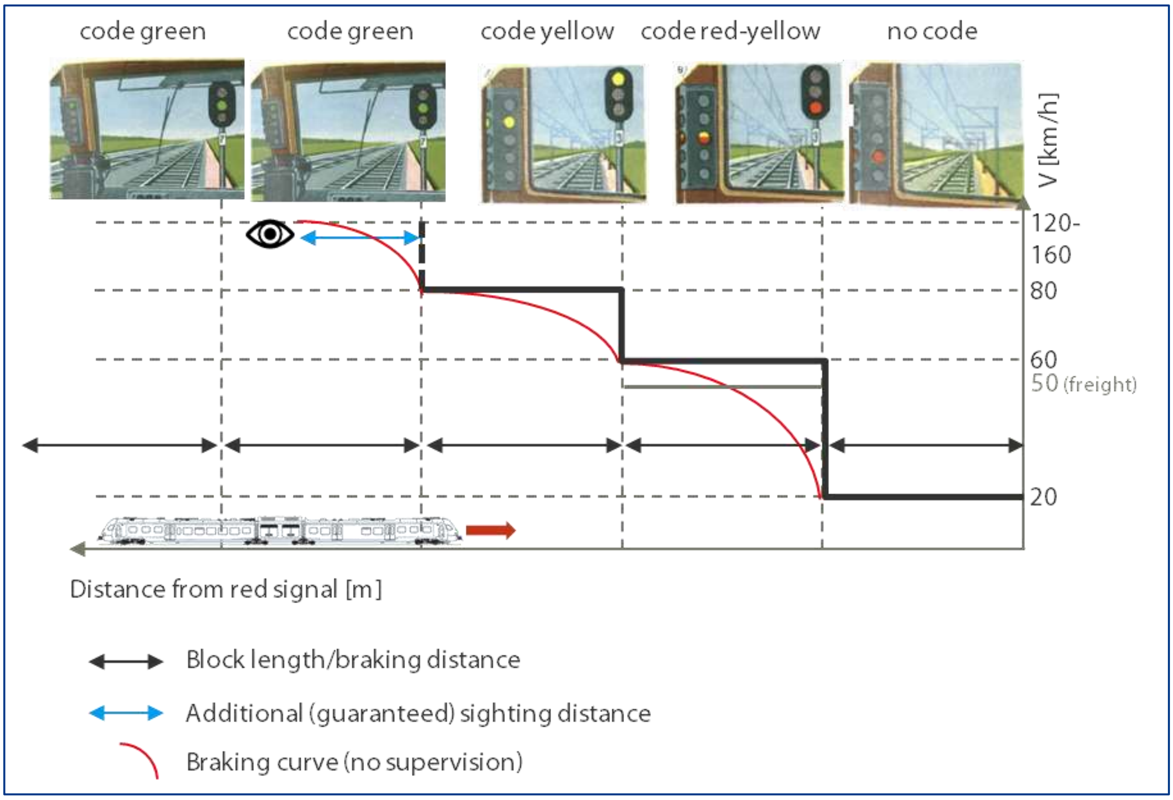


FIGURE 45: ALSN CAB SIGNALLING ASPECTS AND BRAKING OF TRAINS[60]

In a station typically only the running lines/main routes are equipped with coded track circuits for ALSN. This is possible since the driver has always to obey the lineside signals, and the system will detect whether a signal in rear was passed at danger (loss of signal from the track and red cab signal) and always memorized the aspect from the signal in rear.

Track vacancy detection

Occupation of tracks is supervised using various types of Track circuits (TC's). There are various types in use on the open line and in stations.

Open lines are equipped with an Automatic Block system having:

- coded TC's of alternating current (AC) with frequency of 50, 75 or 25 Hz; or
- continuous TC's, which ensure switching-on coding mode towards an approaching train depending on the train direction (TC's with frequency of 50, 75 or 25 Hz of AC for continuous mode or with frequency of 50, 75 or 25 Hz for coding mode)

[60] Source: Own depiction, based on Russian signalling http://scaletrainsclub.com/portal/images/portal_files/vasily/some_books_h15/isi.pdf and http://mysite.du.edu/~etuttle/rail/russrail.htm

- Direct current (DC) TC's.

Stations are equipped with:

- continuous TC's which ensure switching-on coding mode towards an approaching train depending on the train direction:
- TC's with frequency of 50, 75, 25 Hz or audio-frequency of AC for continuous mode and with frequency of 50, 75 and 25 Hz for coding mode; or
- DC TC's.

Maximum Line speed

The maximum line speed in Latvia is currently limited to 120 km/h for passenger trains and 90 km/h for freight trains. The individual restrictions for certain line sections are outlined by written orders to the train drivers[61] separately for even and odd direction and distinguished for passenger and freight trains. Additionally, speed limits may apply for stations' main tracks, mainly to ensure the safety of staff and passengers passing the railway tracks at unsecured level crossings to reach the platforms or work sites. These are also outlined in annex 1 of the network statement (for running lines and other main tracks, e.g. reception sidings).

[61] Order No D-1.14.-128-2017 about fixing of train speeds from 20/01/2017 and annex 1 of LDZ network statement

Virzieni, iecirkņi, posmi	Pāra, nepāra ceļi, vienceļa posmi	Posmā: Pasažieru vilcieni	Posmā: Kravas vilcieni	Stacijas	Pāra, nepāra ceļi, vienceļa posmi.	Stacijā: galvenais ceļš (Stacijas galu kopsavienojums) nepār.	Stacijā: galvenais ceļš (Stacijas galu kopsavienojums) pār.	Stacijā: p/n ceļš (Stacijas galu kopsavienojums) nepār.	Stacijā: p/n ceļš (Stacijas galu kopsavienojums) pār.
1	2	3	4	5	6	7	8	9	10
2. Rīga - Lugaži - Valsts robeža (km 166,300)				Rīga - pas.*	pār. nepār.	35/35*	-	35*	35*
				(*)Pasažieru platformu robežās kravas vilcieniem pa galvenajiem un pieņemšanas-nosūtīšanas ceļiem - 25km/h, t.sk. pa ceļiem Nr.2 un Nr.9.					
Rīga - Zemitāni	pār. nepār.	80	80	Zemitāni*	pār. nepār.	25/25	40/40	25	40
				(*) novirzoties uz galvenajiem ceļiem Nr.III,V,VI,XI- 25km/h.					
Zemitāni - Čiekurkalns*	pār. nepār.	70	70	Čiekurkalns	pār. nepār.	90/70	70/70	40	40
(*) 5.km 7.pk - 9.pk	pār. nepār.	70 25	70 25						
Čiekurkalns - Jugla	pār. nepār.	90	80	Jugla	pār. nepār.	90/80	90/80	40	40
(*)9.km 7.pk - 9.pk	pār. nepār.	90 80	80 80						
Jugla - Garkalne	pār. nepār.	100 120	80 80	Garkalne*	pār. nepār.	80/80 40/40	100/80 100/80	40	40
				(*) p/n ceļš Nr.4 - 25km/h.					

FIGURE 46: TRACK SPEEDS IN 1520 MM INFRASTRUCTURE AS INDICATED IN THE NETWORK STATEMENT (EXAMPLE)

Level crossings

Currently there are more than 500 level crossings in the Latvian railway network. There are various types of level crossings:

- Automatic protected level crossings equipped with light signals and barrier machines;
- Automatic level crossings equipped only with light signals;
- Semi-automatic level crossings equipped with light road signals, barrier machines and barrage (barring) train signals, closed automatically but opened by a keeper;
- Locally operated protected level crossings equipped with light signals and barrier machines (operated by crossing keepers or local station attendant or CTC train dispatcher);
- A few automatic pedestrian level crossings equipped with light signals;
- Non-protected level crossings

In addition to these level crossings there are more than 400 pedestrian level crossings. Most of them are unprotected. These are provided for platform and station access and due to local needs outside stations. Additional speed restrictions may apply depending on the local situation. Depending on available funds pedestrian crossings are equipped with a technical protection or replaced by over or underpasses.[62]

A level crossing (LC) shall be closed within respective time, defined for each specific LC. Its calculated value is based on 4 basic parameters:

- Maximum length of road vehicle is equal to 24 m;
- Minimum speed of road vehicle is equal to 8 km/h;
- LC length, measured for each LC;
- Maximum train speed within LC area according to Network Statement.

According to calculated notification time, respective track section (track circuit) shall be defined as a notification start. For LC located in a station neck or close to the station, a notification shall be sent under the conditions of the route (main or shunting) setting and the occupation of approaching section to this route. This information shall be sent either to the LC keeper board for a keeper notification or to a LC facility for an automatic LC closure. In no case notification time shall be less than 30 seconds.

Signalling facilities (interlocking and/or line block) shall monitor the continuous train passing over the entire area from a notification track section up to section, defined for a notification stop for an automatic and semi-automatic LC's.

Respectively, any modification in each of the above 4 parameters will require a re-calculation of the approaching section and adjustment of signalling facilities

Impact of the signalling system and current operational rules on potential speed upgrades

It is the goal of stakeholders to increase the speed limit on 1520 mm infrastructure to reduce the travel time – depending heavily on the stopping pattern – especially for regional and international services up to 140 km/h and 160 km/h. Though a 1435 mm high-speed line is in development that is compatible to the European railway network offering an integration and therefore more attractive line concept with shorter travel times and direct connected services to European capitals. Still there is potential seen by the contractor and the stakeholders for 1520 mm long distance day and night regional and international services in the region connecting the prospering Riga Airport and important destinations alongside the Rail Baltica corridor profiting from short travel times over long distances to increase the competitiveness of services compared to road traffic and justifying an investment in 1520 mm and 1435 mm infrastructure.

[62] Example of ongoing activities: LDz Sustainability and Annual Report for 2018

According to the Latvian railway law, the crossing of tracks and roads at the same level is not permitted, if the maximum line speed exceeds 140 km/h.[63] That means new over and underpasses are to be introduced if line speed exceeds this level.

In addition the maximum speed is depending on curve radii, special rules for the ALSN train protection system equipped on rolling stock and block section length including 3- or 4 aspect track signalling (4.-aspect signalling is in operation on the line Torņakalns - Kemeri allowing to improve the capacity of suburban trains). Resulting from this a redesign of short block sections might be necessary to ensure the block section length does provide for sufficient brake distance between two adjacent block signals.

These factors must be considered for further assessment of potential line speed improvements.

Overlaps

In railway terminology an overlap is defined as a certain length of track behind a signal that must be clear and is locked for authorisation of a movement to that signal. Overlaps are provided to limit the impact of a signal overrun. In Latvia locked overlaps are not required inside stations. However, the typical design guidelines for stations require the exit signal to be placed 50 m ahead of the fouling point.

For block signals on the open line safety protection sections with a minimum length of 610 m are to be provided behind each block signal. The amount of required track sections for the protection area depends on the required length of the protection area. If the used track section behind the passage signal exceeds this required length, then the whole track section will be used as protection area.

Safety at level crossings is an ongoing concern and various campaigns have been launched to strengthen awareness of the population regarding dangers related to level crossings and trespassing railway tracks.

Routes

Main routes could be set, cancelled and released by relay-based and microprocessor interlockings based on the same functionality from local workplace and from CTC centre (excepting for big and junction stations).

A main route can be cancelled without time delay in case of the approaching section is free. In case of an occupation of the approaching section, route shall be cancelled with 3 minutes delay.

Releasing of a main route shall be performed with time delay of 5 to 23 seconds (i.e. last route section is free for more than 5 seconds and, for arrival and transfer routes shall be provided a releasing delay for facing points with continuous driving surface (CDS), as well as for second and third points without CDS, included in track circuits adjoining arrival-departure tracks. The release delay time shall be 18 seconds.

[63] Dzelzceļa pārbrauktuvju un pāreju ierīkošanas, aprīkošanas, apkalpošanas un slēgšanas noteikum

Also, if after a train passed any track circuit within the route is occupied (falsely), a route shall be artificially released with delay of 3 min.

Cab radio

Railway lines are equipped with train dispatcher communication means and station communication means. The analogue radio communication means of trains operate in the frequency of 2.13–2.15 MHz, while station communication means operate in the frequency of 150 MHz or 450 MHz.

Radio communication devices installed in trains ensure a continuous two-way communication between the traction unit driver (locomotive driver) and train dispatcher (within the range of dispatcher sections), station-masters on duty (within the range of track sections adjacent to the station) and other traction unit drivers (locomotive drivers located in the same section).

All cab radio communication means are not compatible with GSM-R systems.

4.5.2. Equipment and traffic control on Latvian line sections

The main features of the signalling systems applied on the individual line sections in Latvia are outlined in the network statement:

- Type of line block (automatic / semi-automatic),
- Station control (centralized or local),
- Application of centralized dispatching.

As can be seen, on most line sections centralized dispatching is applied. Various types of centralized traffic control systems (CTC) are installed.

Route setting is performed by means of relay-based or electronic interlockings. The route setting at stations is performed locally and, for stations covered by CTC, remote controlled in the following control centres. Overall a high level of centralisation is reached as is indicated by the following status of CTC deployment:

- Riga CTC centre operates line sections: Ventspils – Jelgava (Thales CTC); Jelgava – Krustpils (Thales CTC); Riga – Jelgava (Bombardier CTC); Riga – Ķemeri (Bombardier CTC); Šķirotava – Krustpils (Bombardier CTC); Riga - Lugaži: CTC Dialog/Neva (meaning working place and equipment of CTC Centre is of type Dialog, whilst interfaces with local station interlocking on are of previous type CTC Neva)
- Daugavpils CTC centre operates by line sections: Daugavpils – Rēzekne – Karsava (CTC Dialog / Neva, USSR); Daugavpils – Indra (Thales CTC); Daugavpils – Krustpils (Bombardier CTC); Krustpils – Rēzekne (Bombardier CTC).

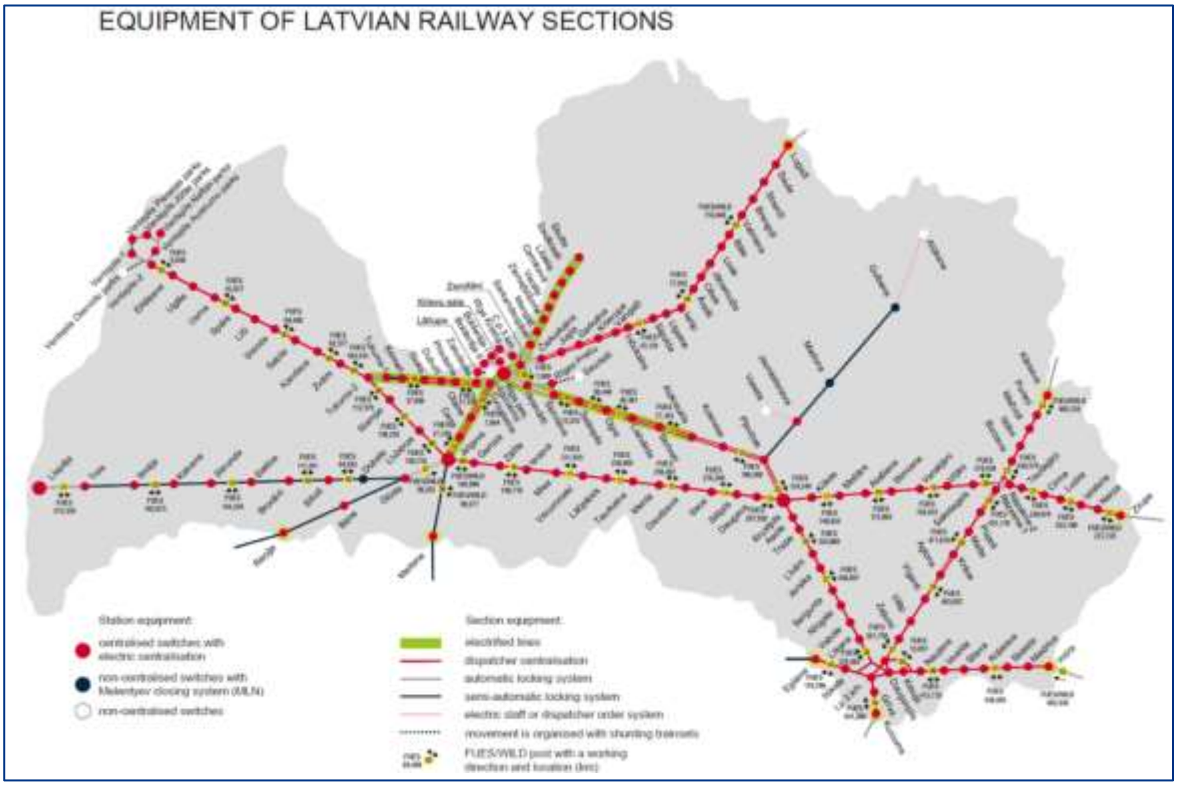


FIGURE 47: SIGNALLING EQUIPMENT OF LATVIAN RAILWAY SECTIONS

On the lines equipped with CTC, major and junction stations, including Riga, Torņakalns, Šķirotava, Ventspils, Jelgava, Krustpils, Daugavpils, Rēzekne, are only monitored by CTC, but are operated locally.

Respectively, stations, covered by CTC Bombardier and CTC Thales, are equipped with their interlocking systems Ebilock-950 of some generations and ESTWL-90. Stations on other sections are equipped with various types of relay-based interlockings, which are interfaced to the respective CTC (types as described above).

Only the section Riga – Ķemeri is currently equipped with an automatic line block system with 4-aspect signalling (due to very intensive initial suburban traffic to Jūrmala coast), whilst all other line sections with an automatic block are equipped with 3-aspect signalling.

4.5.3. Current situation in railway core area

The current situation in the railway core area was studied by BERERIX as part of preparatory works for the Riga Central station redesign. The financial effort to update the track layout and the signalling system is dependent on:

- Currently implemented and homologated interlocking systems

- Implemented and available horizontal interfaces to adjacent interlockings and vertical interfaces to an existing or proposed CTC solution impacting an effort to upgrade an existing solution to reach the proposed target stage for construction phases and final track layout.

According to BERERIX study[64], the current situation in the railway core area can be described as follows:

- The signalling system (SCB) in the main part of the Riga-area is provided by Bombardier. It uses the EBI Lock 950 system as computer-based interlocking (CBI) and the EBI Screen 2000 for the CTC-functionalities (centralized traffic control).
- The Riga CBI is composed of 2 logic software systems within the same computer system: Torņakalns (on the left bank of the Daugava river) and Riga Central station (for the right bank). The Riga Central station software logic as such also covers two sub-stations/yards: Riga Central Station itself and the stabling yard of Vagonu Parks.
- The Riga CBI interfaces directly with the adjacent CBI of Zasulauks and the CBI of Šķirotava. Since all these electronic interlockings are delivered and programmed by the same supplier (Bombardier), these interfaces happen digitally, and within its own specific proprietary protocol.
- There are also two relay-interlockings connected to the Riga CBI: Atgāzene and Zemitāni. These interfaces are implemented more basically by means of electrical connections.

First microprocessor interlocking was implemented for Riga and Torņakalns stations, commissioned in 2001. In the year 2015 a central processing unit was replaced by a modern one (Ebilock-950-R4), simultaneously with Zasulauks station. However, all other facilities, including the object controller systems, the power supply facilities cable network and the track-side equipment were not touched. In about 2016 Šķirotava station with its yard Jāņavārti, was equipped with Ebilock-950 as well. EBILOCK 950 interlocking is widely used in 1520 network and despite its age still available on the market.

Types of line block signalling was kept as before, including 4-aspect signalling for Riga – Zasulauks – Ķemeri section. Lengths of block sections within such a tight area also were kept as before.

Operation of Riga Central station is performed from LDz building Turgeneva 14, where CTC Riga facilities and dispatcher working places are also located. The operation of Riga and Torņakalns area are possible from 2 working places, whereas the operational zone can be changed and also switched to one station attendant.

For a redesign of Riga Central station, various options have been studied by BERERIX including adaption of an existing interlocking system as well as a procurement of a new interlocking system.

[64] Signaling Options Riga Central Station – A high level view and preliminary impact analysis, BERERIX, 02.08.2019

The main advantage of keeping the existing system is to minimize effort for homologation and establishment of interfaces between the different interlocking systems. Furthermore, the scope of an adaption of a signalling system can be limited to Riga Central station, provided there is no need to change the signalling on adjacent line sections, like in Torņakalns. Disadvantage of this approach is the remaining dependency on the availability of know-how and spare parts for a relatively old system.

4.5.4. Conclusion

The specific signalling conditions on the 1520 mm network must be considered for performing operational analysis, incl. a capacity calculation and a timetabling as well as changes in the station track layout. From the current viewpoint ALSN is likely to remain during the next one or two decades due to required interoperability within the 1520 mm network, which applies to the traffic between the Baltic states as well as for traffic relations to Russia and Belarus. The system itself will limit the maximum speed to 160 km/h, but it could be upgraded by other compatible solutions developed for the 1520 mm network. Most of the more modern types require updated trackside equipment and/or extension of an interlocking functionality, which again raises the question which solution shall be applied in the long term. If speeds are upgraded on the line sections with short distances between lineside main signals or entry and exit signals signal locations at stations, these need to be upgraded.

If a suitable common technical solution and implementation plan can be agreed between the Baltic states and suitable solutions for cross border traffic can be developed, ERTMS might be a long-term solution to replace the existing conventional signalling system.

A final decision regarding the future of the interlocking system in Riga Central station is not made yet. For a first construction phase of Riga Central station, the existing signalling system shall be adopted. This is supported by the fact, that track layout changes are mainly limited to closing of existing tracks, which are to be removed. However, each construction stage will require a software change to support changed track topology. Furthermore, the lineside equipment will also be upgraded, where necessary.

From signalling perspective, the following risks need to be assessed in a detailed analysis

- Risk of train overrunning stop signal, if maximum speed > 120 km/h is applied considering braking power of the train, reaction time of brake equipment, reaction time of ALSN on-board device
- Increased risk on protected and unprotected level crossings (including e.g. ensuring of necessary viewing distance for road users to safely clear an unprotected level crossing, earlier activation of protected level crossings).

5. Definition of a cyclic 1435 / 1520 mm timetable

5.1. Overall Methodology

The scope of highly synchronized cyclic timetabling did include 1435 mm timetable and 1520 mm timetable with the aim to provide interconnectivity between both future railway networks.

Timetabling work for 1520 mm services was supported by comprehensive data collection activities related to

- Detailed modelling of the railway core area in RailSys (microscopic infrastructure model)
- Simplified modelling of the railway infrastructure for line sections outside the railway core area (Riga suburban area, national day and night service area).

In the end required infrastructure modelling did include all line sections intended for 1520 mm passenger operation in Latvia according to the scope of this study.

For microscopic modelling of infrastructure and traffic in the railway core area timetabling and simulation software RailSys was used.

To provide a macroscopic model of the infrastructure and traffic outside the core area timetabling software FBS/iplan was applied. The two models were kept synchronized during iterative timetable construction by manual updates. Therefore, the FBS/iplan model also included a simplified model of the railway core area.

This approach was chosen to save time and to minimize the required input from LDz site to a manageable level suitable for the project.

Timetabling principles for 1520 mm were agreed with PV and LDz. Therefore, the consultant provided an assumption list, which was commented by PV and LDz. Unavoidable deviations from this list are documented in this report.

Generally, maximum applicable line speeds are based on the current situation. To develop a consistent speed profile for each line section various data sources (LDz network statement, track speed and gradient profile diagrams etc.) needed to be consolidated.

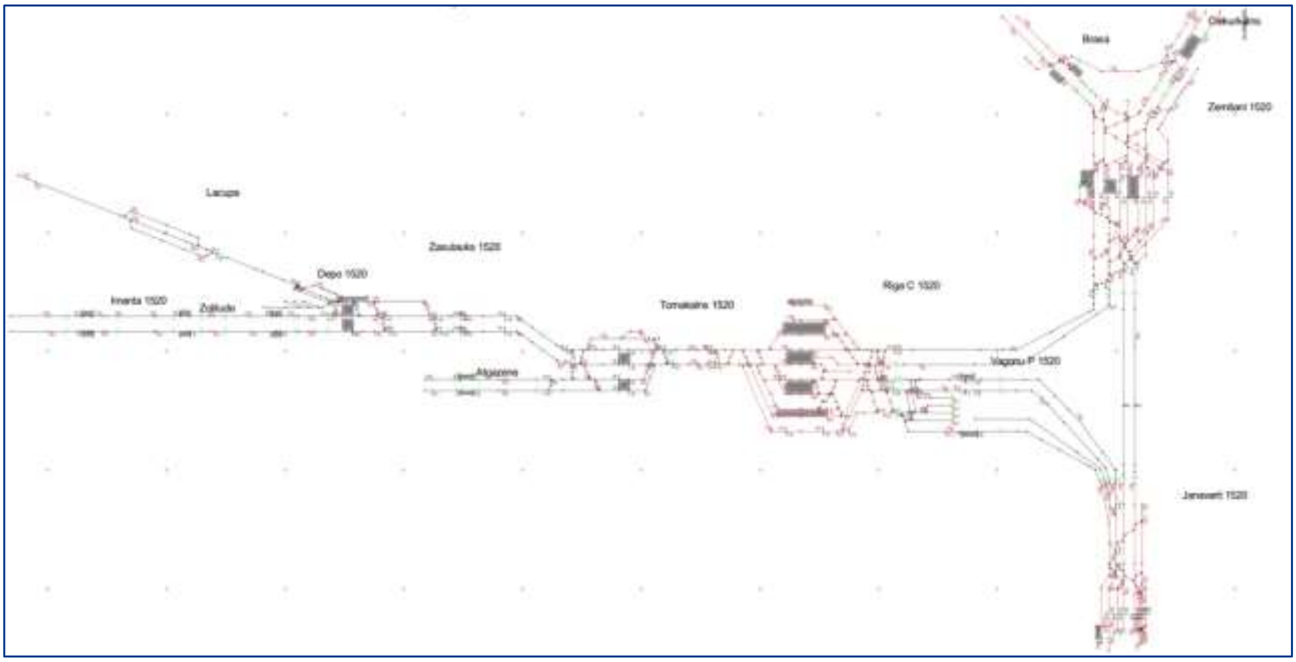


FIGURE 48: MICROSCOPIC 1520 MM INFRASTRUCTURE MODEL FOR THE RAILWAY CORE AREA

Timetabling was performed in an iterative process including involvement of stakeholders (PV, LDz). The comments from the stakeholders were considered in a second optimisation round as far as possible.

The developed master timetable is based on

- Existing infrastructure for all line sections outside the railway core area
- Target stage for Riga Central station and initial plans for the rework of the 1520 mm line sections to provide necessary space for Rail Baltica.

1435 mm timetable is based on the work carried out for the operational plan and the related updated plan performed by Rail Baltica. For 1435 mm timetabling the RailSys model provided by Rail Baltica is used. Due to the many constraints in the 1435 mm timetable it is treated as fixed so far. Related recommendations for improvements will be provided in the final report based on the updated RailSys model reflecting the final track layout for Riga Central station.

Due to the proposed changes in the service pattern for Riga suburban services (cyclic timetable) and proposed significant changes in the timetable for regional services the timetable for 1520 mm services was developed from scratch but considering the required services based on a service pattern as described in chapter 2.4.1. The developed master timetable targets the time period 2026/36 but is constructed in a way, that additional services can be added later on to fill the gaps.

In chapter 2.5.5 the potential travel time improvements in case line speeds would be further increased up to 160 km/h are discussed. Impact of further improvements of travel time on timetable structure and required track layout upgrades will be highlighted in the final report.

5.2. Timetabling Principles/Rules

In this chapter the main principles and rules for development of the master timetable will be summarized highlighting approach and underlying assumptions related to

- Train priorities and sequence of timetable construction
- Station dwell times and assumed stopping pattern
- Applied rolling stock parameters for passenger and freight service timetabling
- Application of run-time supplements and buffer times

The main assumptions were fixed before the setup of the timetable and agreed with RB Rail, LDz and PV at the beginning on the timetabling process based on suggestions by the consultants related to European standards and requirements outlined by PV and LDz.

5.3. Application of a cyclic timetabling principle on Riga Central station

After summarizing the quantity structure and the volume of the rail traffic the next step would be to form an optimal service pattern and timetable concept that fulfils all these basic requirements. The ideal service pattern as seen by the consultant is the cyclic timetable (also named clock-face schedule). The envisaged principle of arrival and departures at a station to provide connections in all directions is shown in Figure 50, on the left side. Here all train lines in the region for both directions meet in one central train station in a 00- or 30-minute node to allow an interchange of passengers between all services. Also, it allows to maximise the possible connections to Rail Baltica services, if a similar principle can be applied.

Analysis of Rail Baltica timetable shows that the proposed service pattern is partly compatible with this principle.

In Figure 49 below the train arrivals and departures at Riga Central station are outlined based on an analysis of the current timetable implemented in RailSys. Based on this picture the possibilities to provide interconnectivity between Rail Baltica services and the 1520 mm network were initially analysed. Special aim was to check compatibility to the idea to provide a node at the full or half hour at Riga Central.

From this picture the following conclusions can be derived:

- The idea to implement a meeting of trains around the timetable symmetry at minute 30 is compatible with HST services from and to Tallinn.The services from and to Warszawa would miss a meeting with arrivals and departures located closely around the half hour. Reason for that is that the long-distance train timetable is constructed around the meeting of the trains in Kaunas Central station. This requirement is to be met to provide interconnectivity between Warszawa – Tallinn services and Kaunas – Vilnius services and to cope with single track sections on both sides of Kaunas Central station (main obstacles for double tracking are Kaunas tunnel and Nemunas river bridge).
- To provide regular arrivals and departures in the new concept (minimum hourly service on all stations outside peak-hours) is required. As a result, the lines RE31 and RE32 will form the backbone of the network.
- To avoid oversupply, especially on the corridor Riga – Skulte – Salacgrīva the RE lines RE21 (Tallinn – Riga Central station - Bauska) and RE26 (Marijampole – Bauska – Riga Central station – Skulte - Salacgrīva) shall be running based on a demand distribution over the day and the needs of cross-border services. To reach this, a terminating of trains in Riga Central station (RE26) and Riga airport (RE21) will be required. Therefore, the provided turning facilities (additional bay platform at Riga airport for RE21 and a dedicated turning siding at the east side of Riga Central station for RE26) have to be used. Feasibility of this approach is subject to a detailed revision of the timetable.
- The current version of the timetable does include overtaking of regional trains by HST trains. This service pattern requires availability of four platform tracks.

Based on this the possibilities to provide a cyclic timetable based on the half hour node as main symmetry axis will be checked. Application of this principle will not only provide advantages for interconnectivity between both gauges but also provide for good interchange conditions in Riga Central station inside the 1520 mm network. Thus, this principle will be taken as basis for further development of the synchronized 1435 mm / 1520 mm timetable concept.

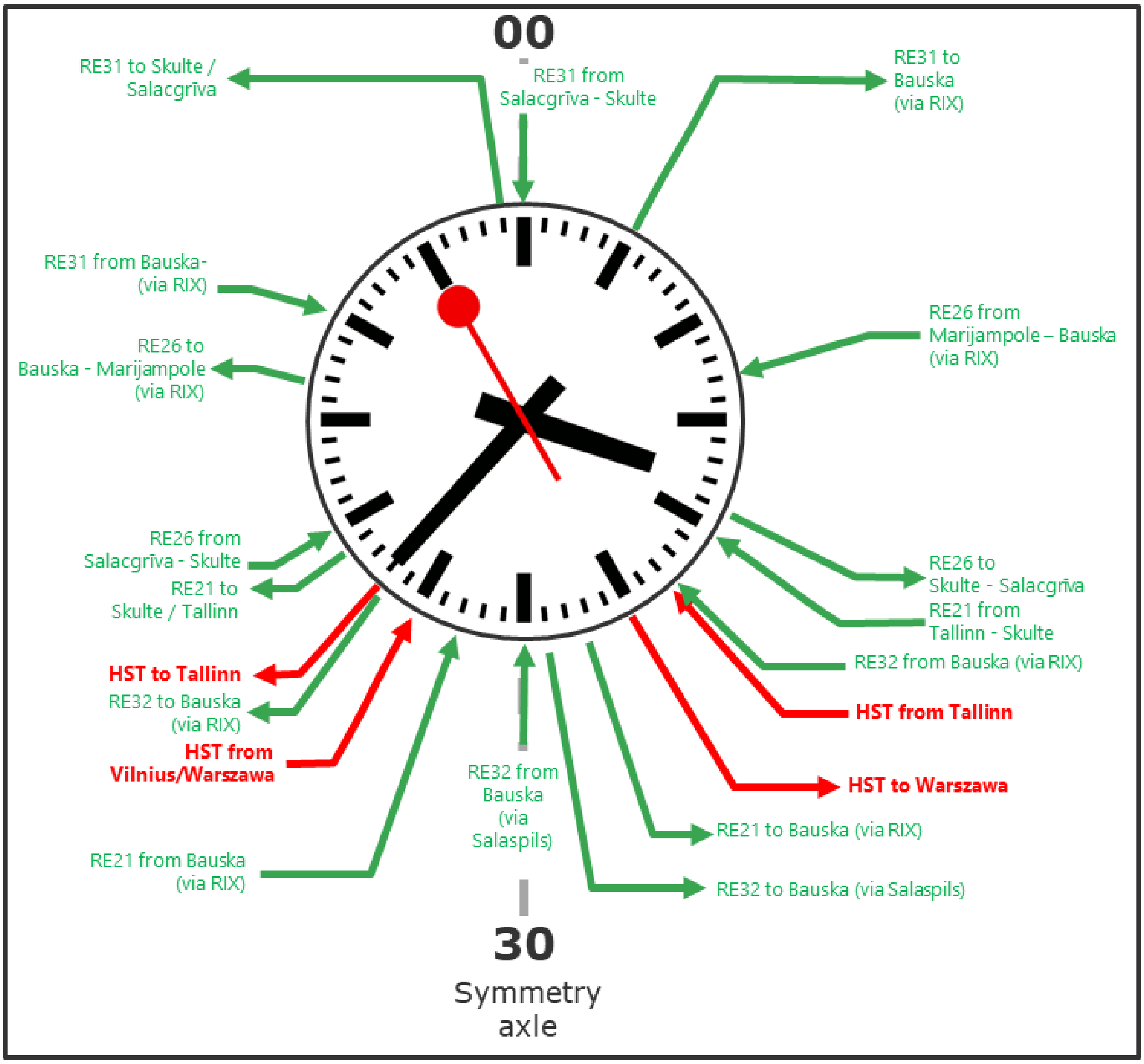


FIGURE 49: 1435 MM TRAIN ARRIVALS AND DEPARTURES AT RIGA CENTRAL STATION[65]

[65] Source: own depiction based on latest version of timetable implemented in RailSys

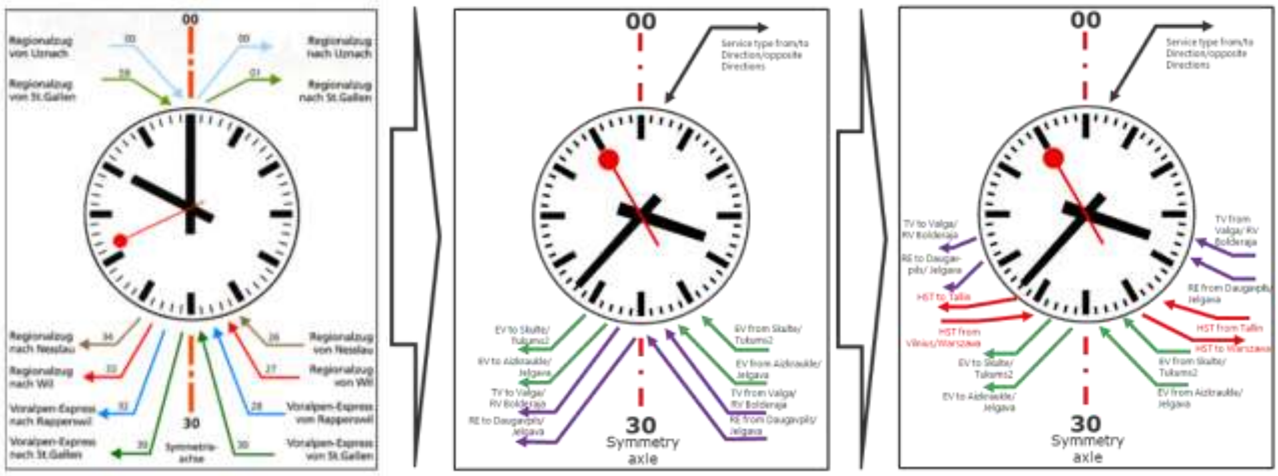


FIGURE 50: SYNCHRONIZING THE CYCLIC TIMETABLES IN RIGA CENTRAL STATION

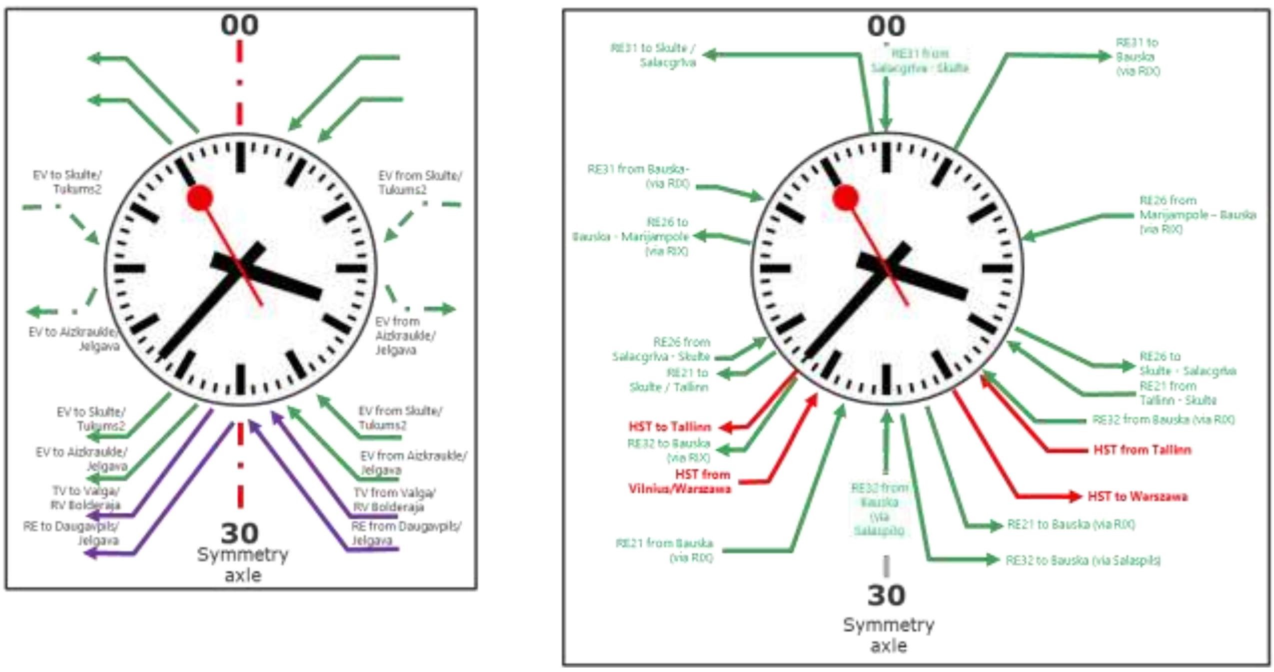


FIGURE 51: ARRIVAL AND DEPARTURE TIMES OF THE 1520 MM AND 1435 MM RAIL BALTICA SERVICE PATTERN

5.3.1. Train priorities and sequence of timetable construction

The construction of the 1520 mm service pattern of the Master Timetable for Riga Central station and the adjacent corridors follows priorities and steps shown below. The central goal is to offer optimal intermodality between the 1520 mm service and the Rail Baltica services in Riga Central station.

Sequence of timetabling:

1. **First definition of the symmetry minute (30-minute node in Riga Central station):** Here the goal is to connect all suburban and regional services of the Latvian railway network to Riga Central station at the half hour according to clock-face scheduling rules (defined in in chapter 5.2). This allows to offer connections between all suburban and regional services and to the Rail Baltica RE and HST services who run through Riga at the half hour (shown in Figure 51 below, symmetry axle 30).

2. **Definition of a minimum overall dwell time of passenger trains in the symmetry minute (including potential cross-border day trains):** 6 minutes are long enough to allow passengers to switch between trains on separate platforms. Since a connection between all train services should be targeted, a minimum time between the arrival of the last train and the departure of the first train should be at least 6 minutes. This means that a train also can stay longer than 6 minutes.

3. **Timetabling of all-day suburban service based on 30-minute interval for all corridors (00- and 30-minute node).** Over the whole day suburban services should at least have a 30-minute interval. Additionally, at least once per hour (or sometimes every 2-hours) a suburban service should run over the whole corridor. Interconnectivity to the regional services in the defined 30-minute node should be maximized to the long running suburban services. Suburban services of the 30-minutes interval which only operate on parts of the corridor are placed in the less important 00-minute node.

   Also, since regional and suburban services sometimes only operate 2-hourly during off-peak it shall be taken care of that these services run through the 30-minute node in the same hour.

4. **Timetabling of less frequent regional services in the 00-minute-node:** Since in the 30-minute node all available platforms are already occupied less important regional services will serve the 00-minute node. Here for example the slower daily train pair services like the R 70 between Riga and Madona-Gulbene which terminates and begins in the 00-minute node. All other regional services (RE 10 Ventspils-Riga, RE 20 Liepaja-Jelgava-Riga-Krustpils-Daugavpils/Rēzekne-Zilupe and the RE 30/I.RE 30 Riga-Sigulda-Valga) could be connected to the 30-minute node.

5. **Timetabling of suburban peak-hour services in the 15- and 45-minute-node in Riga Central station:** After defining the most important nodes in Riga Central station the additional suburban peak-hour services will be added to the 15- and 45-minute node.

Since these services only serve parts of the corridor terminating at intermediate stations[66] closer to Riga, these services are additional direct connections to Riga only to cope with the greater demand for destinations closer to Riga. Therefore, a connection between these services are seen less relevant and shorter station dwell times of 3 minutes in Riga Central station are seen as sufficient to allow entry and exit of passengers during the peak-hour.

6. **Timetabling of freight trains during peak-hour and off-peak:** As requested, by LDz an hourly freight train slot should be possible during the peak-hour. Left over capacity in Riga Central station (in the less frequented 45- and 15-minute node) will be used to integrate freight trains between Bolderāja-Riga-Šķirotava. Freight trains can stop in Riga Central station if required and are limited to a top speed of 25 km/h inside the station.

7. **Timetabling of international night train services in Riga Central station.** Left over capacity in Riga Central station and on the corridor is used to bring night trains into Riga Central station in the morning and out of Riga in the afternoon. Here a minimum station dwell time of at least 20 minutes should be possible for postprocessing and preprocessing. Here it is important to keep the night train slots compatible to today's timing of the night trains.[67]

During the whole process an even distribution of passenger trains is targeted to allow even distribution of passengers between the trains. Also, according to feedback of PV a faster regional service should not overtake suburban services but should get additional travel time instead.

Also, the 30-minute and 00-minute node has no capacity and platforms left for the later added suburban diesel service line CT 12 between Daugavgrīva-Riga-Jugla-Sigulda. Therefore, the service was put into the 15- and 45-minute node in Riga. Also, it is still the target to offer connections between the two suburban lines CT 1 and CT 2 in the 00-minute node in Riga Central station. However, since the capacity in Riga Central station is limited dwell times can be reduced below 6 minutes to have enough capacity to meet the required quantity.

5.3.2. Runtime supplements

In general, the runtime supplements according the principles outline in UIC leaflet 451-168 were applied. For suburban EMU and regional DMU services within the speed limit of up to 140 km/h this means a supplement of 3 % on the runtime. For freight and night trains 5% on the runtime are applied (see Table 20: below).

Service type	Linear runtime supplement	Additional non-linear runtime supplement
Regional, suburban	3 %	1 min per corridor section
Suburban		
Freight	5 %	
Night trains	5 %	

[66] Exception corridor Riga-Jelgava where all suburban services operate between Jelgava and Riga.
[67] Source of night train Timetables: http://l-ekspresis.eu/en/passenger-transportation/train-schedule/
[68] Source: UIC Codex 451-1 version 4, december 2000

TABLE 20: RUNTIME SUPPLEMENTS

Additionally, on double track sections in the suburban area (Riga-Krustpils, Riga-Jelgava, Riga-Tukums, Riga-Skulte, Riga-Sigulda) one additional minute as linear supplement was given to compensate for construction and unplanned maintenance of infrastructure. Linear supplement can be deposited in longer dwell times or linear distributed in the last third of the track section. On single track sections (mostly outside the suburban area) no additional linear supplement was applied since a reserve is often deposited in a longer dwell time at train stations where trains meet with other trains in the opposite direction.

5.3.3. Station dwell times

For all passenger services defined minimum station dwell times are maintained at all times (see Table 21 below). Minimum station dwell times are categorized in standard stops in standard stopping points and smaller or less frequented train stations, bigger or higher frequented train stations which could also serve as a central interchange hub and specially defined dwell times in Riga Central station to meet additional requirements regarding interchange of highly frequented interchange between passengers between fast RE services and suburban services from all directions and corridors.

Station	Targeted minimum station dwell time	Exceptional lower station dwell time	Remarks
Standard train stations and Stopping points on the corridors.	0.7 minutes	-	Minimum station dwell time of 0,7 minutes is always maintained.
Highly frequented, important or bigger train stations	1.0 – 2.0 minutes	-	Due to higher passenger demand frequency.
Riga Central station	6 minutes	3-4 minutes	Due to overtaking dwell time can be up to 12 minutes, in the important 30-minute node the dwell time of 6 minutes is always be maintained.

TABLE 21: APPLIED MINIMUM STATION DWELL TIMES

Dwell time on the corridors

In general, a minimum station dwell time of 0.7 minutes has been applied for all stations and stopping points for passenger services. This value is chosen to be safe side regarding required additional electronic passenger protection systems and equipment for new rolling stock (laser in the doors to check for passengers, central surveillance system to check for safe closure of all doors before moving the train, extending sliding steps for more comfortable entry and exit of passengers and for people with reduced mobility). This is based on the currently ongoing review of DB network access conditions in Germany and the own experience of the consultant regarding problems of too low minimum station dwell times which do not fit with newly purchased modern rolling stock.

The application of dwell times in the construction of the annual timetable has to be reviewed after practical experience with new trains. For specific stations dwell times of up to 2.0 min/1.0 min are assumed based on own experience and check of peak passenger numbers in major stations. Further adjustments in annual timetables are not part of the study. Standard values are based on German rules for timetable construction and own experience (DB Ril 402.0301).

Dwell time at interchange hubs

For important bigger stations with expected higher frequency of passenger at least one to two minutes have been applied. This value was chosen to allow to cope with higher possible passenger exchange during the peak-hours especially for stations on the corridor which lay in a 15, 45, 30 and 00-minute node of the passenger services (RE, CT/EV). This makes these stations suitable for an interchange hub to other local public transport services since this allows to concentrate arrivals and departures with slightly longer dwell times around the nodes. This allows passengers to change from and to suburban and regional passenger transport services. Stations which are suitable as an interchange hub, either within the railway system or with interface to local public transport, are listed in Table 22 below.

Corridor	Station (more or less) in a 15/45, 00 and 30-minute node
Riga-Aizkraukle-Krustpils-Daugavpils/ Rēzekne-Zilupe	Jāņavārti, Ogre, Aizkraukle, Plavinas, Krustpils Daugavpils, Rēzekne, Zilupe
Riga-Jelgava	Jelgava, Olaine
Riga-Sloka-Tukums	Zasulauks, Priedaine, Bulduri, Dubulti, Pumpuri/ Melluži, Sloka, Ķemeri, Smārde and Tukums I/II
Riga-Skulte	Saulkrasti, Skulte
Riga-Sigulda-Valga	Vangaži, Sigulda, Cēsis, Valmiera, Lode, Strenči, Valga

TABLE 22: STATION ON CORRIDORS SEEN FIT AS INTERCHANGE HUB

Dwell time in Riga Central station

In Riga Central station a minimum dwell time of 6 min was targeted to allow the interchange of passengers between all services (including required time to switch platforms) and to consider the exceptionally high frequency of passengers during the rush-hour. For the overtaking of suburban CT/EV services by faster RE dwell times can be longer up to 10-12 minutes for suburban services. Also, the dwell times can be longer than 6 minutes to allow the interchange of passenger between later arriving passenger services.[69] The targeted minimum dwell time of 6 minutes in Riga Central was not always possible to maintain. For the important 30-minute node the minimum dwell times of 6 minutes and longer could be reached to allow the interchange between all services. For the CT/EV services in the 00-minute node and the suburban rush-hours in the 15 und 45-minute node the dwell had to be reduced to 3 and 4 minutes. This had to be done to integrate all required suburban, regional services and hourly freight train slots into Riga central station during the rush-hour. A reduced station dwell time of 3 to 4 minutes is still seen as sufficient for a passenger exchange for suburban services during the rush-hour. This is based on the experience of the consultant and applied principles in Germany where trains with higher capacity and passenger exchange (for example 400 m

[69] Specific applied station dwell times for the 4 nodes in Riga Central station are described in chapter 5.4.3 and in Table 34.

HST trains with 900-100 passengers, 80 % passenger exchange in the station, minimalistic doors at the end of each wagon) have a minimum station dwell times of not more than 2-3 minutes during the rush hour due to capacity limits.

The reduced minimum station dwell time results in the loss of connections between most suburban services in the 15/45 and 00-minute node. Since the 30-minute node is seen as the most important interchange hub between suburban and regional and international services passengers for the other nodes can interchange by waiting for trains of the next node (windmill principle: for example passenger from the 15-minnute node wait for trains of the important 30-minute node).

Turnaround time including terminating and beginning trains

Different minimum times for turning trains around have been applied for regional (R, RE and I.RE), suburban (CT/EV) and night trains as well in general. Also, preparation times need to be considered when passenger services terminate in passenger stations or begin (see Table 23 below).

Service type	Targeted turnaround time (reduced)	Terminating services (reduced)	Beginning services (reduced)
Suburban (CT/EV)	9 minutes (6 minutes)	4 minutes	3 minutes
Regional (RE, R, I.RE)	30 minutes (6 minutes)	30 minutes (4 minutes)	9 minutes (3 minutes)
Night trains	-	30 minutes (20 minutes)	30 minutes (20 minutes)

TABLE 23: APPLIED TIMES FOR TURNING AROUND, TERMINATING AND BEGINNGING TRAINS

Suburban electric services

For suburban services trains should have at least 9 minutes to turnaround (as seen in Table 23 above). Additionally – if necessary – shorter times of minimum 6 minutes are applied during the morning and afternoon peak-hours to allow turning trains around in stations when there are not enough platforms to park more rolling stock. Also, the available number of electric rolling stock is limited. To allow the operations of the required minimum quantity structure per hour on the corridors of suburban services – especially during peak-hours – shorter turnaround times are used to keep the number of additional rolling stock as low as possible. Outside the rush-hour less electric rolling stock is required and allows for longer turnaround around times which also result in the relaxation of the tense rolling stock circulation during the rush-hour periods.

Terminating and beginning trains get as much time as possible at the first and last passenger platform of the run for preparations and postprocessing. However, in the highly frequented Riga Central station available time windows can sometimes – during the peak-hours – be no longer than 3 to 4 minutes. This is still seen as sufficient based on the own experience by the consultant and is been applied on the German railway network with modern rolling stock on daily basis due to capacity limits as well.

Regional services

For regional services a turnaround time of at least 30 minutes is applied in general to allow the staff of the train to use that time for a break and clean the train after long runs (as seen in Table 23 above). The only exception are trains which turn around in Dobele. Applying the same minimum dwell time of 6 minutes – like for suburban services – allows to turn RE20 services around to cope with the 2 available platforms where one is already used for RE20 services from and to Liepaja.

Also terminating and beginning regional services must get suitable dwell times in Riga Central station for preparations and postprocessing of trains at the platforms. However, in the highly frequented Riga Central station available time windows can sometimes – during the peak-hours – be no longer than 3 to 4 minutes. This is still seen as sufficient based on the own experience by the consultant and is been applied e.g. on the German railway network with modern rolling stock on daily basis due to capacity limits as well.

Process	Targeted minimum dwell time	Remarks
Coupling	6 minutes	For coupling of the second train part.
Un-coupling	2-3 minutes	For the first train part to depart.

TABLE 24. APPLIED TIME FOR TRAIN COUPLING AND SHARING

Additionally, trains will couple and uncouple in certain stations like Riga Central station and Krustpils and terminating stations like Dobele, Daugavpils, Zilupe, and Rēzekne to cope with different passenger demand over the day. Also, to use the important fast RE 20 slots in the 30-minute node in Riga Central station for regional services from Rēzekne/Zilupe and Daugavpils at the same time, coupling and un-coupling of trains in Krustpils is applied during the rush-hour. For the coupling of trains, a minimum dwell time for the first train part between arrival and departure has been applied (see Table 24. above). Based on the own experience of the consultant and how it is applied on the German railway network on daily basis, un-coupling of trains is rather uncomplicated and should not take more than 2 to 3 minutes when automatic couplers, e.g. Scharfenberg-couplers are used.

However, shortening of turnaround times below current practice is subject of rolling stock type. It will likely require organizational changes to ensure safety (e.g. documentation and messaging of faults prior to hand-over of the train to the next drive, e.g. electronically).

5.3.4. Stopping pattern and applied station dwell times

In this chapter the stopping pattern of the passenger service types is described for the corridors:

- Riga-Aizkraukle-Krustpils-Daugavpils/Rēzekne-Zilupe,
- Riga-Jelgava-Liepaja,
- Riga-Tukums-Ventspils and the branch line to Bolderāja-Daugavgrīva
- Riga-Skulte
- Riga-Sigulda-Valmiera and Valga

For every corridor the stopping pattern and the applied station dwell times for every service type are explained. The four general service types are the suburban CT (EV), the regional R (RV), the faster regional express RE (RE) and the international I.RE (TV) services. Adjustment in the stopping pattern are highlighted in the remark's column.

All adjustments are explained separately for every service type and corridor.

Indicated station dwell times are the minimum times required for passenger exchange at the platforms, turnaround times for rolling stock are not indicated in the tables.

Corridor Riga-Aizkraukle-Krustpils-Daugavpils/Rēzekne – Zilupe

On the line section between Riga and Krustpils (shown in Table 25 above) suburban CT services operate between Riga and Aizkraukle, and two daily RV service train pairs operate in the rush hours in the morning and in the afternoon between Riga and Gulbene. The trains leave the corridor Riga – Aizkraukle in the station Plavinas. Hourly/2-hourly RE 20 passenger services operate on the whole track section connecting Riga with Daugavpils, Rēzekne and Zilupe.

For CT-services the general minimum station dwell time at all stopping points and stations is assumed to be 0.7 minutes. On stations with a higher passenger demand with roughly more than 1,000 passengers during a peak-hour or important interchange stations like Aizkraukle (shown in column "demand 2015") the dwell time is increased to 1.0 minute. To increase the turnaround time of CT services during the peak-hours – where turnaround times are rather short – stops in the less frequented stopping point of Dārziņi and Rumbula could be left out to increase the time for turning trains around for about 1.5 to 2.0 minutes per left out stop and direction. Also, it would be possible to leave out stops only in the less frequented direction during morning and afternoon peak to increase the turnaround times.

The potential new stop of Salaspils (RB) with connections to Rail Baltica passenger services was not considered yet. With the potential abandonment of stops in Rumbula and Dārziņi enough travel time should be gained which could be used to realize this stop without changing the overall travel time of CT services on the corridor.

The two daily train pairs of the regional R 70 service between Riga and Madona – Gulbene via Plavinas – which serves the 9 o'clock node – does stop at all R (RV) stops in the track section Riga-Aizkraukle. Due to interchanges with suburban services during the morning and afternoon peak, additional operational stops in Šķirotava and longer dwell times than listed occur (see also tabular timetable of RE 20; R 70 in annex 9.1). On the line section Aizkraukle – Plavinas the R70 is the only regional service stopping at the designated R (RV) stations.

Station	Demand 2015 [passengers]	CT (EV) [min]	R (RV) [min]	RE (RE) [min]	I.RE (TV) [min]	Remark [min]
Riga	29,471	6	6	6	6	Only targeted minimum station dwell time shown. Applied specific station dwell times for all passenger services are described in chapter 5.3.3 and 5.4.3
Vagonu parks	381	0.7	0,7	-	-	
Jāņavārti	858	0.7	1.0	1.0	-	
Daugmale	364	0.7	-	-	-	
Šķirotava	786	0.7	+ 1.0	-	-	Operational stop of R (RV) train pair from/to Madona-Gulbene.
Gaisma	116	0.7	-	-	-	
Rumbula	56	0.7	-	-	-	Can be left out to improve turnaround time for CT services in Ogre. Lielvārde and Aizkraukle during peak-hours.
Dārziņi	66	0.7	-	-	-	
Dole	336	0.7	-	-	-	
Salaspils	1,652	1.0	1.0	1.0	-	
Salaspils (RB)	-	-	-	-	-	Potential new stop planned for connection with Rail Baltica. Not considered as stop yet.
Saulkalne	316	0.7	-	-	-	
Ikšķile	1,427	0.7	-	-	-	
Jaunogre	534	0.7	-	-	-	
Ogre	3,960	1.0	1.0	1.0	-	
Pārogre	440	0.7	-	-	-	
Ciemupe	189	0.7	-	-	-	
Ķegums	691	0.7	1,0	-	-	
Lielvārde	1,484	1.0	1.0	-	-	
Kaibala	-	0.7	-	-	-	
Jumprava	337	0.7	1.0	-	-	
Skrīveri	440	0.7	1.0	-	-	
Muldakmens		0.7	-	-	-	
Aizkraukle	601	-	1.0	1.0	1.0	End of suburban CT network
Koknese	-	-	1.0			
Alotene	-	-	1.0			
Pļaviņas	-	-	2.0			
Ozolsala	-	-	-			Closure planned, stop left out by R (RV) service already.
Krustpils	-	-	5.0	5.0	5.0	From here RE 20 diverts to the corridor to Daugavpils and Rēzekne-Zilupe

TABLE 25: STOPPING PATTERN CORRIDOR RIGA – AIZKRAUKLE - KRUSTPILS

The RE 20 operates hourly during the peak-hours and 2-hourly during the off-peak hours and stops at the designated RE stops in Table 25 above. It is recommended to give the RE 20 on the track section Aizkraukle-Krustpils a stopping pattern for slow services (R/RV) to cover the stations and stopping points over the whole day with a continuous passenger service. This would result in the loss of the 00-minute node in Krustpils, which is advantageous to support interconnectivity with Krustpils - Rēzekne-Zilupe services (train coupling and sharing or interchange connection) and to local public transport. Furthermore, the through services of RE 20 would have to be retimed beyond Krustpils towards Rēzekne-Zilupe and Daugavpils (later arrival at main destinations and change of meetings with trains in opposite direction). Thus, this measure is not considered in the current version of the master timetable.

Station	Demand 2015 [passengers]	CT (EV) [min]	R (RV) [min]	RE (RE) [min]	I.RE (TV) [min]	Remark [min]
Krustpils	-	-	5.0	5.0	5.0	Central corridor from Riga via Aizkraukle to Krustpils
Trepe	-	-	0.7	-	-	
Līvāni	-	-	0.7	1.0	-	Only RE20 operates on this corridor and stops at all green marked stations. Despite the RE service should stop in Krustpils and Daugavpils only. Leaving out the stops would not result in a faster travel time due to a fixed service pattern on the single-track section with fixed time windows in train stations to meet with trains in the opposite direction.
Jersika	-	-	0.7	1,0	-	
Nīcgale	-	-	0.7	1.0	-	
Sergunta	-	-		+ 1.0		
Vabole	-	-	0.7	1.0	-	
Liksna	-	-	0.7	1.0	-	
Daugavpils	-	-	5.0	5.0	5.0	

TABLE 26: STOPPING PATTERN TRACK SECTION KRUSTPILS – DAUGAVPILS

On the track section Krustpils-Daugavpils (shown in Table 26 above) of the corridor Riga – Aizkraukle – Krustpils - Daugavpils the RE 20 is the only operating passenger service line. Therefore RE 20 stops in stations which were originally planned for RV only to cover all passenger stations over the day. Also leaving out the stop would not result in a significant reduction of travel times between Krustpils and Daugavpils. Due to the single-track working, the train has fixed time windows at certain stations like Jersika to meet with trains in the opposite direction. Leaving out stops would only result in a longer dwell time at the station where trains meet in either direction. Therefore, the time can be used to stop at additional stations.

Station	Demand 2015 [passengers]	CT (EV) [min]	R (RV) [min]	RE (RE) [min]	I.RE (TV) [min]	Remarks
Krustpils	-	-	5.0	5.0	5.0	
Kūkas	-	-	-	-	-	
Mežāre	-	-	-	-	-	
Atašiene	-	-	-	-	-	
Stirniene	-	-	1.0	-	-	RE20 stops there
Varakļāni	-	-	-	-	-	
Viļāni	-	-	1.0	-	-	RE20 stops there
Sakstagals	-	-	-	-	-	
Rēzekne 2	-	-	5.0	5.0	5.0	
Taudejāņi	-	-	0.7	-	-	
Cirma			0.7	-	-	
Ludza			0.7	0.7	-	
Istalsna			0.7	-	-	
Nerza			0.7	-	-	
Briģi			-	-	-	
Zilupe			1.0	1.0	1.0	

TABLE 27: STOPPING PATTERN CORRIDOR KRUSTPILS – RĒZEKNE – ZILUPE

On the line section between Krustpils via Rēzekne and Zilupe (shown in Table 27) only the RE 20 from Riga operates hourly during peak-hours between Krustpils and Zilupe as single train pairs until Zilupe. Therefore, the RE 20 stops in stations originally planned for RV services only to cover all stations on the corridor.

Corridor Riga – Jelgava – Liepaja

The corridor Riga – Jelgava – Liepaja consists of the electrified track section Riga – Jelgava, where the suburban line CT 2 operates, and the unelectrified track section between Jelgava via Gluda and Dobele to Liepaja where only selected train pairs of the regional RE 20 operate. The stopping pattern is shown in Table 29 below.

Between Riga and Jelgava, the suburban line CT 2 operates every 15 minutes during peak-hours and every 30 minutes during off-peak. The potential new stop in Atgāzene has already been considered. The stop in the station Cena has been left out by suburban services since it is already proposed to be closed.

On Latvian territory, cross-border services to Šiauliai shall stop in Maitene (serving Eleja municipality).

Station	Demand 2015 [passengers]	CT (EV) [min]	R (RV) [min]	RE (RE) [min]	I.RE (TV) [min]	Remarks
Riga	29,471	6,0	6,0	6,0	6,0	Only targeted minimum station dwell time shown. Applied specific station dwell times for all passenger services are described in chapter 5.3.3 and 5.3.4
Torņakalns	-	0.7	1.0	1.0	1.0	0.7 min are seen as general minimum station dwell time. Some trains may have slightly longer dwell times.
Atgāzene	221	0.7	-	-	-	New location, already considered for suburban services.
Turība	691	0.7	-	-	-	
Tīraine	486	0.7	-	-	-	
Baloži	274	0.7	-	-	-	
Jaunolaine	337	0.7	-	-	-	
Olaine	1,844	1.0	-	-	-	
Dalbe	146	0.7	-	-	-	
Cena	87	-	-	-	-	
Ozolnieki	449	0.7	-	-	-	
Cukurfabrika	1,031	0.7	-	-	-	
Jelgava	3,300	0.7	2.0	2.0	2.0	Terminating station of suburban line CT 2
Viesturi	-	-	-	-	-	To be closed
Dobele	-	-	1.0	1.0	-	Hourly RE 20 services terminating during peak-hours.
Biksti	-	-	1.0	1.0	-	RE 20 serves R (RV) station
Brocēni	-	-	1.0	-	-	Potential new location
Saldus	-	-	1.0	1.0	-	
Skrunda	-	-	1.0	1.0	-	RE 20 serves R (RV) station
Ilmāja	-	-	1.0	1.0	-	RE 20 serves R (RV) station
Grobiņa	-	-	1.0	1.0	-	
Liepāja	-	-	2.0	2.0	2.0	
Krimūnas			-	*0.7*	-	*Optional stop subject to further demand analysis*
Bēne			-	*1.0*	-	*Optional stop subject to further demand analysis*
Auce			-	*1.0*	-	*Optional stop subject to further demand analysis*
Mažeikiai (LT)			2.0	*2.0*	-	

TABLE 28: STOPPING PATTERN ON THE CORRIDOR RIGA – JELGAVA – LIEPAJA

Beyond Jelgava the RE 20 is the only operating passenger service stopping at the designated stations and stopping points. During rush-hour the RE 20 operates non-stop hourly between Riga and Dobele. Selected train pairs are extended to Liepaja. Since the RE 20 is the only service on the track section Jelgava-Dobele-Liepaja the RE stops also in station designated for R (RV) services only like Biksti, Skrunda and Ilmāja. The RE 20 does not stop in Viesturi since this station is planned to be closed in the future and the service pattern is already quite tense between Jelgava and

Dobele. The stop at Brocēni cannot be serviced by the RE 20 due to limitations on the single-track section Dobele-Liepaja. This could be solved in the future by increasing the top-speed up to 120 km/h instead of 90 km/h (for more information check the corridor description in chapter 5.5.3 on page 162).

Optional services (RE20) to Mažeikiai shall stop in Bēne (1,100 inhabitants) and Auce (2,700 inhabitants) since the stations are close to the municipalities. Subject to further demand and cost-benefit analysis a stop in Krimūnas (<400 inhabitants) could be considered.

Corridor Riga-Tukums-Ventspils and the branch line to Bolderāja – Daugavgrīva

The assumed stopping pattern on the corridor Riga – Tukums – Ventspils is presented in Table 29 below.

CT services are assumed to stop at all intermediate stations with a minimum dwell time of 0.7 minutes. The dwell times at larger stations are increased to 1.0 minutes to cope with the higher passenger flows.

A new stop at Stradiņi (between Torņakalns and Zasulauks) is included in the service pattern, which is served by all CT trains.

Due to single track working between Sloka and Tukums station dwell times at Sloka, Kemeri and Tukums-1 are extended to allow meeting with trains in opposite direction. Due to single track working between Tukums and Ventspils, an operational stop for northbound RE 10 services has to be foreseen in Sabile.

The faster RE 10 services need to follow the slower peak-hour suburban services (CT 1). This leads to increased travel time in the peak hours. This time reserve is used to provide additional stops at Priedaine, Bulduri and Majori in the peak-hours.

Station	Demand 2015 [passengers per day]	CT (EV) [min]	R (RV) [min]	RE (RE) [min]	I.RE (TV) [min]	Remarks
Riga	29,471	6,0	6,0	6,0	6,0	Only targeted minimum station dwell time shown. Applied specific station dwell times for all passenger services are described in chapter 5.3.3 and 0
Torņakalns	1,599	0.7	1.0	1.0	1.0	Are seen as general minimum station dwell time. Some train may have slightly longer dwell times.
Stradiņi	-	0.7	-	-	-	Newly planned station
Zasulauks	1,953	0.7	1.0	1.0	-	Diverting freight trains and suburban diesel services CT 12 to Bolderāja and Daugavgrīva.
Depo	176	0.7	-	-	-	Stop of all CT assumed in service pattern, could be considered for closure if adjacent train depot is relocated subject to proposed future site development
Zolitūde	1,743	0.7	-	-	-	
Imanta	2,868	0.7	1.0	1.0	1.0	
Babīte	1,082	0.7	-	-	-	
Priedaine	498	0.7	-	1.0	-	Additional stop of RE 10 during peak-hour
Lielupe	1,079	0.7	-	-	-	
Bulduri	2,407	0.7	1.0	1.0	-	Additional stop of RE 10 during peak-hour
Dzintari	1,488	0.7	-	-	-	

Station	Demand 2015 [passengers per day]	CT (EV) [min]	R (RV) [min]	RE (RE) [min]	I.RE (TV) [min]	Remarks
Majori	2,489	1.0	-	1.0	-	Additional stop of RE 10 during peak-hour
Dubulti	1,055	1.0	1.0	1.0	1.0	
Jaundubulti	317	0.7	-	-	-	
Pumpuri	378	0.7	-	-	-	
Melluži	502	0.7	-	-	-	
Asari	452	0.7	-	-	-	
Vaivari	385	0.7	-	-	-	
Sloka	2,410	1.0	1.0	1.0	1.0	
Kūdra	82	-	-	-	-	
Ķemeri	437	0.7	-	1.0	-	Additional stop of RE 10 during peak-hour
Smārde	235	0.7	-	-	-	
Milzkalne	69	0.7	-	-	-	
Tukums 1	1.306	2.0	1.0	1.0	1.0	Longer stops of CT 1 due to terminus stations.
Tukums 2	154	2.0	1.0	1.0	1.0	Longer stops of CT 1 due to terminus stations.
Pūre	-		1.0	-	-	
Kandava	-	-	-	-	-	
Sabile	-	-	-	+ 10.0	-	Operational stop of northbound RE 10 for meeting with RE in opposite direction.
Stende	-	-	1.0	1.0	-	
Ugāle	-	-	1.0	-	-	
Ventspils	500	-	1.0	1.0	-	

TABLE 29: STOPPING PATTERN ON CORRIDOR RIGA – TUKUMS – VENTSPILS

Branch line Zasulauks – Bolderāja – Daugavgrīva

The line section Zasulauks – Daugavgrīva is currently not served by passenger trains. In the future this will change with the proposed line suburban service CT 12 Sigulda – Jugla – Riga – Daugavgrīva, which is proposed to operate half-hourly (see also section 2.4.2). The stopping pattern for these train is indicated in Table 30 below.

In the master timetable Daugavgrīva is considered as final destination. Intermediate stops are proposed at Dzirciems, Nordeķi, Lāčupe, Bolderāja. Generally, a stopping time of 0.7 minutes is assumed. In the current version of the master timetable not all intermediate stops are modelled. However, the proposed timetable structure indicates, that it will be possible to include all proposed stops into the service pattern, provided the capacity on the line can be ensured by double tracking of line section Zasulauks – Bolderāja.

Station	Demand 2015 [passengers]	CT (EV) [min]	R (RV) [min]	RE (RE) [min]	I.RE (TV) [min]	Remarks
Zasulauks	1.953	0.7	-	-	-	
Dzirciems	-	0.7	-	-	-	Newly planned station
Nordeķi	-	0.7	-	-	-	Newly planned station
Lāčupe	-	0.7	-	-	-	
Bolderāja	-	0.7	-	-	-	
Daugavgrīva	-	0.7	-	-	-	

TABLE 30: STOPPING PATTERN ON THE BRANCH LINE ZASULAUKS – DAUGAVGRĪVA

Corridor Riga - Skulte

On the corridor Riga – Skulte, suburban services stop at the defined pattern as shown in Table 31 below. This stopping pattern is applied for all suburban services on the corridor without variations.

Station	Demand 2015 [passengers]	CT (EV) [min]	R (RV) [min]	RE (RE) [min]	I.RE (TV) [min]	Remarks
Riga	29,471	6,0	-	-	-	Only targeted minimum station dwell time shown. Applied specific station dwell times for all passenger services are described in chapter 5.3.3 and 0
Zemitāni	1.709	1.0	-	-	-	
Brasa	551	0.7	-	-	-	
Sarkandaugava	446	0.7	-	-	-	
Mangaļi	428	0.7	-	-	-	
Ziemeļblāzma	1.311	1.0	-	-	-	
Vecdaugava	131	0.7	-	-	-	
Vecāķi	619	1.0	-	-	-	Higher seasonal demand
Kalngale	297	0.7	-	-	-	
Garciems	453	0.7	-	-	-	
Garupe	122	0.7	-	-	-	
Carnikava	991	1.0	-	-	-	
Gauja	355	0.7	-	-	-	
Lilaste	151	0.7	-	-	-	
Inčupe	46	0.7	-	-	-	
Pabaži	255	0.7	-	-	-	
Saulkrasti	585	1.0	-	-	-	
Ķīšupe	97	0.7	-	-	-	
Zvejniekciems	122	0.7	-	-	-	
Skulte	183	1.0	-	-	-	
Skulte (RB)	-	1.0	-	-	-	Proposed line extension to provide interchange to Rail Baltica

TABLE 31: STOPPING PATTERN ON THE CORRIDOR RIGA – SKULTE

Corridor Riga – Sigulda – Valmiera – Valga

The proposed stopping pattern for the corridor is presented in Table 32 below. On the track section between Riga and Sigulda a suburban stopping pattern is applied by the CT 12 line between Daugavgrīva – Riga - Sigulda.

Beyond Sigulda only regional and international services with stops at all intermediate stations are planned. During the peak-hours the line CT 12 is extended to Valmiera by applying the regional R (RV) stopping pattern on this line section. All suburban services stop in the newly planned stopping points Alfa and Teika. Stops in Baltezers and Silciems are already not serviced anymore by the suburban services since these stations are planned to be closed.

The overall quantity structure north of Sigulda for regional express RE (RE), regional R (RV) and international service (TV) is seen so low by the consultant that all fast products shall have a stopping pattern for slow trains (R/RV) on this line section to allow a steady distribution of trains over the day on all stops. Therefore, all regional trains stop in Sigulda, Āraiši, Cēsis, Lode and Lugaži and also at Inčukalns (south of Sigulda). Additionally, due to timing of trains between the available slots in Riga Central and due to fixed intervals in the single-track sections between Krievupe-Vangaži and Sigulda-Valmiera-Valga regional trains have more than 5 minutes dwell time in Zemitāni. To use this time in an efficient way and to exploit the full passenger demand potential, all regional trains have additional stops on the newly proposed stations Teika and Alfa.

Station	Demand 2015 [passengers]	CT (EV) [min]	R (RV) [min]	RE (RE) [min]	I.RE (TV) [min]	Remarks
Rīga	29.471	6.0	6.0	6.0	6.0	Only targeted minimum station dwell time shown. Applied specific station dwell times for all passenger services are described in chapter 5.4.3
Zemitāni	1.709	1.0	1.0	1.0	1.0	Are seen as general minimum station dwell time. Some train may have slightly longer dwell times.
Čiekurkalns	128	0.7	-	-	-	
Teika	-	0.7	0.7	0.7	0.7	New stop. All services stop here.
Alfa	-	0.7	0.7	0.7	0.7	New stop. All services stop here.
Jugla	214	1.0	-	-	-	
Baltezers	14	-	-	-	-	to be closed
Garkalne	-	0.7	-	-	-	
Krievupe	53	0.7	-	-	-	
Vangaži	82	0.7	-	-	-	
Inčukalns	390	0.7	1.0	1.0	1.0	
Egļupe	-	0.7	-	-	-	
Silciems	12	-	-	-	-	to be closed
Sigulda	724	0.7	1.0	1.0	1.0	
Līgatne	78	-	1.0	-	-	
Ieriķi	37	-	1.0	-	-	
Melturi	7	-	-	-	-	
Āraiši	20	-	1.0	1.0	1.0	Planned new stop
Cēsis	207	-	1.0	1.0	1.0	
Jāņamuiža	19	-	-	-	-	
Lode	103	-	1.0	1.0	1.0	
Bāle	11	-	-	-	-	to be closed.
Valmiera	127	-	1.0	1.0	1.0	
Brenguļi	14	-	-	-	-	to be closed.
Strenči	20	-	1.0	-	-	
Seda	9	-	-	-	-	to be closed
Saule	9	-	-	-	-	to be closed
Lugaži	57	-	1.0	-	1.0	Planned new stop.
Valga	-	-	5.0	5.0	5.0	

TABLE 32: STOPPING PATTERN ON THE CORRIDOR RIGA – SIGULDA – VALGA

5.3.5. Runtime calculation for rolling stock

Excluded from publication.

5.4. Infrastructure Utilisation in railway core area

5.4.1. Introduction

In the following sections the specific features of the proposed 1520 mm timetable for the railway core area as defined in 1.5 of this report will be described in detail. Based on the developed timetable the main operational bottlenecks will be highlighted and discussed in the concluding section. This will be the basis for the definition of required infrastructure improvements in the core area. Related final recommendations will be outlined in the final report.

Due to the outlined principle of using Riga as a symmetry node and due to the heavy infrastructure utilisation Riga Central station and the line sections in the railway core area was used as a starting point for timetable construction and rolling out the service pattern on the adjacent corridors.

5.4.2. Overview of provided paths

With the current developed service pattern and infrastructural utilisation pattern in Riga Central station and the adjacent track sections, the following train paths (shown in Table 33 below) could be provided into and through Riga Central station.

No.	Corridor	Service type	Line	Paths per hour per direction		Remarks
				Peak	Off-peak	
1	Riga-Plavinas/Krustpils-Daugavpils/Rēzekne-Zilupe and Riga- Plavinas-Madona-Gulbene	Suburban service	CT 2	4	2	
2		Regional express service	RE 20	1	0,5-1	During peak-jour 2 path per hour requested
3		Regional service	R 70	1	-	
4		Freight trains	FR	~1,5~2+3	2+3	1,5 to 2 trains thorough Riga and up to 3 per hour on the corridor
5a	Riga-Jelgava-Liepaja **(via Daugava River bridge)**	Freight trains	FR	1	1	Max. 11 daily train pairs required, slots Riga – Torņakalns (Zasulauks) are shared with trains to Daugavgrīva (Tukums)
5		Regional service	RE 20	1	0,5	
6		Suburban service	CT 2	4	2	
7	Riga-Zasulauks-Bolderāja-Daugavgrīva **(via Daugava River bridge)**	Freight trains	FR	1	1.5~2	Slots Riga – Torņakalns (Zasulauks) are also used for trains to Jelgava (Tukums)
8		Suburban services	CT 12	2	2	Diesel rolling stock

No.	Corridor	Service type	Line	Paths per hour per direction		Remarks
9	Riga-Zasulauks-Tukums-Ventspils **(via Daugava River bridge)**	Suburban services	CT 1	4	2	
9a		Freight trains	FR	-	1	Max. 4 daily train pairs required, sharing slots with trains to Daugavgrīva
10		Regional services	RE 10	0,5	-	
11	Riga-Skulte	suburban	CT 1	3	1,5	
12		Freight trains	FR	0,5	1	Via bypass Šķirotava-Zemitāni
13	Riga-Sigulda-Valga	Suburban services	CT 12	2	2	Diesel rolling stock
14		Regional	RE 30	1	0,5	
15		Freight	FR	1	1	Via bypass Šķirotava-Zemitāni
16	Number of trains over the Daugava River bridge (West of Riga Central station)			~ 13-14	~ 8,5	Depending on the number of freight trains during peak-hour.
17	Number of trains coming east of Riga Central station			~ 13-14	~ 8,5	

TABLE 33: PROVIDED PATHS PER HOUR IN THE CORE AREA THROUGH RIGA CENTRAL STATION

The table shows the number of suburban and regional passenger and freight trains per hour and direction which could be integrated into the track occupation of Riga Central station during the peak and off-peak hours. Here it is important to distinguish between trains entering Riga Central from the West via the Daugava River Bridge (shown in Row 4 to 9) and from the East.

Services to Riga Central station from the west

West of Riga Central station trains from and to Riga must cross the double track Daugava River Bridge between the stations Riga Central station and Torņakalns to gain access to the three corridors Riga-Jelgava, Riga-Tukums-Ventspils and Riga-Daugavgrīva. This makes the Daugava River bridge a natural bottleneck for all services west of Riga. As shown in rows 5 to 10 of the table above the requested hourly freight train path by LDz and the passenger service pattern for regional and suburban services could be brought into Riga station during the peak-hour. During off-peak less suburban and regional services are required. These available slots are used for 2 freight train slots over the Daugava River Bridge or for freight trains to Jelgava during the off-peak.

During off-peak the 2 freight train slots over the Daugava River bridge can be used to run two freight trains per hour and direction to Daugavgrīva (shown in row 7). Also, these two slots can be used to run freight trains to Jelgava instead (shown in row 5a). Since there are only two slots considered over the Daugava River bridge, the three possible freight trains to Jelgava and Daugavgrīva must share the two available slots (freight train slots shown in row 5a and 7).

Services to Riga from the east

East of Riga Central station the tracks for two of the three double track corridors are directly leading into the station. The required suburban, regional and freight services (shown in row 1-4 and 11-15) can run conflict free into the station. The freight train from the freight yard Šķirotava to the corridor Riga-Skulte and Riga-Sigulda (row 12 and 15) are not running through Riga but using the bypass between Šķirotava and Zemitāni. For the regional express service

(RE) from the corridor Riga-Aizkraukle-Krustpils (shown in row 2) only one train path per hour could be brought into Riga central station. If necessary, the second train path of the slower regional service (R/RV) (shown in row 3) could be used to bring regional services separately into Riga. In the current elaboration the hourly regional service path is used to bring the daily trains pair of the R70 between Riga-Plavinas-Madona/Gulbene into Riga Central station.

5.4.3. Specific features of the provided timetable

Interconnectivity between trains in Riga Central station

The central goal was to distribute passenger services (regional and suburban) evenly over one hour to maximise the even distribution of passengers between the different passenger trains and to provide a most attractive service offer. Also, it was targeted to allow connections between all passenger services in Riga Central station in a clock face cyclic timetable (principles described in chapter 5.3). This results in the distribution of the train services in Riga Central station around 00-, 15- , 30- and 45-minute nodes (as shown in Table 34 below). For the purpose of this documentation, the suburban lines CT 1 and CT 2 are divided into sub-lines depending in which node they run through Riga Central station. For example, suburban trains which run through Riga in the 30-minute node are called CT 1.30 and CT 2.30.

For the important 30-minute node (shown in row 1 in Table 34 above) interchange possibilities between all long running services of the suburban lines CT 1 and CT 2 and the important RE 10; 20 and 30 are provided. Interchange between all Riga suburban services is possible as well. Also, the minimum station dwell times of 6 minutes for all services could be achieved. Between the terminating RE 30 (track 1) and the beginning RE 10 (track 3) a same-platform-connection with 3 minutes interchange time is possible.

In the 00-minute node (shown in row 2 in Table 34 above) the minimum station dwell time of the CT 1.00 to Skulte and the CT 2.00 to Lielvārde is slightly below the targeted minimum station dwell time (3-4 minutes) but still seen as sufficient since there are only suburban services connected in the node. The early departure of the CT 1.00 and CT 2.00 going east at minute 00 results in lower station dwell times and the loss of connections in the direction Skulte-Riga-Aizkraukle and Aizkraukle-Riga-Skulte. A later departure and longer dwell time is possible in the core area but would reduce the available time for turning trains around at their destinations on the corridors to Aizkraukle and Skulte (described in chapter 5.5.1 and 5.5.4).

No.	Node	services	Connection between services	Station dwell times	Remarks
1	30-minute node	CT 2.30, CT 1.30, RE 20, RE 10, RE 30	Between all services	Minimum 6 minutes for regional services, more for overtaking of suburban services	Same level connection between RE 30 and RE 10 (platform 1, 2 and 3)
2	00-minute node	CT 1.00, CT 2.00, R 70	No connection in the direction Skulte-Riga-Aizkraukle and Aizkraukle-Riga-Skulte	Below 6 minutes CT 1.00 and CT 2.00 in eastern direction	
3	15-minute node	CT 1.15, CT 2.15, CT 12 freight train to/from Bolderāja	Almost no connections between the services. Waiting for the next 30- or 00-minute node possible.	Most services slightly below 6 minutes but still seen as sufficient	Connections less relevant due to focus on additional capacity for passengers for closer Riga Area.
4	45-minute node	CT 1.45, CT 2.45, CT 12 freight train to/from Bolderāja			
5	In between	Night trains from and to Minsk and Moscow	Connection seen less relevant, arrive before 00-minute node	20 minutes for beginning and terminating night trains	

TABLE 34: CONNECTED SERVICES TO THE NODES AND OFFERED CONNECTIONS

For the 15- und 45-minute node (shown in rows 3 and 4 in Table 34 above) almost no connection between the services are possible and the defined minimum station dwell times are never reached. This is seen as sufficient for two reasons (as already described in chapter 5.3 on page 110). First, the trains in these two nodes only operate during the rush-hour and are seen as additional capacity for commuters to the city centre. Thus, connections to other corridors are seen as a lower priority for these services compared to the 30-minute node. Secondly, if passengers of these trains want connections to other corridors, they can use trains in the next 30- or 00-minute node since the waiting time for the next node during rush-hour is 15 minutes only. Also, the diesel suburban line CT 12 was introduced in a 30-minute interval between Bolderāja – Riga – Jugla – Sigulda, and (only during peak-hour) Valmiera. This train serves the 15- and 45-minute node also. This allows the service to offer connections to the 30- and 00-minute node by simply waiting for the next node (windmill principle).

Night trains (shown in row 5 above) use time windows before and after the 30-minute node to have as much time as possible at the 550 m long platform number 9 to allow for the necessary train preparation and post-processing at the platforms including check-in and check-out of the passengers. It was possible to provide these trains a dwell time of 20 minutes at the platforms.

Finally, freight train slots had to be provided even during the peak-hour. With the current infrastructure utilisation in the core area it was possible to integrate hourly slots per direction over the Daugava River bridge into the service pattern. Freight trains will have operational stops on track 10 and at platform track 3 in the 15- and 45-minute node.

Occupation of the section Riga Central - Torņakalns

The major challenge was to find paths into the station for the required number of train paths for arriving trains without at grade crossing conflicts between the trains in the opposite direction leaving the Riga Central station. Also, the relatively low turnout speeds of 40 km/h in combination with large switch areas on both sides of the station in Riga but also in the adjacent nodes of Torņakalns and Zemitāni resulted in long train headway times of around 5 to 6 minutes. Also – like mentioned before – the Daugava River Bridge forms a natural bottleneck for all services west of Riga. If the required number of trains (listed in Table 33) would have entered and left the station one after another on the right track over the Daugava River bridge the station dwell time of most train services would have been too long to allow all trains to call at Riga Central station within one typical rush-hour.

The goal was to avoid at grade crossing conflicts and to reduce the train headway times between the entering and leaving of trains and with it the station dwell times but still allowing connections between the services. This was achieved by a timetable regime with simultaneous operation of trains in the same direction over Daugava River on the right- and left-hand track. The resulting operational principle is shown in Figure 52, which includes infrastructure occupation and train routing for Torņakalns, the Daugava River bridge, Riga Central station and the adjacent track sections to Jelgava, Zasulauks, Zemitāni and Jāņavārti. Trains from Zemitāni and Jāņavārti will take advantage of the separate lines running on the respective right-hand tracks. The required train routes are provided by the existing signalling system, which is equipped to allow left-hand-running over Daugava River bridge.

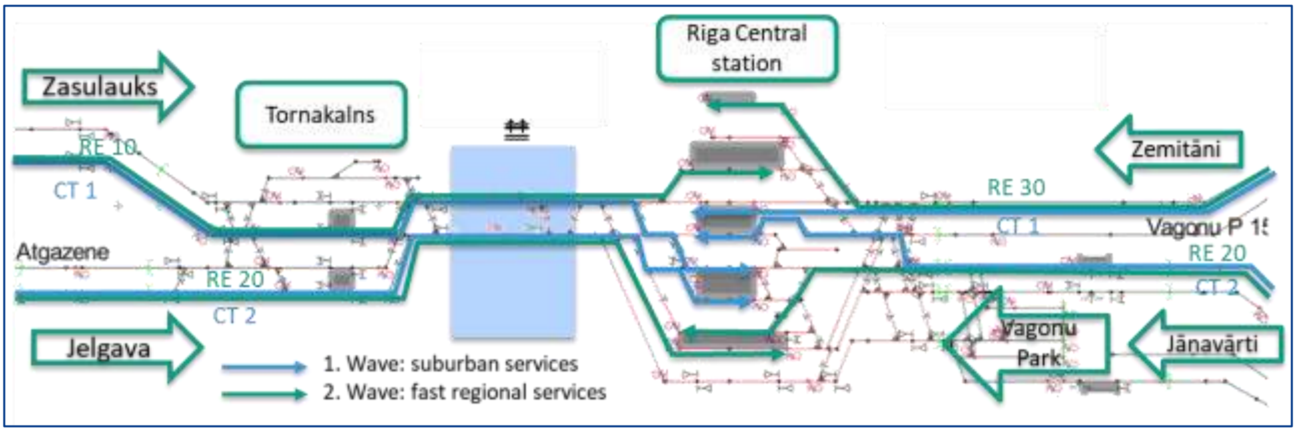


FIGURE 52: ENTRY OF TRAINS IN 2 WAVES BEFORE THE NODE

For the most frequented 30-minute node the station will be served by faster regional and suburban services in two waves. In the first wave the suburban services of the CT 1.30 and CT 2.30 cross the Daugava Rive bridge simultaneously on the right- and left-hand track. The approach is repeated with the RE 10 (from Tukums) and RE20 (from Jelgava) crossing the Daugava River bridge in the second wave after arrival of the CT trains.

As can be seen the suburban train services (blue) would arrive in Riga Central station at first. Trains arriving at Riga Central station from Tukums (Zasulauks) and Jelgava will use both tracks over the Daugava River bridge simultaneously.

The same procedure is executed for trains entering Riga from the east. Suburban and regional passenger train services stop at their designated suburban and regional platforms. Also, suburban trains of both lines and the same eastbound or westbound direction stop at the same middle platform at Riga Central station. This is possible due to the current signalling system, where overlaps for station entry and exit signals are provided. Otherwise such manoeuvres would not be possible, or the exit signals need to be relocated to provide the necessary overlap without blocking the entry from the opposite direction leading to shorter usable track lengths of the station tracks. For example, the overlap of the entering RE20 from the east would block the western switch area. Then no trains over the Daugava River bridge on the right track could enter the station at the same time.

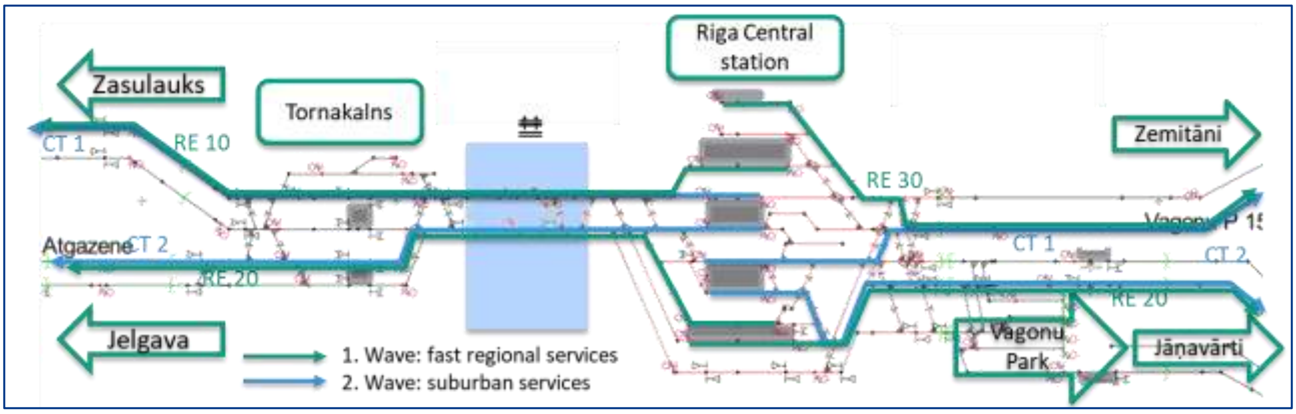


FIGURE 53: EXIT OF TRAINS IN TWO WAVES AFTER THE NODE

After the 30-minute node (aka after the half hour) services leave the station in two waves (shown in Figure 53 above). Hereby the same procedure is repeated in the opposite direction. In the first wave the regional services leave the station running parallel over the Daugava River bridge at the same time on the left- and right-hand track. In the second wave the suburban services leave the station crossing the Daugava River bridge at the same time.

All services enter before the 30-minute node (aka before the half hour). No trains can cross the bridge in the opposite direction in this time window. Since on the east side of Riga corridors are connected directly into the station the RE 20, CT 1.30, CT 2.30 and the RE 30 can leave the station in two waves as well but conventional without running parallel on the right- and left-hand track.

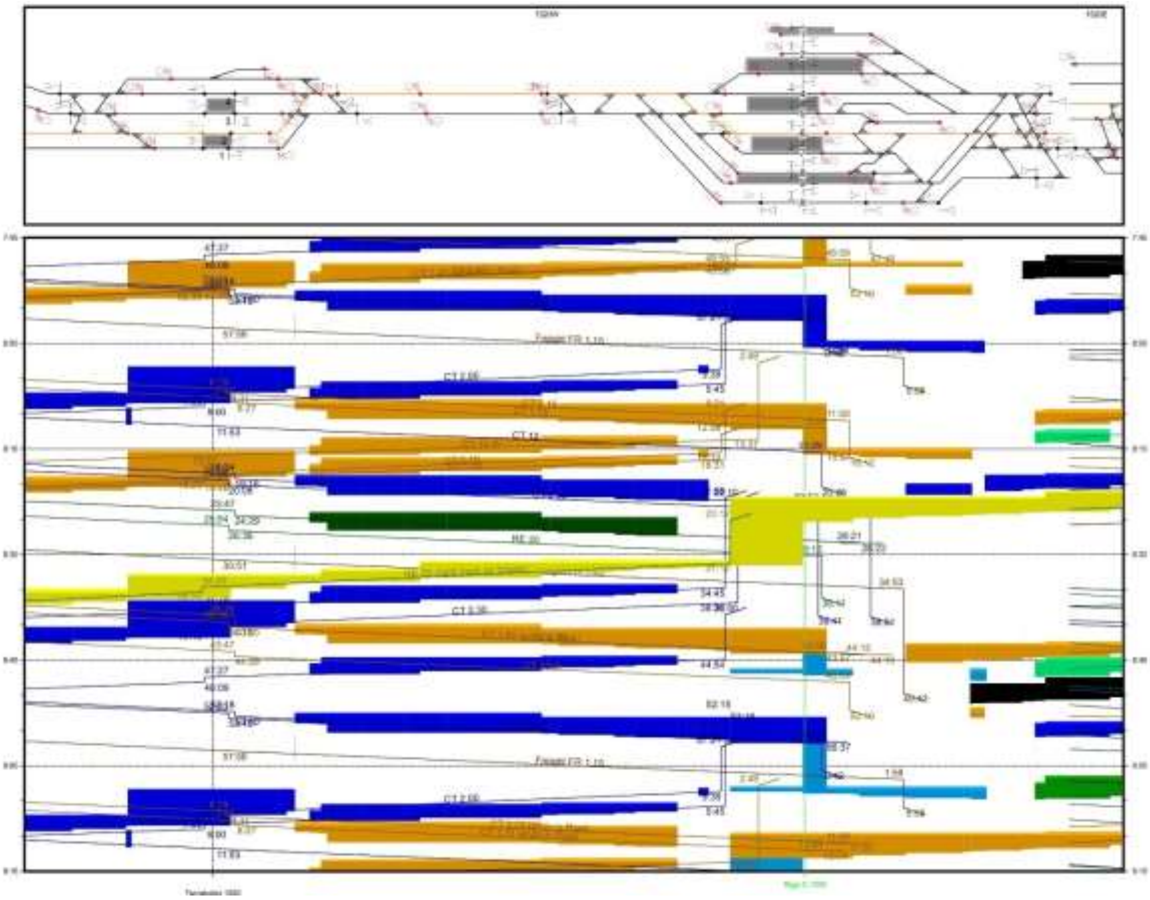


FIGURE 54: GRAPHICAL TIMETABLE WITH TRACK OCCUPATION WESTBOUND

The same procedure of two trains entering the station via the Daugava River bridge parallel on the left and right hand track is applied for arriving trains before the node times 00, 15, and 45 and for trains departing in Riga Central after the node times 00, 15, and 45 (as shown in Figure 54 above). Here the slots of the first wave are used by suburban services and slots of the second wave are used for freight trains and the services of the suburban line CT 12 (Daugavgrīva-Riga-Sigulda). This results in a "ping-pong" like service pattern on the Daugava River bridge where up to four trains at once run westbound followed by a bundle of up to four eastbound trains (shown in the graphical timetable in Figure 54 above).

Depending on the hour and depending on the node time one of the two slots in the first or second wave is not used. Then this slot can be used flexibly for single freight or other trains in the opposite direction as well. For example, the yellow marked RE 20 to Jelgava in Figure 54 is using the right instead of the left-hand track. This is because the 2-hourly RE 10 to Ventspils is not operating in this hour. Therefore, the slot can be used for a westbound freight train to Bolderāja or Jelgava.

During peak-hours available slot and capacity over the Daugava River bridge are used for passenger and freight trains. During off-peak the suburban peak-hour train slots are not used and are available for additional freight trains instead. Additionally, regional service does not use every possible hourly 30-minute node during off-peak. These slots can be used for freight trains as well. Since the slots in the 15- and 45-minute node are less tense and therefore easy to access for freight trains, it is recommended to use the slots every 30-minutes and relax the service pattern in the 30-minute node to reduce delays.

Track Occupation Riga Central station

With this approach it is possible to let trains arrive and depart from both directions at the exact same minute in Riga Central station at the 30-minute node. This allows to minimize the station dwell time for through running services to the minimum of 6 minutes providing interchange connections between all passenger services arriving/departing at the 30-minute node. The described concentration of services in these 4 nodes results in the track occupation of Riga Central station shown in Figure 55 below.

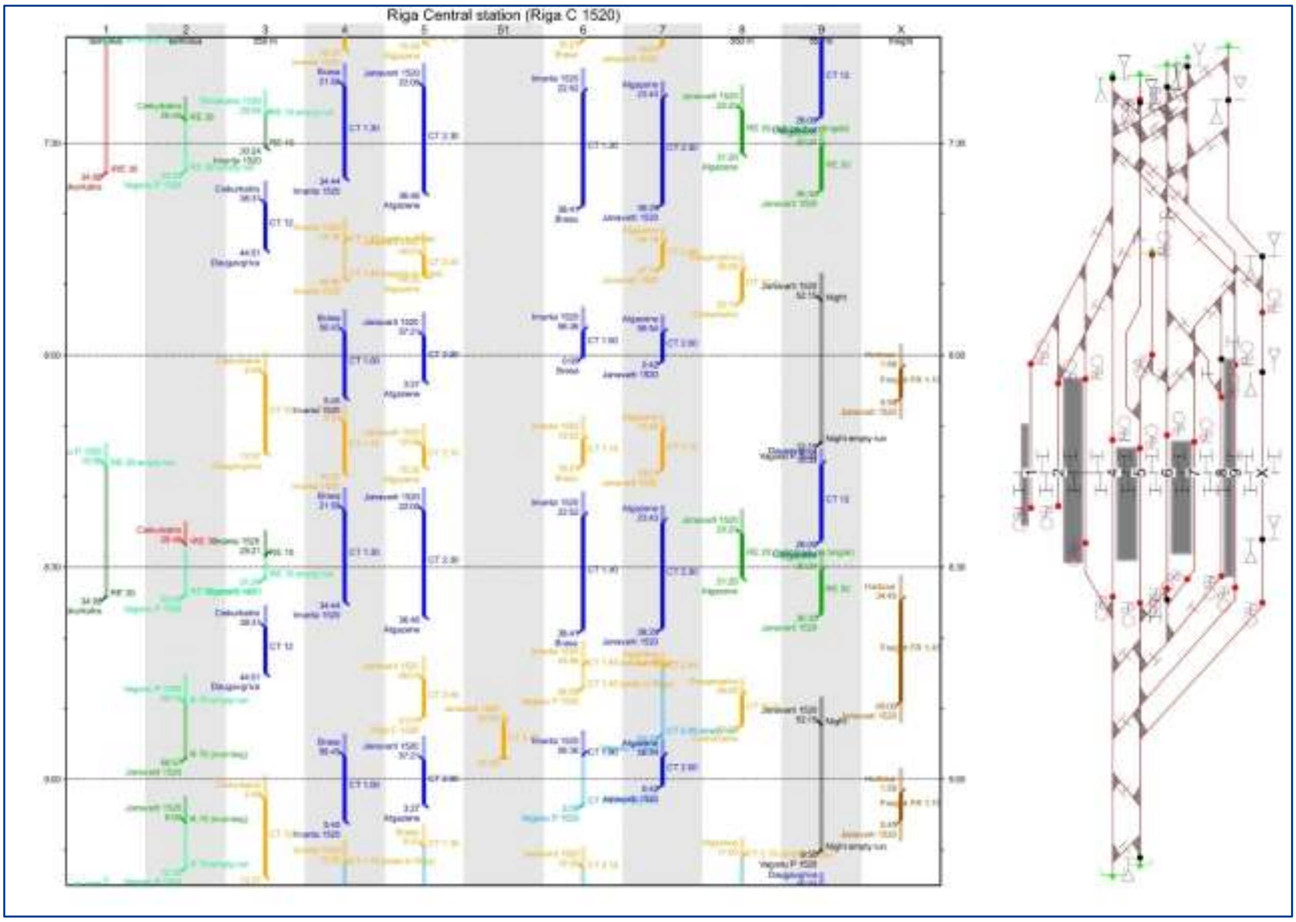


FIGURE 55: TRACK OCCUPATION OF RIGA CENTRAL STATION DURING A PEAK-HOUR

As described above regional and suburban trains stop at their designated platforms. Through-running suburban trains of both lines in the same direction (west- and eastbound) stop and meet at the same middle-platform (CT 1.30, CT 2.30). Regional trains of the line RE 20 stop and meet at the designated regional platform 8 and 9 in both directions in the 30-minute node. This is possible without at-grade crossing conflicts in the switch areas when entering and leaving the station at the same time. This means connections between regional and suburban services are only possible, if passengers change platforms. This must be considered when the station is dimensioned for passenger exchange (steps, lifts, escalators, underway etc.). Exception is the connection between the RE 30 and RE 10 in platform 1, 2 and 3 and connections between suburban services of different lines and the same direction on the middle-platform 4 and 5 (westbound) and 6 and 7 (eastbound). These platforms are connected on the same level and can be reached without using steps or lifts allowing shorter transfer times for changing between interconnecting trains.

Since the RE 10 between Ventspils-Tukums-Riga is only operating 2-hourly, trains arrive in the even hour on track 3 and terminate and begin in the odd hour in Riga on the same platform.

In the 00-minute node the trains of both suburban services in one direction could be placed on a middle platform (platforms 4/5 and 7/8). A later departure and longer dwell time is possible but would reduce the rolling stock turnaround time on the corridor Aizkraukle and Skulte (described in chapter 5.5.1 and 5.5.4). In the 45- and 15-minute node, suburban peak-hour services are also using the same designated suburban middle-platforms and still provide the platform capacity for the CT 12 services (Daugavgrīva – Zemitāni – Sigulda and vv.). Only the diesel suburban line CT 12 must use the regional platforms 3 and 8 since the suburban middle-platforms are almost always occupied with suburban trains. Here a possible double-track occupation could allow the CT 12 to stop on the suburban platform as well.

On the 550 m long platform 9 a time window for the beginning and termination of night trains could be provided to allow a station dwell time of at least 20 minutes. The RE 30 is terminating at platform 1 and beginning on platform 2.

Also, hourly freight trains around the 45- and 15-minute node are possible via track 10 and 3 with a longer stop at Riga Central station. Due to required paths for passenger services only one train path per hour per direction can be provided (alternating either at 45- or 15-minute node depending on the hour of the day). Outside the peak-hour, 2 freight trains per hour and direction can pass Riga Central station in both directions around the 15- and 45-minute node.

The maximum speed of freight trains inside Riga station is assumed to be limited to 25 km/h making it even more capacity consuming – due to the long track section occupations – to get the trains through Riga Central station during the peak-hour. This assumption is based on the current traffic regulations for Riga Central station as outlined in the network statement. It shall be checked whether this bottleneck can be removed by allowing 40 km/h maximum speed in accordance with provided turnout speeds. This will require closure of currently existing pedestrian level crossings. Main benefit of this would be to provide for a higher timetable stability.

5.4.4. Operational bottlenecks and conclusions

In general, the service pattern in and around Riga Central station is quite dense and it can be said that the maximum possible quantity structure of train services during the peak-hour has been reached with the proposed master timetable applying the principles as described above. This results in many cases in absolute minimum train headway times without any or little buffer time between two successive train movements. For that reason, additional reserves were applied either as additional travel time on critical track sections or as longer dwell time in stations for trains entering the core area in order to support the punctual arrival of train services when entering the critical sections beginning in Jāņavārti, Zemitāni and Torņakalns.

Though, the complexity of the current service pattern does not allow simple answers for the expected quality and punctuality of the service pattern. The numerous trains and the interactions between them depend on the delay distribution of trains entering the core area. These delays may differ every time when trains using a certain slot are entering the core area and thereby could result in a different disruption situation between two successive trains every time depending on the overall traffic situation. To prove the stability of the provided timetable, a detailed timetable stability analysis using multiple simulation and stochastic delay and dwell-time distributions is necessary to calculate the quality of the developed service pattern, to identify possible further operational bottlenecks and to adjust the timetable to avoid unnecessary propagation of smaller delays in the network. The identified bottlenecks and flaws than can be solved by adjusting the timetable in a second step. This activity is beyond the scope of the current study.

For now, operational bottlenecks will be outlined that could be identified when constructing the timetable. Most of these bottlenecks could have a negative impact on the achievable punctuality of trains or – in the worst case – lead to a necessary reduction of the amount of services to allow a stable operation in practice. A lower density of the service pattern could have at least a positive impact on the quality and punctuality as well as on stabilizing this long-term service pattern.

The operational bottlenecks of the current and proposed infrastructure are shown in Table 35 below.

No.	Bottleneck	Type
1	Low Turnout speed of switches (25-50 km/h)	Speed restriction
2	Limited maximum speed for freight trains in Riga Central station (25 km/h)	Speed restriction
3	ALSN train protection speed limit of 60 km/h in the last block section before red.	Speed restriction
4	Odd number of trough platforms (uneven 7 instead of even 8 tracks)	Station capacity
5	400 m and 550 m platforms in Riga Central station with no double occupation	Station capacity
6	Unequal train headway times of left- and right-hand running trains on the Daugava River bridge	Track capacity
7	At grade crossing of trains inside the station when entering/leaving different corridors	Station capacity
8	Almost no buffer times between train services	Operational
9	Short times for turning trains around and terminating/beginning services in Riga Central station	Operational

TABLE 35: LIST OF POTENTIAL BOTTLENECKS

In general, the practical speed limit for trains in the core area is only around 40 km/h for passenger and 25-40 km/h for freight trains. The reason for that is the standardized turnout speed of switches of 40 km/h (listed in Table 35 above). Since trains must use diverging turnouts in almost every station (Torņakalns, Riga Central station, Zemitāni etc.) and the distance between the stations is rather low, the higher open line speeds of around 100 km/h are often not reached or used. For freight trains the speed limit in Riga Central station is additionally limited even lower to only 25 km/h. Together with the fact, that these trains have a rather slow acceleration and the last wagon of these long trains has to pass the last switch in rear first before increasing speeds (5.000 t, 850 m) the practical speed of freight trains around Riga is even lower.

To increase the capacity of the track sections in the core area the general speed limit for freight trains and the turnouts could be increased to 60 km/h. This would increase the practical speed limit for freight trains by 50 % and thus allowing to reduce the train headway times and to increase the capacity of the highly occupied core area. A higher maximum speed of turnouts is not seen as highest priority due to spatial constraints and the speed limitations of ALSN. In the critical peak times with a dense occupation, when trains are operated close to the minimum train headway times where successive trains almost always have not more than one free block distance between each other, the ALSN speed limit for the line sections between a yellow and a red signal (starting at the signal showing yellow aspect) and the short distances between two adjacent signals on the Daugava River bridge lead to a practical limit of achievable maximum train speed of 60 km/h for passenger trains and 50 km/h for freight trains in the most densely occupied track sections between Riga Central station and Torņakalns.

Platform capacity limitations of Riga Central station

When developing the service pattern, it turned out that the proposed number of seven through platforms at Riga Central station is one below the theoretical required eight platforms to provide for meeting of all trains in the most occupied node (30-minute node). Also, 2 terminus tracks from the east side are available only, limiting the capacity for single peak-hour services and long running international services from Valga, Daugavpils and Rēzekne to terminate and begin on a separate platform in Riga. Furthermore, there are no separate platform tracks available allowing a termination of trains from the west side. These limitations are difficult to address since a provision of additional platforms is hardly possible due to spatial constraints. The developed timetable does provide a compromise to handle this bottleneck, e.g. by avoiding a termination of trains in Riga Central station where a through running of trains with a short stop in Riga Central station can be provided instead.

Even though Riga Central station has quite long through platforms of 400 m and even 550 m, two trains cannot stop at one platform at the same time (so called double platform occupation). Here a high potential does exist to increase the capacity of Riga Central station during the peak-hour, for coupling and un-coupling of trains. This would allow more operational flexibility over the day by beginning and terminating trains from the peak-hour for example. Finally, this would allow for interchange of passengers between up to four trains at the same time using one island platform without the need to change platforms by stairs or escalators. From the current viewpoint most of the passenger trains are not planned to be longer than 100 m, thus such a principle would allow a more flexible operation in peak times and provide for instance a significant benefit for passengers changing trains without obstacles within a short time, including significantly more convenient situation for passengers with reduced mobility.

In Figure 56 a conceptual double track occupation for Riga Central station in the 30-minute node is shown. In the current version of the master timetable, suburban diesel trains (line CT 12) have to stop on designated regional and long-distance train tracks 3 and 8. This is due to missing available suburban tracks in Ria Central who are almost anyway occupied with stopping suburban passenger services. Based on feedback by PV the suburban diesel line CT 12 shall also stop at designated suburban platforms 4, 5, 6 and 7. To also allow the line CT 12 to stop at the designated suburban platforms, a double track occupation at track 4 and 6 is considered. With this solution trains of the CT line 12 and CT line 2 are stopping at the same platform and suburban trains of all lines in the same direction are stopping at the same middle platform (track 4 and 5 and track 6 and 7). This allows for easier same-platform interchange of passengers between all suburban lines in eastbound or in westbound direction and reduces passenger movement in the station itself during rush-hour.

Further equipment of additional tracks for double-track occupations allows to stop regional and suburban freight trains at the same platform at the same time. This increases same-platform-connections for passengers between regional and suburban services. For example, the RE 20 to Jelgava-Dobele-Liepaja and Aizkraukle-Daugavpils/Rezekne could stop at the same platform. This would allow to provide additional capacity at the designated regional 550 m platforms 8 and 9 for regional services, night trains or beginning and terminating services in Riga Central station.

This approach however cannot be applied right away in the current version of the Master timetable. Further development in the timing of the trains have to be implemented to allow conflict-free double track occupation in Riga Central station.

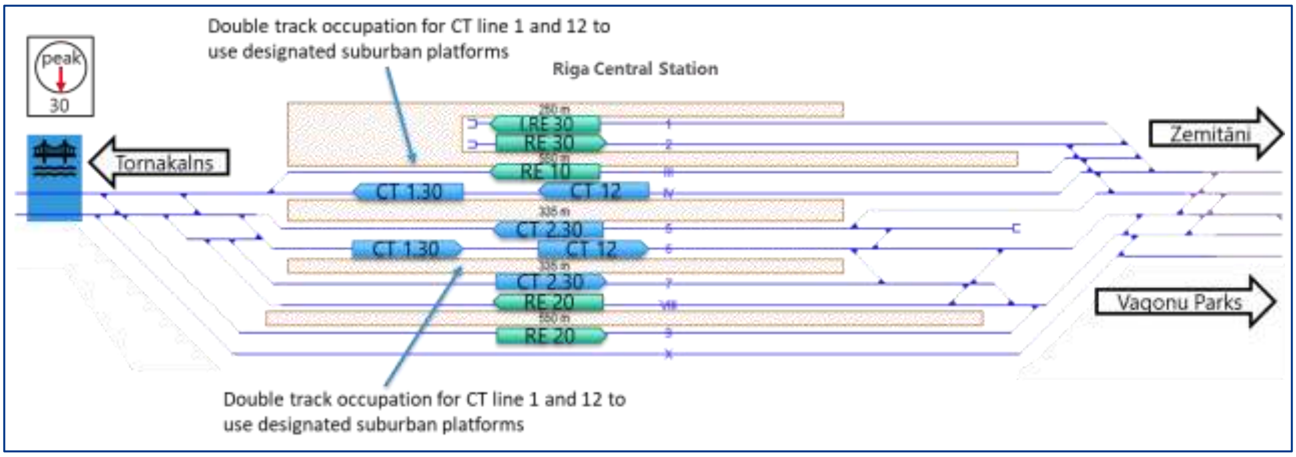


FIGURE 56: CONCEPTUAL TRACK OCCUPATION WITH TWO TRAINS PER PLATFORM (EXAMPLE)[70]

The Daugava River bridge is equipped for bidirectional working allowing simultaneous trains in the same direction at the same time. Though the currently provided block section length for “wrong direction working” on the left-hand track leads to higher train headway times (roughly 2 minutes longer). This results in longer dwell times for trains of the “second wave” approaching/leaving Riga on the left-hand track and reduces the available capacity on the bridge which forms the natural bottleneck in the core area. In the end this increases the valuable dwell time in the track

[70] Source: Own depiction based on earlier stage of timetabling study

occupation in Riga Central station (shown in Figure 52 and Figure 53). Here an equal number of blocks on both tracks and directions on the Daugava River bridge should be implemented when the signaling system is further modernized.

Further adjustments of track occupation for Riga Central station

According to feedback from stakeholders the 550 m long through platforms 3, 8 and 9 are seen a platform designed for regional and international services while the 400 m long island through platforms (tracks 4/5) and 6/7) are planned for suburban services. The terminus platforms 1 and 2 are mainly designated for beginning and terminating services from the east running on the corridors Riga-Sigulda-Valga and Riga-Aizkraukle-Daugavpils/Rēzekne (shown in the track diagram in Figure 57 below).

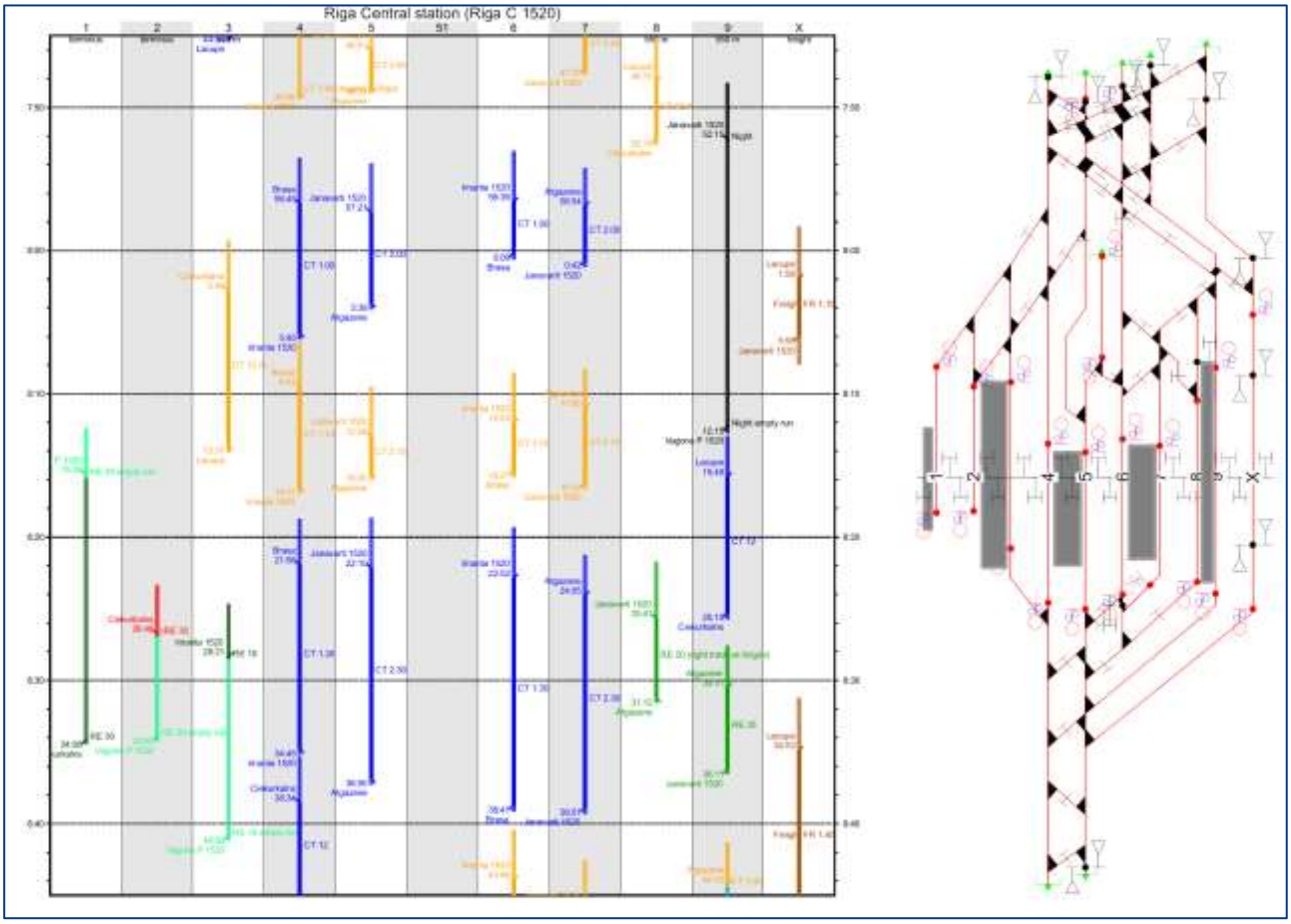


FIGURE 57: POSSIBLE ADJUSTED TRACK OCCUPATION IN RIGA CENTRAL STATION

For that reason, it was initially checked if it would also be possible to stick to the originally intended principle as intended by LDz and PV. As a result, the westbound suburban services (peak- and off-peak) would use tracks 4 and 5 and eastbound services would use tracks 6 and 7. The regional services also now use the designated regional platform, The 2-hourly beginning and terminating RE 10 is operating on track 3 while the RE 20 in both direction is stopping at tracks 8 and 9.

As a consequence of the changed track occupation, the departure time for the eastbound CT12 on platform 9 had to be changed from minute 20 to minute 25 and leaves Riga now 5 minutes later towards the corridor Riga-Jugla-Sigulda. For that reason, the services on the corridor Riga-Sigulda-Valga must be further developed. According to a first rough assessment necessary adjustment on this corridor would be feasible.

At grade crossings at Riga Central station, Torņakalns, Zemitāni

Though, from the train station Torņakalns, Riga Central station and Zemitāni corridors are diverging in separate directions, no under/overpasses to eliminate possible at grade crossing conflicts do exist in the current track layout. Currently it is not planned to improve this situation. This leads to numerous crossing train routes in the station and the switch areas and is reducing the overall capacity of the core area.

- In Riga Central station services to Tukums will need to cross the tracks of lines from Aizkraukle (or the track on the opposite direction
- Freight services using track X in Riga Central station must cross the line in the opposite direction when leaving for Jelgava/Bolderaja
- Trains from Zasulauks must cross the tracks for trains to Jelgava in the opposite direction at entrance or exit of Torņakalns station
- Trains from Bolderaja must cross the main line in the opposite direction to reach the right-hand track towards Torņakalns
- Trains from Sigulda must cross the track for trains to Skulte at Zemitāni to reach the left-hand track towards Riga Central station

Practical impact on timetable construction can be shown by the following example.

To avoid bottlenecks in platform occupation the CT services are proposed as through services. Following the demand, it would be logical to interconnect Tukums and Aizkraukle line as one service. This was not possible due to at grade crossing conflicts in Riga Central station and Torņakalns. Resulting from that the services from Tukums are interconnected to services to Skulte which leads to trains terminating in Riga Central station. Furthermore, RE 10 is limited to a 2-hourly service. Also, the regional services do terminate and begin in Riga in separate even and odd hours only. A future improvement to an hourly and/or through service with the RE 30 to Sigulda-Valmiera-Valga for example is not possible due to at grade crossings and the missing of an 8th through platform track in Riga.

Overall, the related conflicts to these at-grade crossings could be solved in the timetabling process for the master timetable.

For Torņakalns station it was discussed whether a cut-and-cover solution avoiding at-grade crossings would be advantageous and feasible since a cut and cover solution is to be developed for Rail Baltica line crossing Jelgava line.

The related principle is shown in Figure 38. Since the track under passing Jelgava line could be used for passenger services only and not by heavy freight trains due to the steep gradients necessary to reach required height level at east side of Torņakalns station within the available short distance. With the optimized timetable a feasible track occupation for Torņakalns station was developed. Resulting from that, the limited effect of such a solution is still to be proven based on a comprehensive timetable stability analysis.

For the other remaining at-grade crossing a feasible track occupation could be developed as well. Thus, there is no urgent need to replace the existing at-grade-crossings. Nevertheless, the occupation times and train headways for a train crossing the critical section shall be minimized. This must be supported by the measures described above, where possible. For Zasulauks, a redesign is required to provide the necessary capacity for passenger trains from/to Daugavgrīva (see also following section).

Single track line Zasulauks – Daugavgrīva

The proposed service pattern does include a completely new passenger service between Riga Central station and Daugavgrīva. To allow attractive overall travel times the services should be operated in a half-hourly basis. A shorter service frequency is not possible due to the lack of infrastructure capacity prohibiting additional trains over Daugava River bridge. The possible timing of the trains to Daugavgrīva heavily depends on the available free slots. Same applies for the freight trains running from/to Bolderāja and the new Riga port area at Krievu Sala (branch from Bolderāja-2 station). Currently, the line to Daugavgrīva is operated as freight-only line without passenger services and is just a single-track line on the complete length from Zasulauks to Daugavgrīva. The structure of the timetable resulting from the occupation of the line section Zasulauks – Torņakalns – Riga Central station does not allow a conflict free operation of freight and passenger services on this single-track line. Furthermore, there is no capacity for additional stops of freight trains in/before Zasulauks station. In addition to that braking/accelerating of freight trains would have negative impact on available line capacity and passenger services between Torņakalns and Zasulauks. Thus, double tracking of the line section Zasulauks – Bolderāja must be treated as precondition for operation of proposed passenger services. This does also include the change of the switch area on the west side of Zasulauks station in order to allow simultaneous operation of trains to and from Lāčupe and thus avoiding additional constraints in the timetable.

Limited time for passenger trains at platforms to turnaround, to begin or to terminate

Within the framework of the developed service pattern, certain passenger services in Riga Central have quite short available times for turning around at the platform when beginning or terminating in Riga Central station. Terminating and beginning trains are connected empty runs from and to Vagonu parks (shown in Figure 55 and in Annex 7, empty runs are indicated in light blue color). Not in all cases the minimum station dwell time for terminating and beginning trains in Riga Central station of 9 minutes (already defined in Table 23 in chapter 5.3.3) could be applied. In these cases, the dwell time was reduced within the possible limitations of 3 minutes for beginning and 4 minutes for terminating trains. This was due to two factors, first available possible maximum dwell time at the platform and slot availability for the necessary empty-runs from and to Vagonu parks.

Capacity for freight trains

The proposed track layout for Riga Central station will provide one dedicated freight track (track X) which allows a freight train with full length of 850 m to stop without obstruction of other movements. In the developed timetable all freight trains need to stop in Riga Central station to synchronize with available paths on the line sections east (Šķirotava direction) and west (Daugava River bridge) of Riga Central station. Westbound trains have to be coordinated with contra-flow traffic (up to 12 passenger trains per hour in opposite direction during peak hours, 6-8 off peak). With respect to requirements established the target was to provide 2 train paths per hour per direction. This target could not be fully achieved. With the need to stop in Riga Central station and the limitations on the west side approx. 1.5 trains could be scheduled via track 10. One westbound train path was provided on track 3. In practice, this path will only be feasible outside the peak hours due to the tight timing over Daugava river bridge. The length of trains using this path is restricted to 650 m due to the limited usable length, if trains are not allowed to occupy the switch area on the east side. An additional bottleneck is the current operational rule, which restricts the train speed at the platform to 25 km/h. This will lead to extended run times and thus longer occupation of the switch areas. In turn the slot over Daugava river bridge cannot be used and this path cannot be offered, at least outside peak times.

In Table 36 the number of scheduled paths for west and eastbound trains is depicted for every hour of the day. As can be seen the capacity for freight trains will be significantly reduced during peak hours. To depict usability of the paths by train length 2 values are presented – one for trains with up to 850 m length (using track X) and one for all paths including paths via track 3 with max. usable length of approx. 650 m. These figures are valid for the master timetable 2026/36. If traffic is further increased in the long term and peak times might be extended the availability of paths will shrink. As can be seen the limiting factor is the path availability for westbound freight trains. In total 34 usable paths per day for westbound freight trains were timetabled. Thereof 24 paths are usable for trains with full length (850 m). For eastbound freight trains 42 paths per day can be provided.

Usable freight paths through Riga Central station (train length 650 m)																									
Hour	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	Total
West bound	2	2	2	2	2	1	0	0	1	2	2	2	2	2	1	0	0	0	1	2	2	2	2	2	34
East bound	2	2	2	2	2	2	1	2	2	2	2	2	2	2	1	1	1	1	1	2	2	2	2	2	42
Usable freight paths through Riga Central station (train length 850 m)																									
Hour	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	Total
West bound	2	2	2	2	2	1	0	0	1	1	1	1	1	1	1	0	0	0	1	1	1	1	1	1	24
East bound	2	2	2	2	2	2	1	2	2	2	2	2	2	2	1	1	1	1	1	2	2	2	2	2	42

TABLE 36: TIMETABLED PATHS FOR FREIGHT TRAINS THROUGH RIGA CENTRAL STATION IN THE MASTER TIMETABLE

The stated figures indicated in Table 36 do include a "safety margin" for westbound trains to deal with tight traffic situations in peak hours and, which means in hours with dense traffic not all timetabled paths are stated as available to deal with runtime adjustment resulting from further model calibration and timetable stability analysis.

5.5. Infrastructure utilisation outside the core area

Infrastructure utilisation outside the core area was studied to provide for three goals:

- To ensure that infrastructure and developed timetable in the railway core is compatible to the infrastructure on the adjacent line sections
- To study the rolling stock circulation to check requirements for rolling stock maintenance and layover facilities and to ensure operational efficiency of the developed timetable
- To identify bottlenecks preventing attractive travel times and limiting capacity

The timetable for line sections outside the core area is based on the mesoscopic FBS model developed by the consultant. This model is based on the infrastructure data provided by LDz as part of the network statement and the supporting documentation of the current infrastructure by LDz.

In the following sections the specific features of the developed timetable and the related operational and infrastructural bottlenecks will be described in detail on a per corridor basis for all main lines starting at Riga and the branches relevant for passenger service.

5.5.1. Corridor Riga – Aizkraukle – Krustpils – Rēzekne/Daugavpils

The service pattern and infrastructure utilisation on the corridor Riga-Aizkraukle-Krustpils consists of the suburban line CT 2 with the up to 4 train pairs per hour during the rush-hour (CT 1.00, 1.15, 1.30 and 1.45) the arriving and departing regional R (RV) train pair of the line R 70 from and to Madona/Gulbene via Plavinas at the full hour in Riga, the hourly regional express service RE 20 between Liepaja-Dobele, Riga-Krustpils-Daugavpils and Rēzekne-Zilupe and the arriving night trains coming from Moscow and Minsk (shown in Figure 58 below). Additionally, freight trains run between the harbour Bolderāja-Daugavgrīva and the freight yard in Šķirotava and up to 3 freight train slots per hour are provided between Šķirotava and Krustpils. The peak-hour service pattern is almost identical with the afternoon with the variation that the night trains leave Riga and mostly operate outside the afternoon peak-hour between 6 and 7 pm.

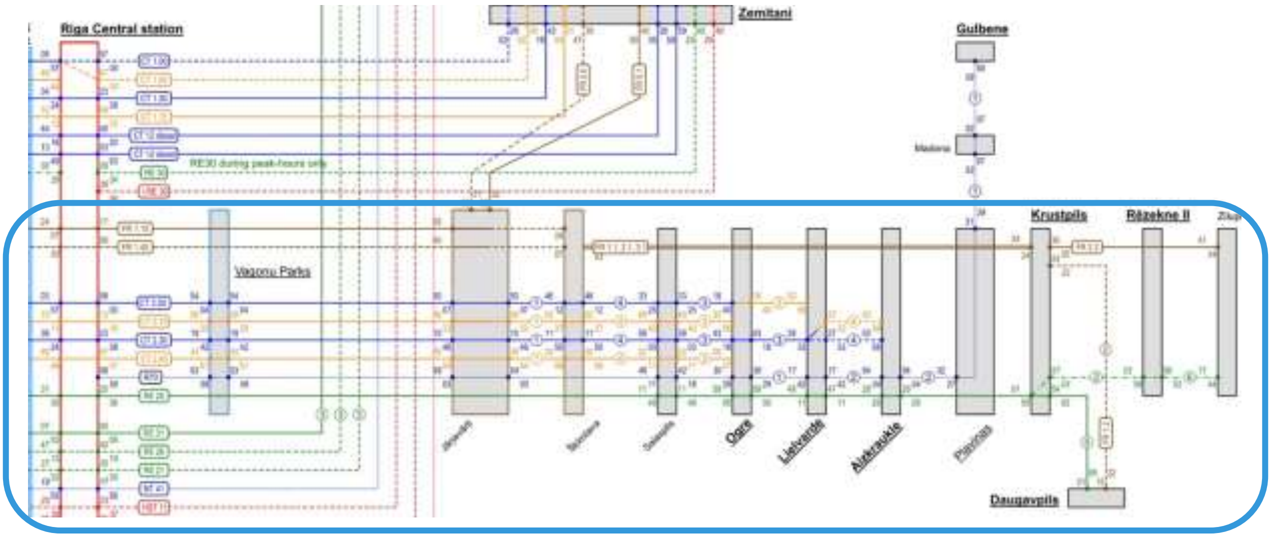


FIGURE 58: SERVICE PATTERN ON THE CORRIDOR RIGA-AIZKRAUKLE-DAUGAVPILS/RĒZEKNE-ZILUPE

Next the infrastructure utilisation of the passenger and freight service during peak-hours, off-peak hours and the track sections to Daugavpils and Rēzekne-Zilupe will be explained.

Service pattern on the corridor during peak-hours

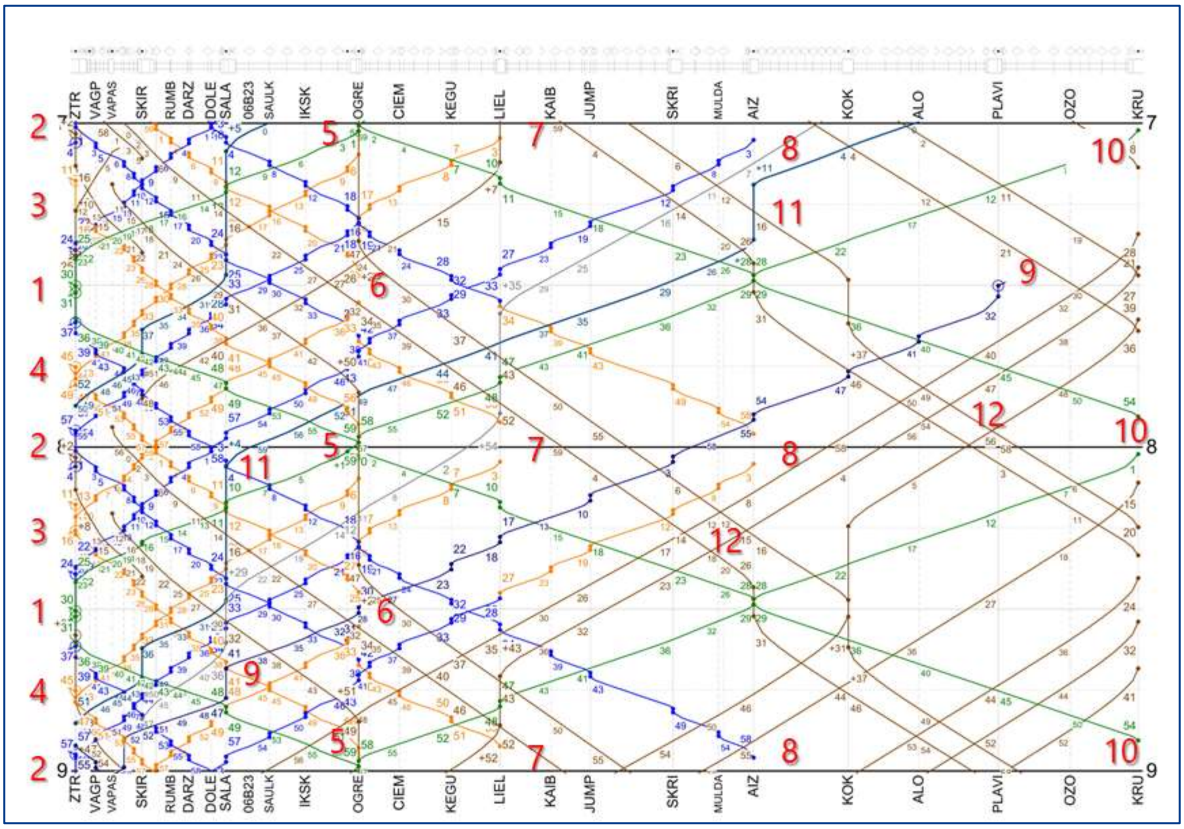


FIGURE 59: GRAPHICAL TIMETABLE CORRIDOR RIGA-AIZRAUKLE-KRUSTPILS PEAK-HOUR

The typical infrastructure utilisation of the corridor during peak-hours is shown in Figure 59 above:

1. In the **30-minute-node in Riga Central station** the hourly suburban CT 2.30 between Jelgava-Riga-Aizkraukle and the hourly RE20 from/to Daugavpils and Rēzekne operate. The faster regional express is leaving first (green) followed by the slower suburban service (blue).
2. In the **00-minute-node in Riga Central station** the suburban CT 2.00 between Jelgava-Riga-Lielvārde operate through Riga and the morning train pair of the R 70 between Gulbene-Madona-Plavinas arrive and depart in Riga around 9 am. Also, in the hour 8 and 9 the night trains from Moscow and Minsk are arriving having quite long operational dwell times in Salaspils (SALA) to fit into the highly frequented Station and between the other train paths.
3. In the **15-minute-node in Riga Central station** the hourly suburban CT 2.15 operates between Jelgava-Riga-Ogre.
4. In the **45-minute-node in Riga Central station** with the hourly peak-hour service of the suburban line CT 2 (CT 1.45) operates between Jelgava-Riga-Ogre.
5. The hourly suburban peak-hour service CT 2.15 from Riga and the hourly CT 2.45 to Riga are caught up by the faster hourly RE 20 shortly before they arrive in the terminus station Ogre. To avoid the overtaking the RE 20 is getting 4 minutes additional travel time between Ogre and Riga (ZTR). This will have a positive effect on the punctuality of the regional service as well.
6. The hourly CT 2.15 and CT 2.45 are turning around in Ogre in the 30- and 00-minute-node in a short time window of 6 and 9 minutes. The terminating trains are using the third platform in Ogre and entering and leaving the station via a turnout with top speed of 40 km/h reducing the available time for the turnaround up to 2 minutes. While leaving the station the trains must cross open line track with trains coming from Riga.
7. The hourly CT 2.00 is extended to Lielvārde during the peak-hour and is terminating from minute 56 to minute 2 within 6 minutes in the 00-minute node.
8. Hourly the suburban CT 2.30 is terminating in Aizkraukle. The time for turning the train around is 6 minutes from minute 58 to minute 3 within 5 minutes. Also, the RE 20 in both directions is meeting in Aizkraukle around the 30-minute node resulting in potentially good connection to local public transport services.

The terminating suburban services use always the third track when terminating in Ogre, Lielvārde (LIEL) and Aizkraukle (AIZ) by using the turnout with a reduced top speed of only 40 km/h. This increases the overall travel times on the corridor by 2 minutes and reduces the available time for turning the trains around. To increase the time for the turnarounds and make up for the slow turnout speed during the peak-hours, it is recommended to leave out stops in less frequented station like Dārziņi and Rumbula at least in load direction (see also chapter

5.3.3 and Table 25 on page 121). This would increase the turnaround time under optimal circumstance by 6 minutes and would stabilize the tense service pattern during peak-hour.

Since the peak-hour is only between two (morning) and three (afternoon) hours, short turnarounds are only executed once or twice. This means delays won't build up over long periods and are also compensated by the long station dwell times in Riga Central station. Additionally, most of the services are running through Riga and often having longer turnaround times on the other corridors to reduce possible delays.

Also, by turning around on a third outside platform train have to cross tracks with trains in the opposite direction.

The morning regional train from Gulbene-Madona-Plavinas R 70 to Riga is fixed between the CT 2.15 in Ogre in the 00-minute-node and CT 2.00 in Riga. The different travel times leads to a longer dwell time in Salaspils of 3 minutes. The same principle is applied symmetrical for the train in opposite direction.

9. The regional R70 is leaving and entering the corridor around the 30-minute node in Plavinas (PLAVI).
10. The RE 20 is operating in Krustpils (KRU) around the 00-minute node by using both platforms at the same time.
11. It is quite a challenge to bring single night trains into the Riga during the morning peak-hour. Night trains have to make several longer stops in Aizkraukle, Salaspils and Šķirotava sometimes for 30 minutes to find a slot in Riga Central station to have a dwell time of at least 20 minutes to terminate the train. Since the around the 30-minute node all platforms are occupied, the night trains have to arrive behind 30-minute node to maximize the dwell time in Riga. In the current solution the train has as slot to Riga and arrive before the 00-minute node at minute 52 and therefore has at least 20 minutes on the only available 550 m platform 9 until the first trains enter Riga in the 30-minute to occupy all available through-platforms 3 to 9. again.
12. On the corridor 3 freight train slots are provided per hour (brown lines). During the peak-hour the number of slots can be reduced to 2 slots per hour. Also due to the different travel times and the smaller time windows for freight trains between the suburban peak-hour services, freight trains have to be overtaken in almost all station like Salaspils, Ogre, Lielvārde, Aizkraukle and Plavinas. The goal to allow freight trains to operate nonstop between Šķirotava and Krustpils could not been achieved.

Service pattern on the corridor during off-peak

The off-peak service pattern is shown in Figure 60 below.

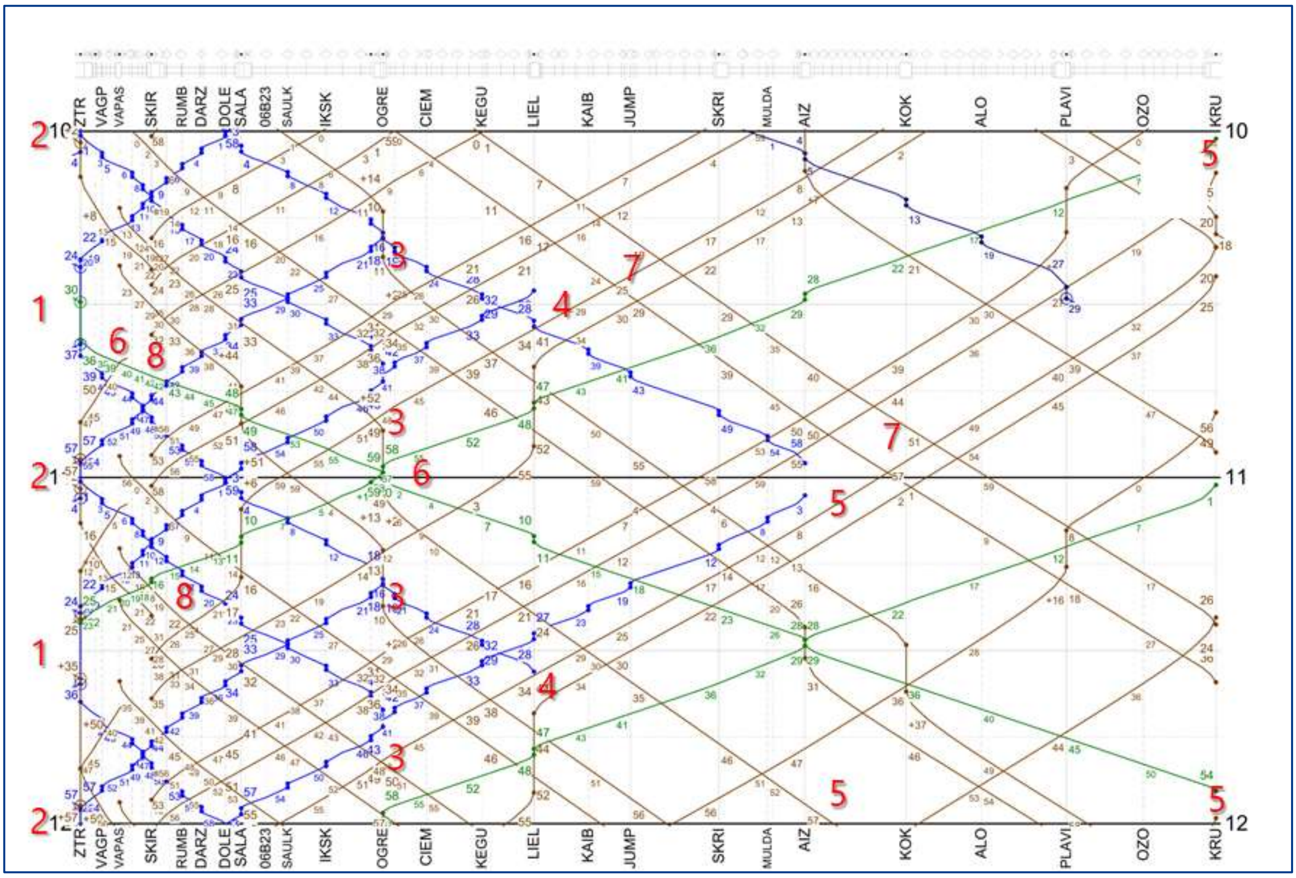


FIGURE 60: GRAPHICAL TIMETABLE CORRIDOR RIGA-AIZKRAUKLE-KRUSTPILS OFF-PEAK

During off-peak the service pattern is more relaxed in general with suburban services operating only every 30 minutes between Riga and Ogre and only hourly or 2-hourly until Lielvārde and Aizkraukle. The RE 20 is operating is using it hourly available slot mostly 2-hourly between the peak-hours. This allows the integration of 3 freight trains slots per hour with less overtaking then during the peak-hours. Specific features of the timetable are described below with reference to the numbers indicated in Figure 60 above.

1. The service pattern of the **important 30-minute-node in Riga Central station** will be served unchanged over the day during peak-hour and off-peak. CT2.30 and RE20 will offer connections to fast and suburban services to other corridors.

2. Also, the **00-minute-node in Riga Central station** will be served unchanged over the day during peak-hour and off-peak, offering connections between suburban services on other corridors.

3. The hourly CT 2.00 will terminate in Ogre from the 45-node to the 15-node with 30 minutes of turnaround time.

4. The important hourly CT 2.30 will terminate in Lielvārde (LIEL) every two hours, increasing the short turnaround time (6 min) in the peak-hour to one hour during off-peak.

5. The important hourly CT 2.30 will be extended to Aizkraukle (AIZ) every two-hour serving the 00-minute-node having either a short turnaround time of 6 minutes or alternatively a turnaround time of roughly two hours by using a now available peak hour unit.

In general, the turnaround times of the suburban CT 2 services in Ogre, Lielvārde and Aizkraukle are more relaxed during off-peak. This relaxes the service pattern during off-peak and will reduce possible build up delays from the peak-hour period rather quickly.

6. Regional express services (RE 20) remains unchanged of the whole day during peak-hour and off-peak, serving the 30-minute-node in Riga and Aizkraukle and the 00-minute node in Ogre and Krustpils. During the off-peak the hourly slot of the RE 20 will only be used for 2-hourly services between Daugavpils, Riga and occasionally Jelgava (JELG) and Dobele (DOB).

7. In the hour where no fast RE 20 is operating the 3 freight train slots can run mostly without overtaking between Šķirotava and Krustpils. In hours where RE 20 is operating the freight trains have to stops in stations like Plavinas, Aizkraukle and so on to fit between the suburban and regional service and to get an available slot to get into and out of Šķirotava.

8. During off-peak hourly freight trains between Šķirotava via Riga to the harbour in Bolderāja are available. They are using the 45-minute node slot of the suburban peak-hour services towards Bolderāja and the 15-minute node slot from the harbour. The freight trains arrive and depart in Šķirotava around the 30-minute node together with freight trains from and to Krustpils. Track section Riga-Aizkraukle-Krustpils

RE 20 between Riga and Daugavpils and the corridor to Rēzekne-Zilupe

The RE 20 is operating via Krustpils to Rēzekne-Zilupe and to Daugavpils. Therefore, in the 00-minute node in Krustpils a longer dwell time for connection slot on the track section Riga-Krustpils, Krustpils-Rēzekne-Zilupe and Krustpils-Daugavpils is available.

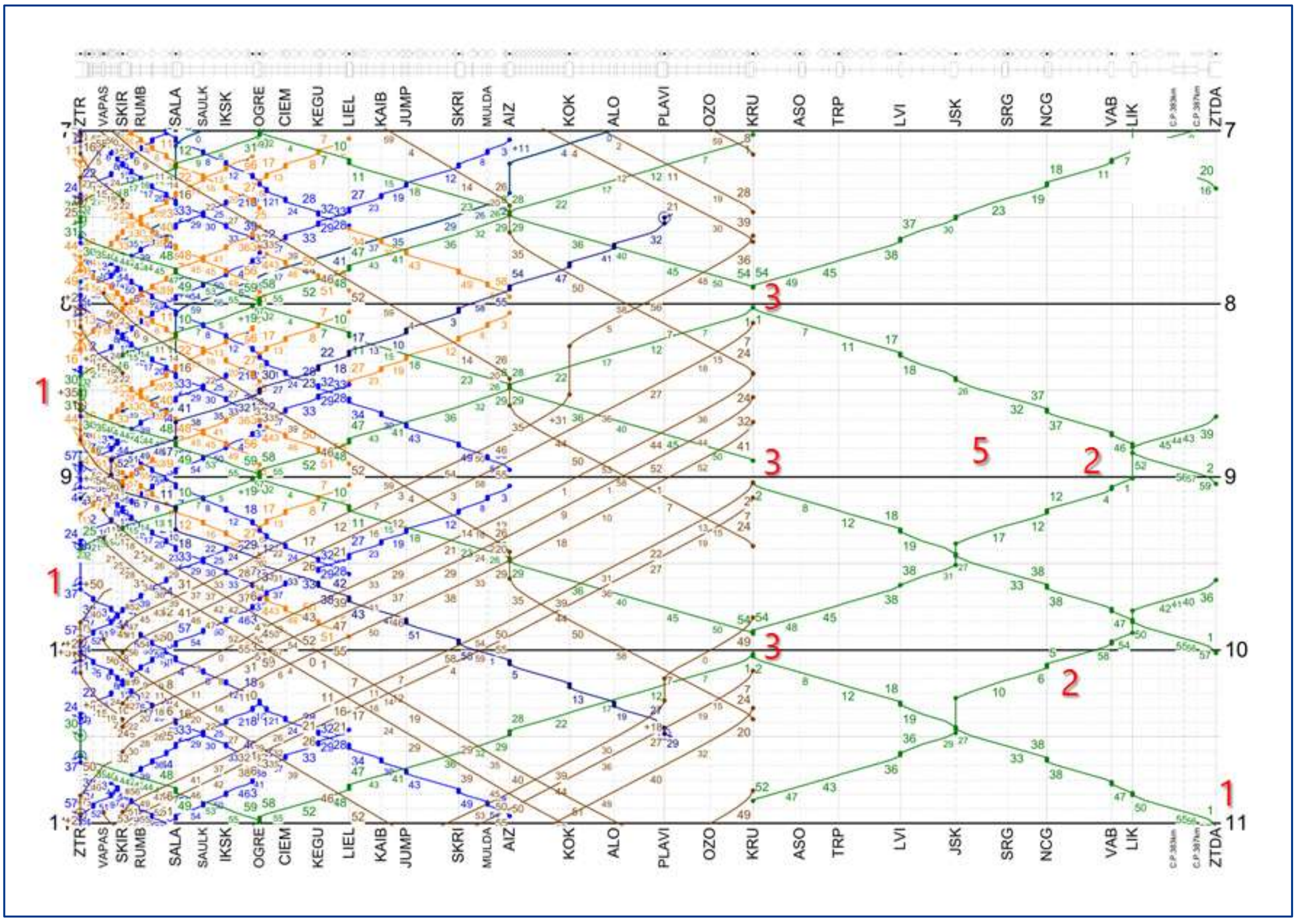


FIGURE 61: GRAPHICAL TIMETABLE TRACK SECTION RIGA-KRUSTPILS-DAUGAVPILS

The service pattern of the RE 20 for the track section Krustpils (KRU) and Daugavpils (ZTDA) can be seen in Figure 61 above:

1. The regional express RE 20 is connected to the important 30-minute node in Riga Central station with connection to other regional and suburban services and the rail Baltica service pattern.

2. Since the single-track section Krustpils (KRU)-Daugavpils (ZTDA) does not have allow a fast RE 20 in both directions at the same time only RE 20 in load direction or connected to the rush-hour node in Riga or Daugavpils operates with lower dwell time on the corridor. Trains in the other direction with arrival or departure outside the rush hour in Riga or Daugavpils must wait station like Līksna (LIK) or Jersika (JSK).

3. RE20 operate around the 00-minute node in Krustpils with a longer dwell time of at least 6 minutes. This is done to allow trains to couple and un-couple in Krustpils (KRU). With this approach trains from Rēzekne-Zilupe and Daugavpils (ZTDA) can be coupled in Krustpils (KRU) and can operate at the same time window to the 30-minute node in Riga Central.

4. Between 0,5 and 1,0 train slots per hour are possible on that track section during the day. This was only possible however with numerous operational stops on the corridor resulting on a longer travel time of up to 4 hours.

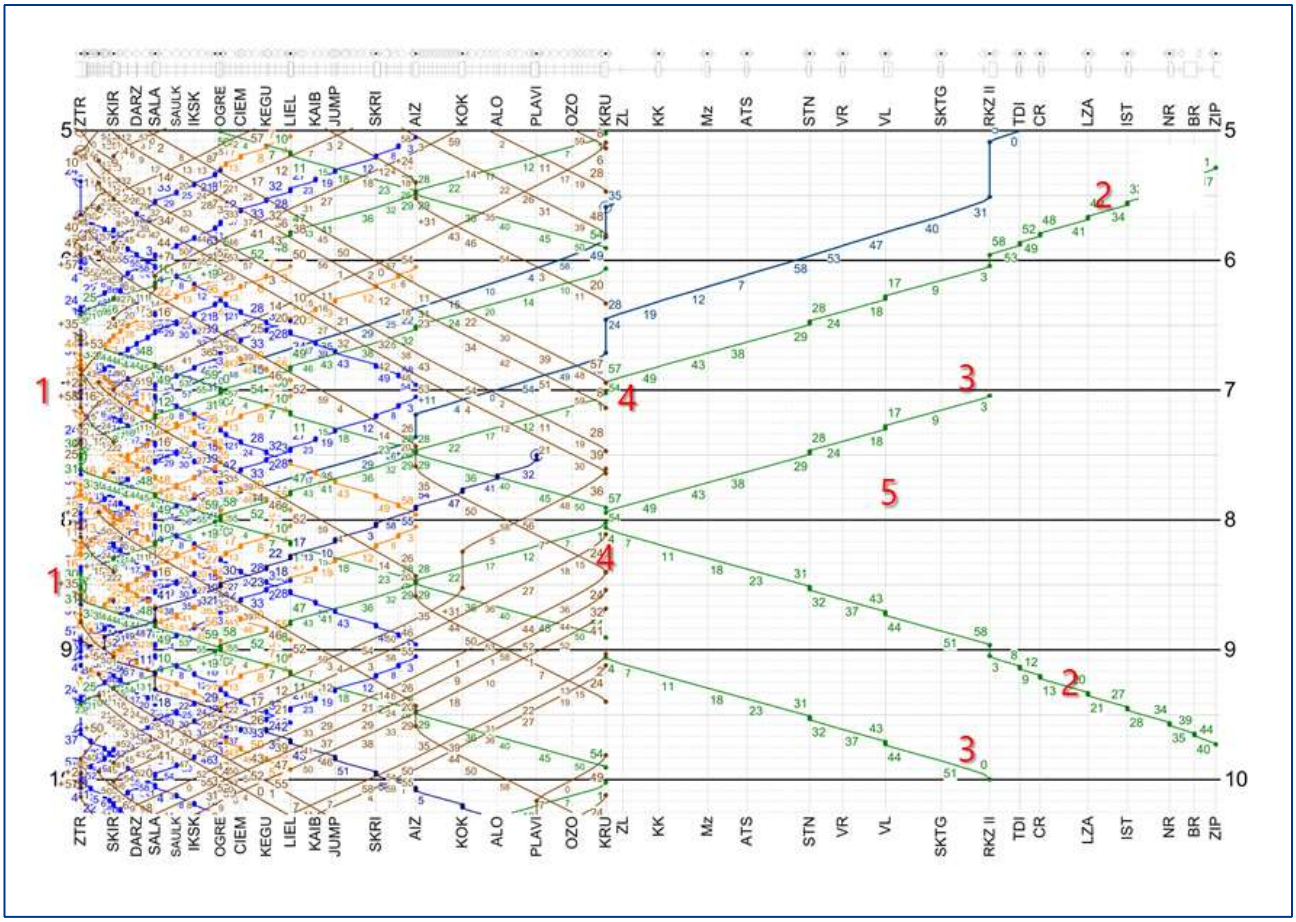


FIGURE 62 GRAPHICAL TIMETABLE TRACK SECTION KRUSTPILS-RĒZEKNE-ZILUPE

The service pattern of the RE 20 between Riga and Rēzekne-Krustpils consists of 2 train pairs between Zilupe and Riga and 5 trains pairs between Riga and Rēzekne[71]. Goal is to connect the RE 20 to the important 8:30 o'clock node Riga Central station.

1. The RE 20 services between Riga-Rēzekne-Zilupe are connected^^ to the **30-minute node in Riga Central station** with connection to all important regional, suburban and Rail Baltica services.
2. The long running RE 20 between Riga and Zilupe are connected toward Riga to the 8:30 o'clock node in Riga (ZTR) departing in Zilupe (ZIP) and quarter past 5. In the opposite direction RE 20 to Zilupe departs at 7:30 to arrive in Zilupe just before 10 o'clock.

[71] Source:

3. During rush-hour in the morning and hourly service pattern between Riga and Rēzekne is required by PV. For this reason, the RE 20 between Riga and Rēzekne is operating on hour later than the RE 20 from/to Zilupe.

4. RE20 operate around the 00-minute node in Krustpils with a longer dwell time of at least 6 minutes. This is done to allow trains to couple and un-couple in Krustpils. With this approach trains from Rēzekne-Zilupe and Daugavpils can be coupled in Krustpils and can operate at the same time window to the 30-minute node in Riga Central. RE 20 train from Rēzekne-Zilupe enters Krustpils 3 minutes prior to the RE 20 from Daugavpils. Eastbound the trains is leaving second 2 minutes after the RE 20 to Daugavpils departed. This gives enough time for the RE 20 to couple and un-couple in Krustpils if required during the peak-hours.

5. On the track section Krustpils-Rēzekne-Zilupe an hourly slot for freight trains has been applied. Since the slot are only possible with numerous stops and a long travel time of four and more hours the practical and more economical number of freight trains on this corridor is seen be less than an hourly slot.

On the double track section Riga-Krustpils between 2 and 3 freight slots are possible during peak and off-peak. However, beyond Krustpils the practical altogether number of freight train slots on the track section to Zilupe and Daugavpils is only 1,5 to 2 slots per hour.

Night train services

Night trains operate nonstop between Riga (ZTR) and Krustpils (KRU). Since the future travel time outside of Latvia cannot be proposed in detail the current arrival and departure times at Krustpils are used as starting point for timetable construction. Stops seen in the timetable are just operational stops due to infrastructural and service pattern restraints. Alternatively, additional run-time supplements can be implemented to avoid energy-consuming operational stops.

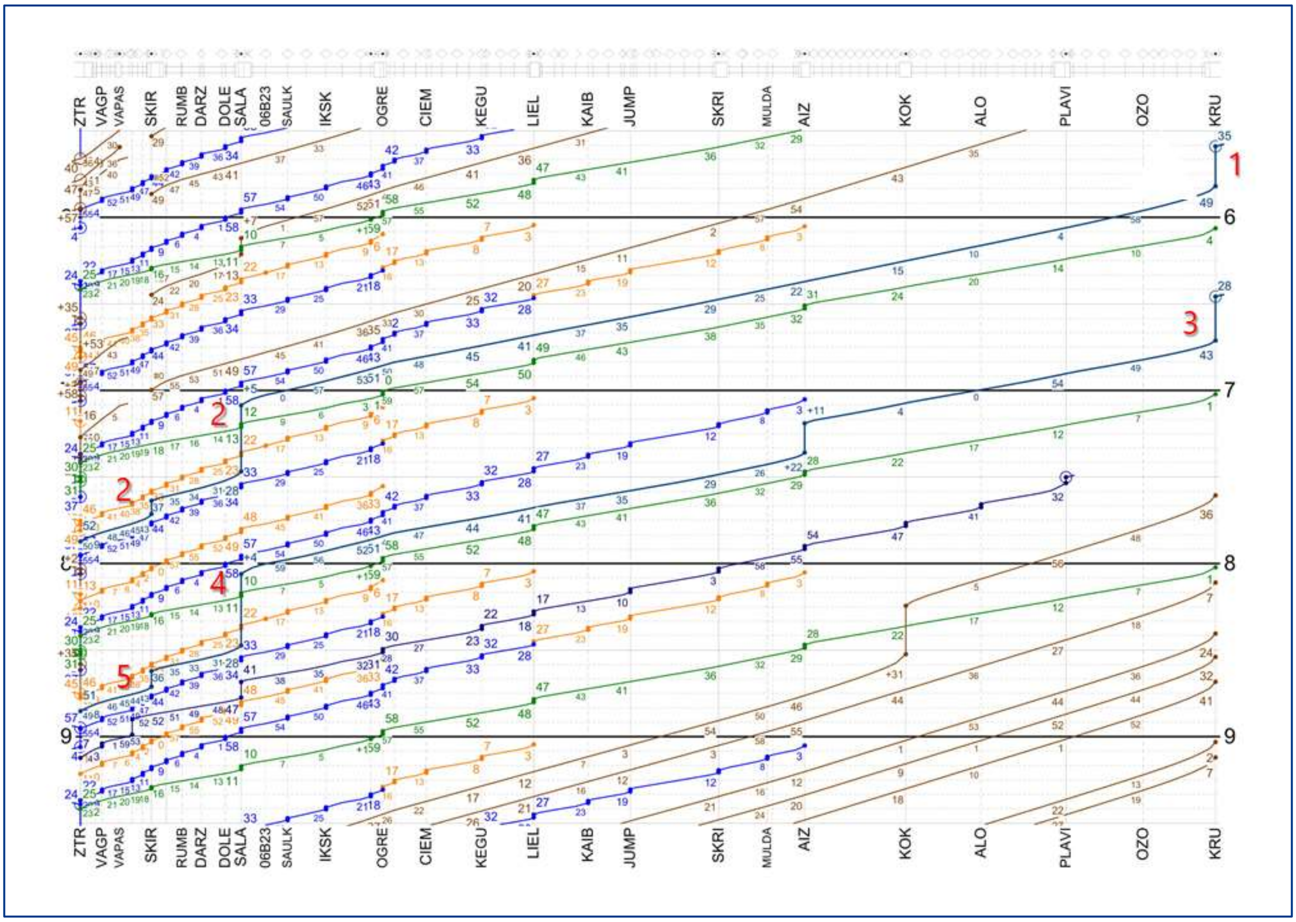


FIGURE 63: MORNING NIGHT TRAIN INBOUND TO RIGA

Arriving night trains in the morning towards Riga Central station are shown in Figure 63 above and are described below with reference numbers relating to the situation in the figure. The trains arrive too late in Krustpils to use the more suitable time window between the CT 2.15 and CT2.30. Between these trains no overtaking would be required.

1. The first night train in the morning (from Moscow/St Petersburg) is assumed to depart from Krustpils approx. as in the current timetable.
2. The second night train in the morning operates between the RE 20 and the CT 1.30. To get a free slot into Riga, overtaking of the night train at Salaspils (SALA) and an additional operational stop in Šķirotava (SKIRO) is required to avoid train headway-conflicts.
3. Night trains from Minsk with today arrival time in Krustpils including the planned stop. For this train an additional operational stop in Aizkraukle is required to avoid train-headway conflicts with the CT 1.30.
4. Same procedure for this night trains with overtaking in Salaspils (SALA).
5. Additional operational stop in Šķirotava (SKIRO) necessary to avoid train headway-conflicts.

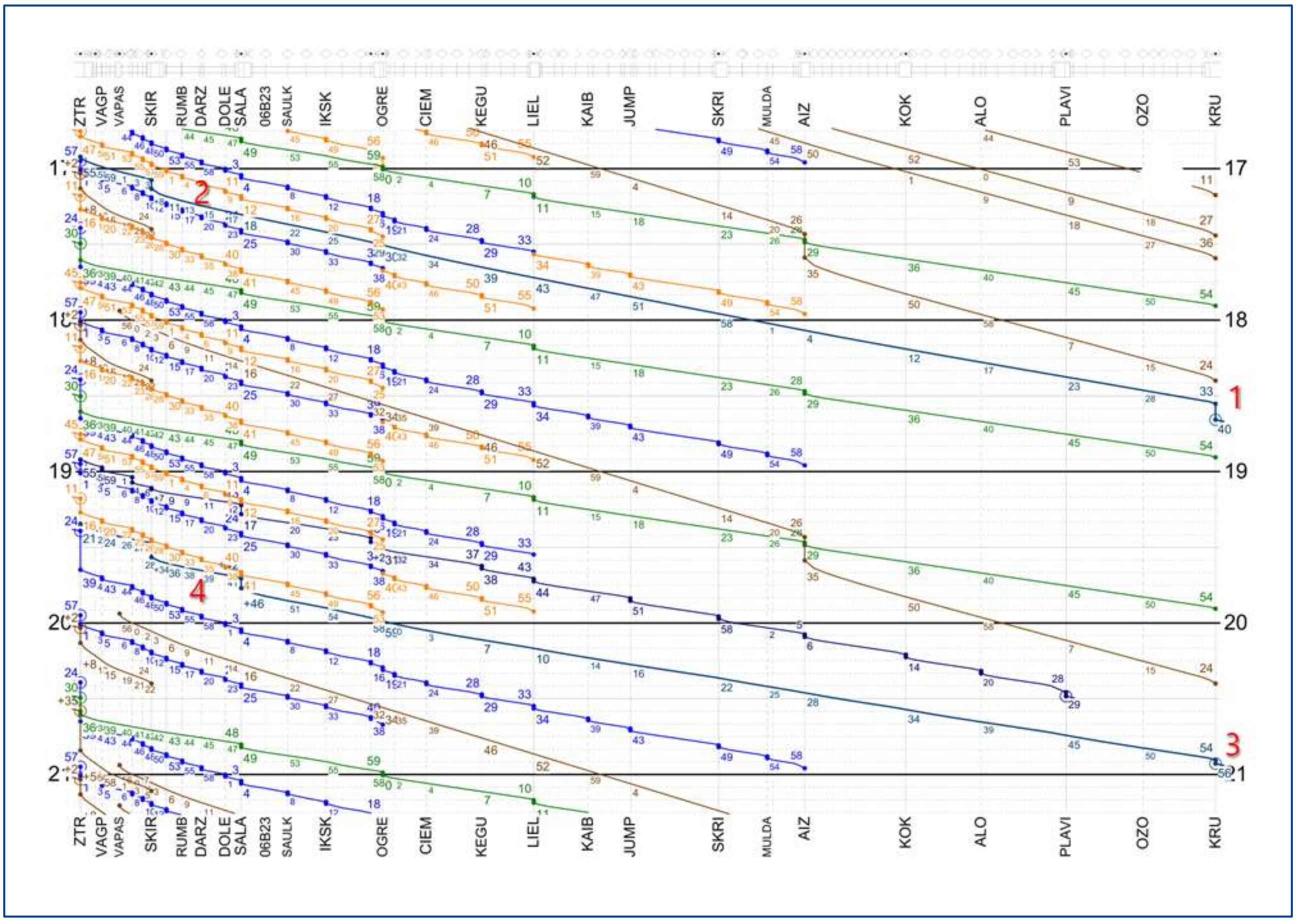


FIGURE 64: EVENING NIGHT TRAIN OUTBOUND FROM RIGA

The situation in the afternoon/evening when the night trains are leaving Riga for Moscow/St. Petersburg (first train) and Minsk (second train) is depicted in Figure 64 above and described below. Again, reference to the numbers indicated in Figure 64 is made.

1. Leaving night train to Moscow / St Petersburg.

2. Operational stop in Šķirotava (SKIRO). Alternatively, a run-time supplement could be integrated into the timetable to avoid operational stops.

3. Leaving night train to Minsk.

4. For the night train to Minsk, operational stops in Šķirotava (SKIRO) and Salaspils (SALA) are required. Alternatively, additional run-time supplements could be provided in the timetable to avoid operational stops.

5.5.2. Corridor Riga – Tukums – Ventspils

In this chapter, the timing of the suburban and regional services between Riga, Sloka and Tukums during the peak-hours and during the off-peak and the resulting line utilisation are described. The operating suburban CT/EV services and regional RE services are shown in Figure 65 below. Diesel CT services (CT 12) and slots for freight trains (FR 1.15 and FR 1.45) divert in Zasulauks towards Bolderāja and Daugavgrīva. They will be described in Chapter 5.5.5 on page 170 as part of the corridor Daugavgrīva – Riga – Sigulda – Valga.

On this corridor the suburban line "CT 1" Tukums – Riga – Skulte operates and consists of 4 train pairs per hour and during the peak hour (orange and blue lines) and 2 train pairs per hour and direction during off-peak (blue only). The train pairs are marked with additions according to the time they run through Riga Central. For example, CT 1.30 runs through Riga during the half hour in the 30-minute node. Orange marked track sections show additional services and extension of suburban services beyond their usual terminus station during the peak-hour.

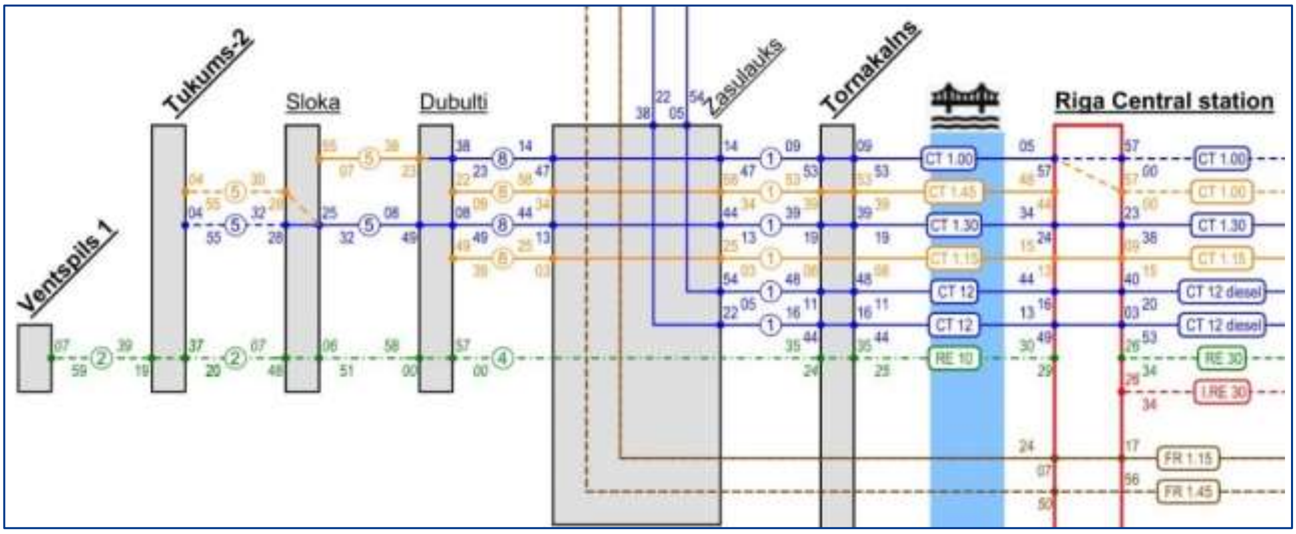


FIGURE 65: SERVICE PATTERN ON THE CORRIDOR RIGA-TUKUMS-VENTSPILS

Service pattern during peak-hour

The suburban services CT 1.00, CT 1.30 and CT 1.15 are run-through services through Riga to the corridor Riga-Skulte (service pattern described in Chapter 5.5.4 on page 166). The regional service RE 10 between Riga and Ventspils, the suburban rush-hour service in the 45-minute node (CT 1.45) and every second suburban service in the full hour (CT 1.00) during the off-peak are terminating in Riga.

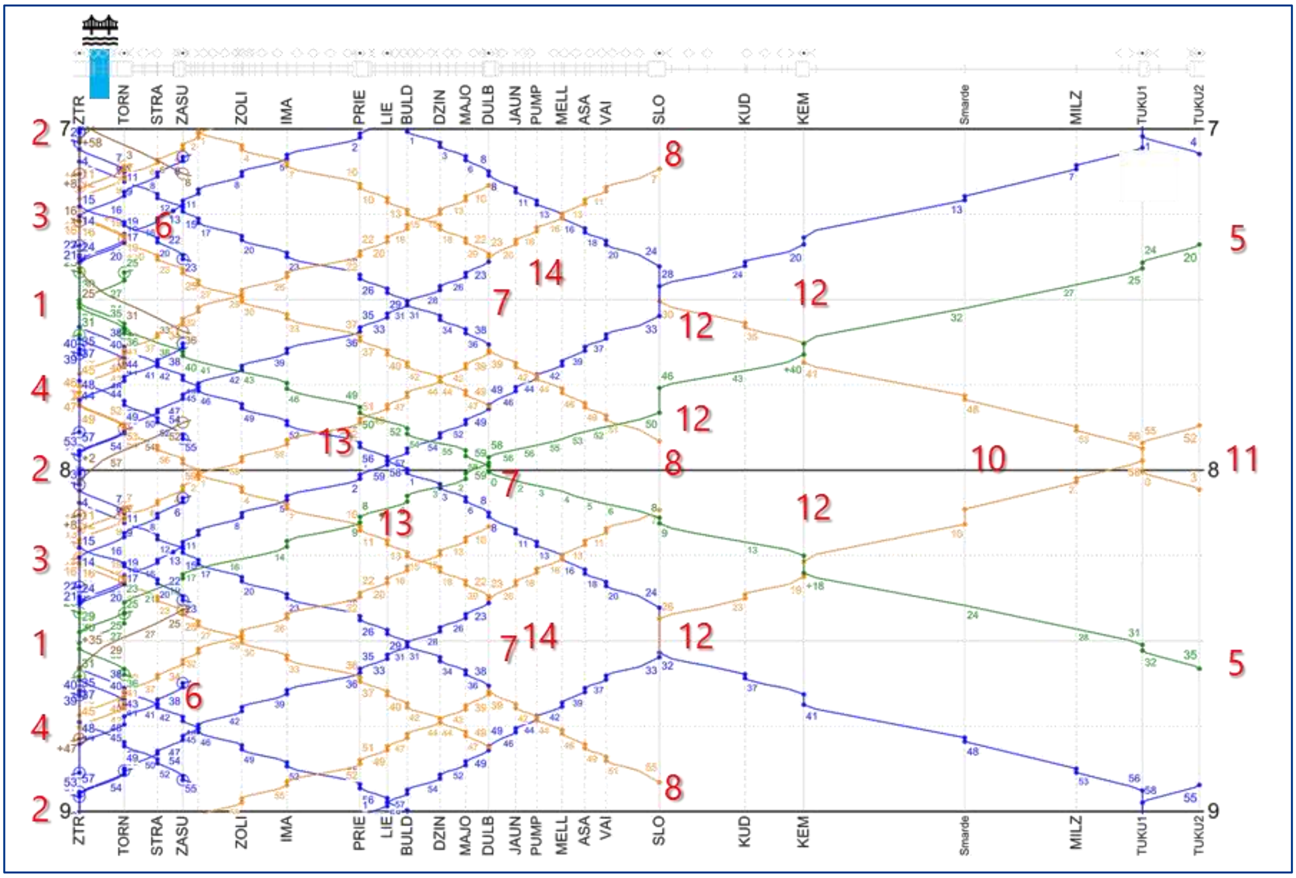


FIGURE 66: GRAPHICAL TIMETABLE CORRIDOR RIGA-SLOKA-TUKUMS-II DURING PEAK-HOUR

In Figure 66 above the service pattern during the peak-hour between 7 am and 9 am is showing the general concept and structure of the services pattern and repeats every 2 hours. The same concept is being repeated during the afternoon rush hour between 4 and 7 pm. Inbound and outbound suburban (CT/EV) and regional (RE) services arriving and departing in Riga Central station according to the clock-face scheduling timetable principles of the cyclic timetable (described in Chapter 5.3).

Description of the peak-hour service pattern of suburban (CT/EV), regional (RE) and freight trains (see Figure 66 above, reference numbers relate to situation indicated in the figure):

1. In the **30-minute node** the hourly CT 1.30 (blue) between Riga (ZTR) and Tukums-II (TUKU2) and the 2-hourly RE 10 (green) between Riga and Ventspils operate. The CT 1.30 departs after the faster RE 10 and arrives before the faster RE 10 in Riga Central station (ZTR). Additionally, a slot for an hourly freight train (brown) between Šķirotava freight yard and Bolderāja alternately in a 2-hourly pattern as forerunner or follower in the opposite direction is being used in the track section between Riga and Zasulauks.

2. In the **00-minute node** the hourly CT 1.00 between Riga (ZTR) and Sloka (SLO) runs through Riga (ZTR) at the full hour. During rush-hour the train is an hourly run through service to the corridor Riga-Skulte and is extended hourly to Sloka (orange line section) instead of terminating in Dubulti (DULB).

3. In the **15-minute node** only during peak-hour the hourly CT 1.15 (orange) operates hourly between Dubulti (DULB) and Carnikava (on the corridor Riga-Skulte). Additionally, the 30-minute diesel CT 12 service between Daugavgrīva and Sigulda operating shortly behind the CT 1.45 to Riga as follower and as forerunner in the opposite direction on the track section between Riga and Zasulauks (ZASU).

4. In **45-minute-node** only during peak-hour the CT 1.45 (orange) operates hourly between Dubulti (DULB) and Riga (ZTR). Additionally, the 30-minute diesel CT 12 service between Daugavgrīva and Sigulda operating shortly behind the CT 1.45 to Riga as follower and as forerunner in the opposite direction on the track section between Riga and Zasulauks (ZASU).

5. Regional service RE 10 operates 2-hourly between Riga (ZTR and Ventspils) departing at the odd hour (7.30) from Riga (ZTR) and arriving at the even hour (8:30) in Riga (ZTR) serving the important 8:30-node with connection to all important regional, suburban services and single train pairs in Latvia.

6. At the station Zasulauks the suburban diesel CT 12 service every 30 minutes and an hourly freight train service diverts to Bolderāja and Daugavgrīva.

Terminating of suburban CT 1 services on the corridor and capacity bottlenecks:

7. The suburban peak-hour services CT 1.15 and CT 1.45 terminate in Dubulti (DULB) every 30 minutes and turnaround from/to the CT 1.15 from/to the CT 1.45 having roughly 15 minutes for the process. The services use the middle track of Bolderāja (DULB) to avoid at grade crossing conflicts with other trains.

8. The CT 1.00 is terminating hourly in Sloka (SLO) during the peak-hour from minute 55 to minute 07 within 12 minutes using one of the two available platforms in Sloka. The second platform is used for stopping regional train pairs between Riga and Ventspils during the rush-hour at the same time.

10. Capacity on the track section between Ķemeri and Tukums-II is limited by a single track and single block section. This limits the number of trains to about 3 per hour.

11. During the rush-hour the CT 1.30 is extended hourly to Tukums-II (orange line section, 12) instead of terminating every second hour in Sloka. Due to the meeting with CT and RE services on the single-track section Sloka-Tukums-II during rush-hours only (also point 12) the travel times are extended and avoid a short turnaround on the CT 1.30 in the opposite direction resulting in a 31st required electric rolling stock during the rush-hour.

12. During peak-hour RE and CT services have increased travel time due to crossings in Ķemeri and Sloka. During peak-hour the RE 10 services must stop in Ķemeri although it is not in their regular stopping pattern.

13. This increases the travel time of RE 10 by about 10 minutes between Riga and Tukums-2. To harmonize travel and dwell times RE trains stop additionally in Priedaine, Majori and Bulduri.

14. Single freight train paths are possible during peak-hour between Torņakalns and Ķemeri in both directions as diverted freight train to Bolderāja and Daugavgrīva. Capacity limitation (described in point 10) do not allow for a fourth freight train on the section between Ķemeri and Tukums.

It has to be noted that currently there is only one electrified platform track in Tukums-1 station. This means that for the targeted master timetable the second platform track must be also equipped with overhead line to support meeting of two trains meeting in Tukums-1 station. Alternatively, the timetable must be slightly adjusted. One solution would be to terminate the peak-hour trains in Tukums-1 providing a short turnaround. This would also save one rolling stock. Disadvantage of this approach is that Tukums-2 is not served by the proposed CT peak-hour services.

Adjusted service pattern during off-peak:

During the off-peak no CT 1 peak-hour services (CT 1.15 and CT 1.45) and extended mainline suburban services (marked in range in Figure 66) operate on the corridor. This results in a more relaxed service pattern and in longer turnaround times in general allowing for additional freight train slots on the corridor and between Riga and the Harbour.

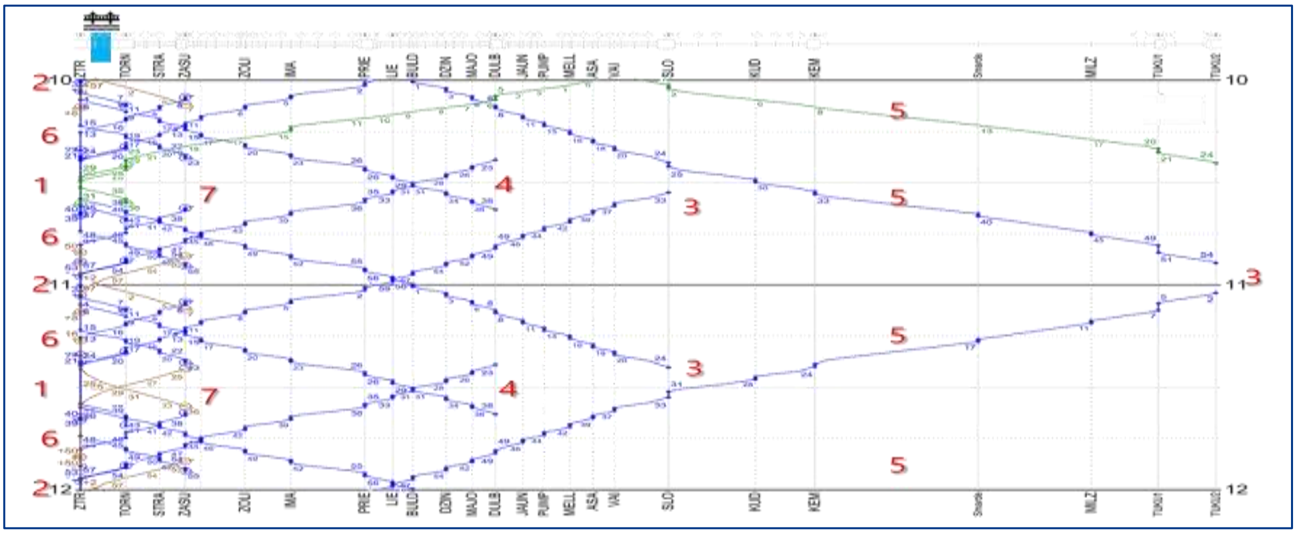


FIGURE 67: GRAPHICAL TIMETABLE OF CORRIDOR RIGA-TUKUMS-II DURING OFF-PEAK

1. The **30-minute-node** will be served unchanged over the day during peak-hour and off-peak. CT1.30 and RE10 will offer connections to fast and suburban services on other corridors.

2. The **00-minute-node** will be served unchanged over the day during peak-hour and off-peak. CT1.00 will offer connections to suburban services on other corridors.

3. Hourly CT 1.30 will only be extended every 2 hours to Tukums-II (TUKU2) and will terminate every 2 hours in Sloka (SLO). Tukums-II a short turnaround time of 8 minutes is possible and can be used to reduce the number of electric rolling stock during the off-peak.

4. Hourly CT 1.00 will terminate in Dubulti with a turnaround time of roughly 40 minutes.

5. Travel time of regional and suburban services can be reduced due to less trains per hour on the track section Ķemeri-Tukums-2.

6. Hourly freight train paths through Riga Central station are possible during off-peak hours using the 15- und 45-minute-node of the suburban peak-hour services.

7. Hourly freight train paths between Zasulauks and Bolderāja can also be extended to Ķemeri and to Tukums-II during off-peak hours.

Selected RE 10 services to Ventspils

In Figure 68 below the graphical timetable for the RE 10 between Riga (ZTR) via Tukums II (TUKU2) and Ventspils (VENT1 and VENT 2) is shown.

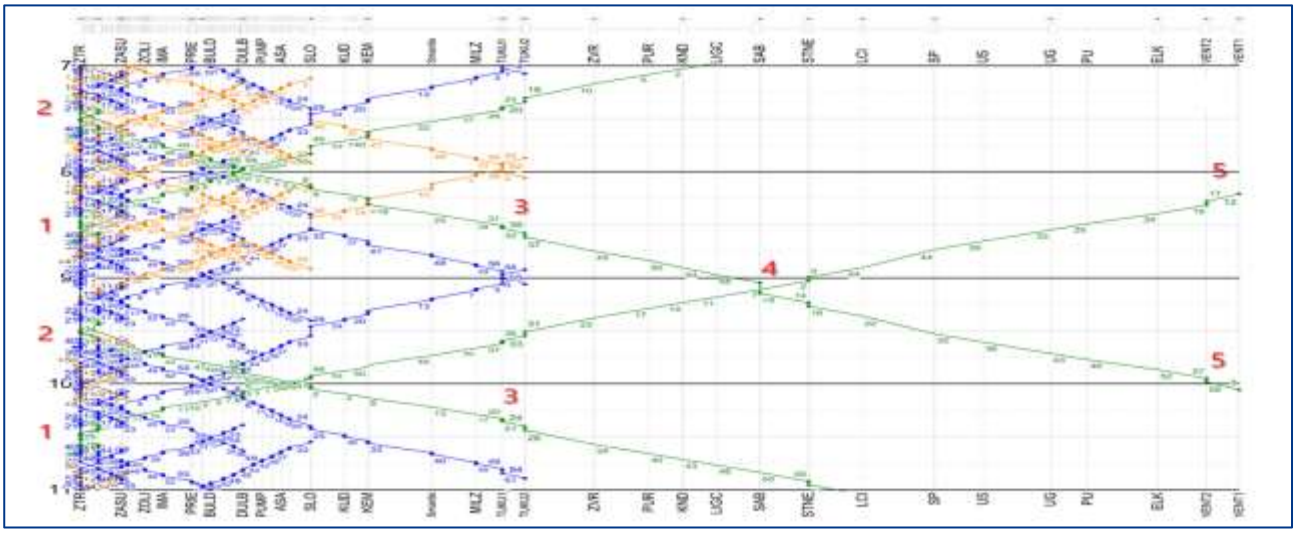


FIGURE 68: GRAPHICAL TIMETABLE RE 10 TO VENTSPILS BETWEEN 7 AND 11 AM

1. The RE 10 operates as regional service 2-hourly between Riga and Ventspils. In the even hours the RE is running inbound and terminates in Riga on track 3 in the 30-minute node

2. 2-hourly in the odd hour the RE 10 run outbound to Ventspils and begins on track 3 in Riga in the 30-minute node.

3. The RE 10 runs through Tukums around the 30-minute node. During peak-hours (around 7:30 and 8:30 o´clock) the service runs through Tukums about 10 minutes earlier/later due to meeting with CT 1.30 in

Ķemeri. This suburban line is extended to Tukums hourly which results in the meeting. During the off-peak the trains can run nonstop between Sloka and Tukums resulting in a 10 minutes shorter travel time on that track section.

4. Trains of the RE 10 in load direction have a higher priority. Trains in opposite direction must have operational stops to meet trains in the opposite direction, increasing the travel time by about 10 minutes.

5. This results in different arrival and departure times of the RE 10 in Ventspils which can differ up to 10-20 minutes.

Increasing the open line speed or avoid meeting with trains on the single-track section Sloka-Tukums during peak-hour could result in a meeting of the RE 10 in the station Stende (STNE).

In general, the infrastructure of the corridor is suitable for a 15-minute interval of suburban services during the rush-hour. Also, the number of station tracks and the available time for turning trains around is seen as sufficient to operate the proposed service pattern over the whole day.

Only the track section Sloka-Ķemeri-Tukums-II is seen as a bottleneck. It results in additional required rolling stock and increased travel time of 10 minutes during the rush-hour. Regarding the fact that the City of Tukums has about 18,000 inhabitants, a 2-hourly suburban service is seen as too low to tap the potential passenger demand. Here it is recommended to increase the number of trains to Tukums and to provide partially double track between Ķemeri and Smārde.

5.5.3. Corridor Riga – Jelgava – Šiauliai/Liepaja

Service pattern of suburban and regional service on the corridor Riga-Jelgava is quite simple compared to other corridors. All suburban and regional services operate over the whole line (shown in Figure 69 below). Regional services will be extended hourly to Dobele and every two hours to Liepaja in one direction during peak-hour.

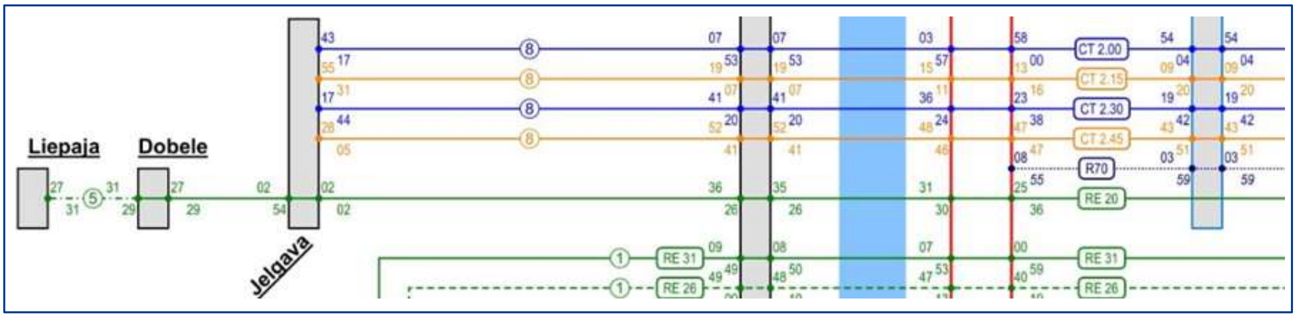


FIGURE 69: SERVICE PATTERN ON TEH CORRIDOR RIGA-JELGAVA-LIEPAJA

Service pattern during peak-hour

The typical service pattern on the corridor Riga-Jelgava during the peak-hours is shown in Figure 70 below.

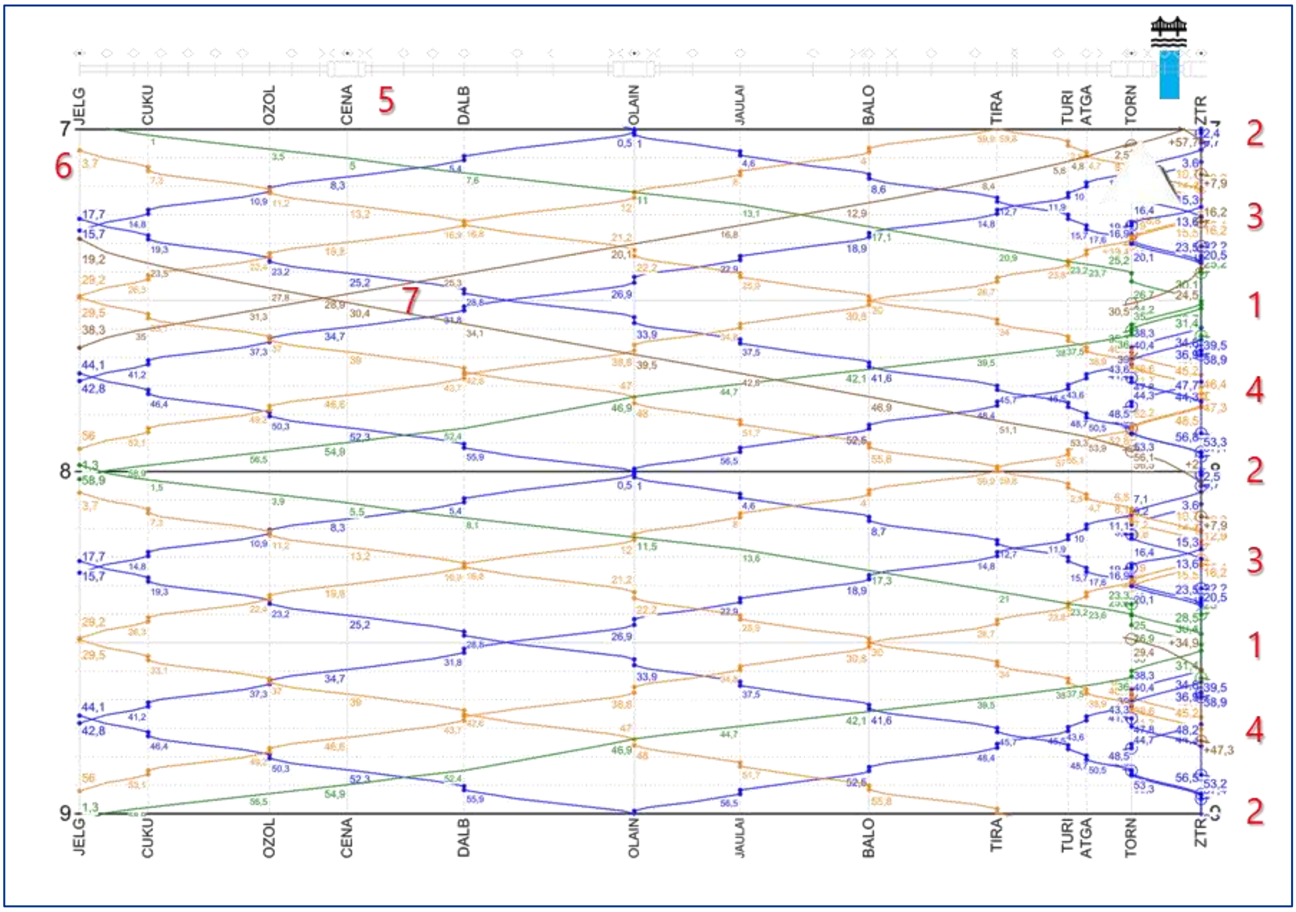


FIGURE 70: GRAPHICAL TIMETABLE OF CORRIDOR RIGA-JELGAVA DURING PEAK-HOURS

The general characteristics of the service pattern are described in the point below:

1. In the **30-minute-node in Riga Central station** the hourly suburban line CT 2.30 between Jelgava-Riga-Aizkraukle and the hourly RE 20 from/to Daugavpils and Rēzekne operate. The suburban line CT 2 is running as forerunner to Riga and follower behind the RE 20 when leaving Riga Central station towards Jelgava. The regional service is a nonstop service between Riga and Jelgava.

2. In the **00-minute-node in Riga Central station** the suburban line CT 2.00 between Jelgava-Riga-Lielvārde operates.

3. In the **15-minute-node in Riga Central station** the peak-hour suburban service CT 2.15 between Jelgava-Riga-Ogre operates.

4. In the **45-minute-node in Riga Central station** the peak-hour suburban service CT 2.45 between Jelgava-Riga-Ogre operates.

5. Cena (CENA) station is not considered as a passenger stop for suburban services already.

6. During peak-hour no short turnarounds in Jelgava (JELG) are possible. Suburban services will wait 15 minutes for next service in opposite direction to turn around. All services arrive and depart in one of the 15-, 30-, 45- and 00-minute nodes. This allows to connect these services to local public transport services.

7. Additionally, hourly freight train slot during peak-hour are possible (one freight train per hour per direction). These trains have to use the same slots over the Daugava River bridge as the freight trains from and to Daugavgrīva, which means either one hourly service can be operated to Daugavgrīva or to Jelgava. Entering freight trains from the east avoiding the required freight train slots around the full hour in Torņakalns.

Adjusted service pattern during off-peak:

During the off-peak suburban services operate in 30-minute interval. The RE 20 is only operation every two hours.

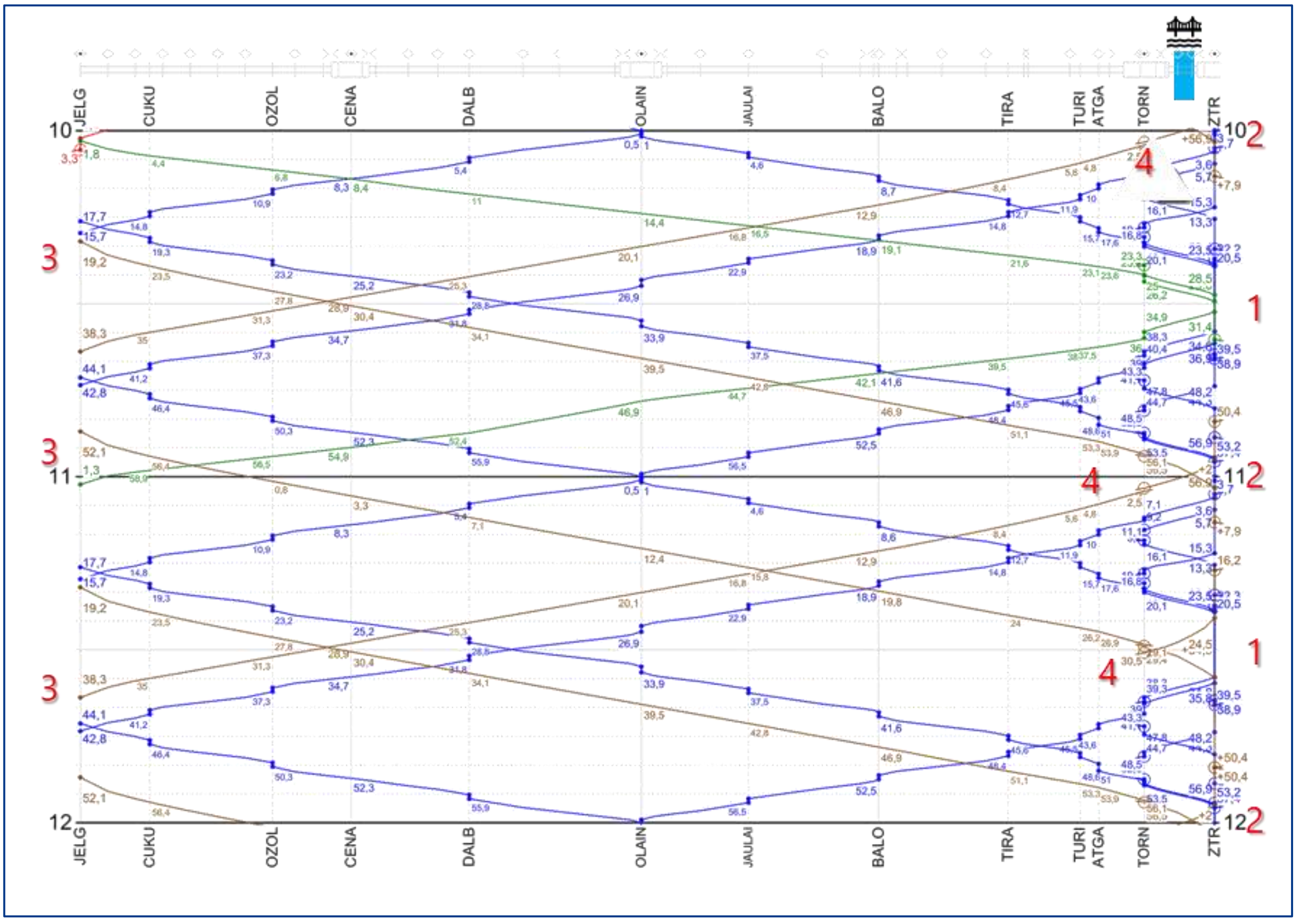


FIGURE 71: GRAPHICAL TIMETABLE OF CORRIDOR RIGA-JELGAVA DURING OFF-PEAK

1. The **30-minute-node in Riga Central station** will be served unchanged over the day during peak-hour and off-peak. The suburban CT 2.30 and the regional RE 20 will offer connections to fast and suburban services on other corridors.

2. The **30-minute-node in Riga Central station** will also be served unchanged over the day during peak-hour and off-peak, offering connections between suburban services on other corridors.

3. During the off-peak stable turnaround times of 30 min are possible in Jelgava (JELG).

4. During off-peak 2 freight trains per hour in both directions are possible. They use the same freight trains slot of the freight trains to Daugavgrīva.

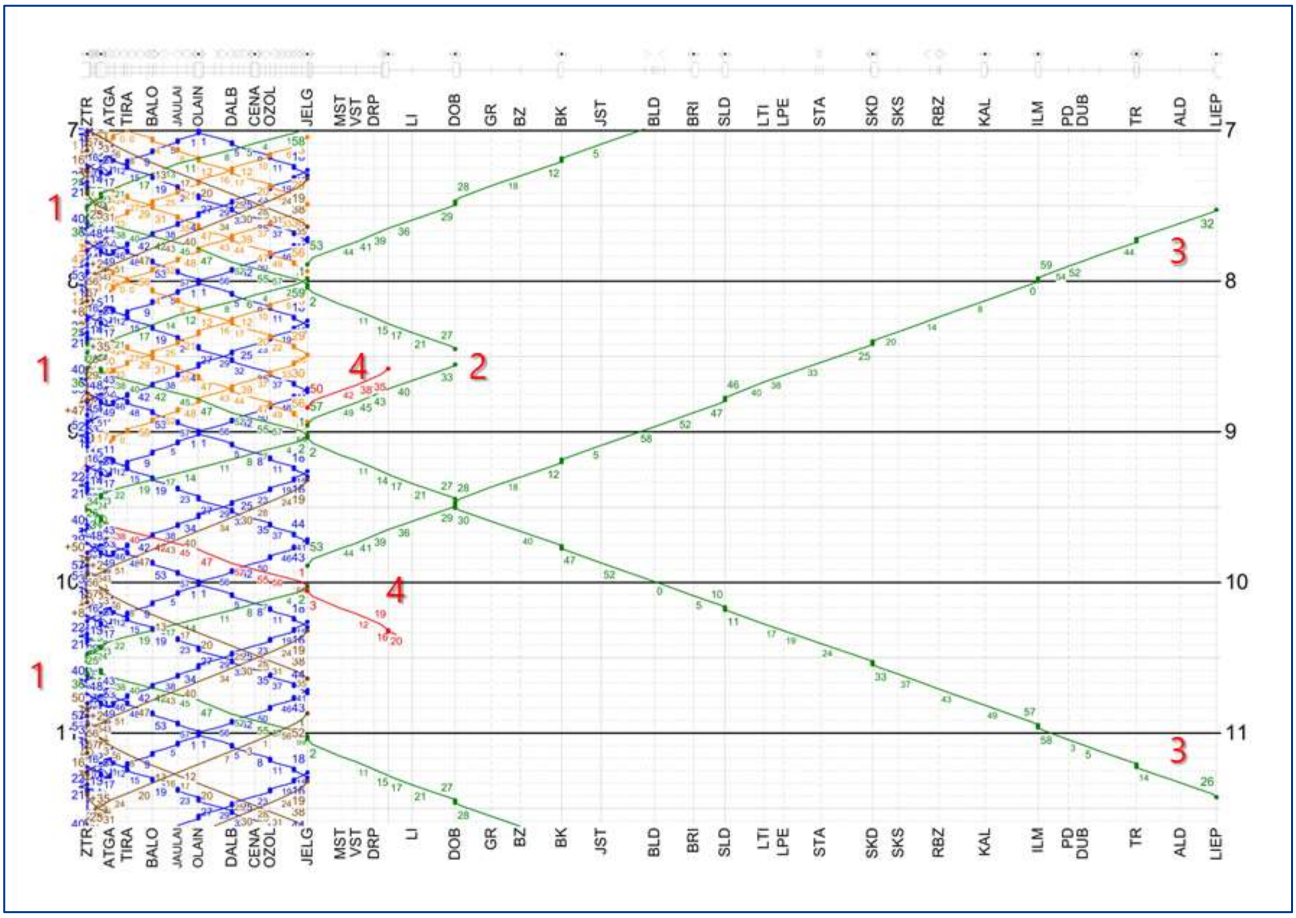


FIGURE 72: REGIONAL SERVICE RE 20 RIGA-JELGAVA-DOBELE-LIEPAJA

In Figure 72 above the infrastructure utilisation of the RE 20 train pairs to Liepaja, Dobele and international cross-border services (red) are shown.

1. All regional services are connected to the hourly 30-minute node in Riga Central station (ZTR).

2. During peak-hour hourly regional services will operate between Riga-Jelgava-Dobele. Here a minimal Turnaround time of 6 minutes is applied. Also, regional trains pairs from and to Liepaja met in Dobele (DOB)

3. Due to the limited capacity between Dobele (DOB) and Liepaja (LIEP) 2-hourly trains pairs of the RE 20 run in one direction at a time only with the earliest useful station to meet in Dobele (DOB). Other Stations The trains arrive and depart in Liepaja (LIEP) around the 30-minute node.

4. Since only one slot per hour is available to connect regional services to Riga Central station, international services could begin/terminate in Jelgava (JELG) at the third platform and offer connections to suburban and regional services from and to Riga. Also unused slots of the RE 20 during off-peak could be used to connect international service from Šiauliai directly with Riga Central station.

Speed upgrade on the corridor to Liepaja to at least 120 km/h open line top speed could allow a more efficient use of the infrastructure. RE 20 services could then also meet in Saldus (SLD) with trains in the opposite direction. RE 20 services would than – due to travel time reduction – terminate in Liepaja at the full hour (00-minute node) and meet with beginning services in the opposite direction. This would allow a 2-hourly regional service in both directions at the same time while regional service would hourly operate between Riga-Jelgava-Dobele.

5.5.4. Corridor Riga – Skulte

In this chapter the service pattern on the corridor Riga-Skulte is described. The corridor is served by the suburban CT 1 passenger line as through service Skulte – Riga Central – Tukums. Three suburban services operate during the rush-hour and 1.5 during off-peak on the corridor to Skulte. Not all services are operated over the full length of the line. Depending on the daytime (peak-/off peak) trains are also terminated at intermediate destinations - Saulkrasti and Carnikava on the Riga – Skulte line and Dubulti and Sloka on the corridor to Tukums. Train services on the Skulte corridor are integrated in the 00-, 30- minute node (all day) and in the 15-minute node (only in peak hours). Resulting from the possible arrivals and departures in Riga and the single-track sections north of an approximate 20 minute service pattern can be provided in peak hours on the most occupied line section (Riga – Carnikava). In the future the provided timetable could be developed further to provide a regular 30-minute interval in off-peak hours.

Additionally, an hourly freight train slot between Zemitāni, Brasa and Mangali is reserved (shown in Figure 73 below).

Since on the corridor Riga – Skulte a lower number of suburban services per hour is required (up to three train pairs per hour) compared to the corridor to Tukums (four train pairs per hour during peak times on the most occupied sections) some of the trains have to terminate in Riga Central when arriving from Tukums.

Also, the future infrastructure improvement between Mangali (MANGA) and Ziemeļblāzma (ZIEM) has been considered already (shown in Figure 74 below). Here the current single-track section between these stations will be improved to double track. For the currently developed service pattern the additional infrastructure is not required.

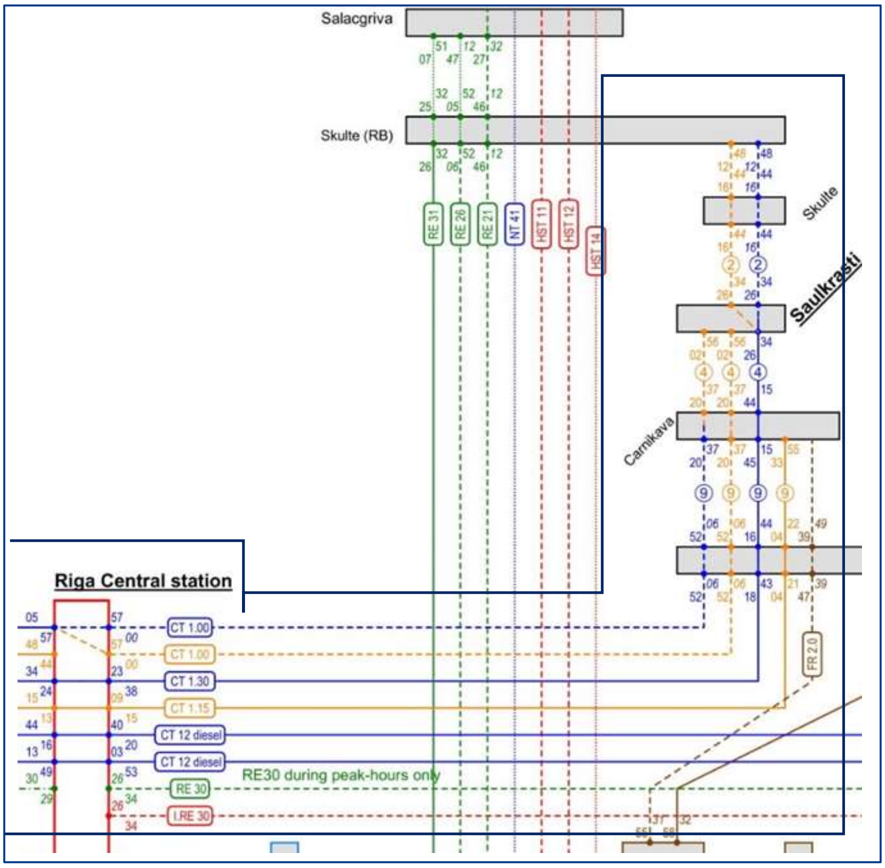


FIGURE 73: SERVICE PATTERN ON THE CORRIDOR RIGA-SKULTE

Service pattern on the corridor Riga-Skulte during peak-hour:

In Figure 74 below the service pattern during the peak-hour between the 7 and 9 am is showing the general concept and structure of the services pattern and repeats every 2 hours. The same concept is being repeated during the afternoon rush hour between 4 and 7 pm. Inbound and outbound suburban (CT/EV) services arriving and departing in Riga Central station according to the clock-face scheduling timetable principles of the cyclic timetable.

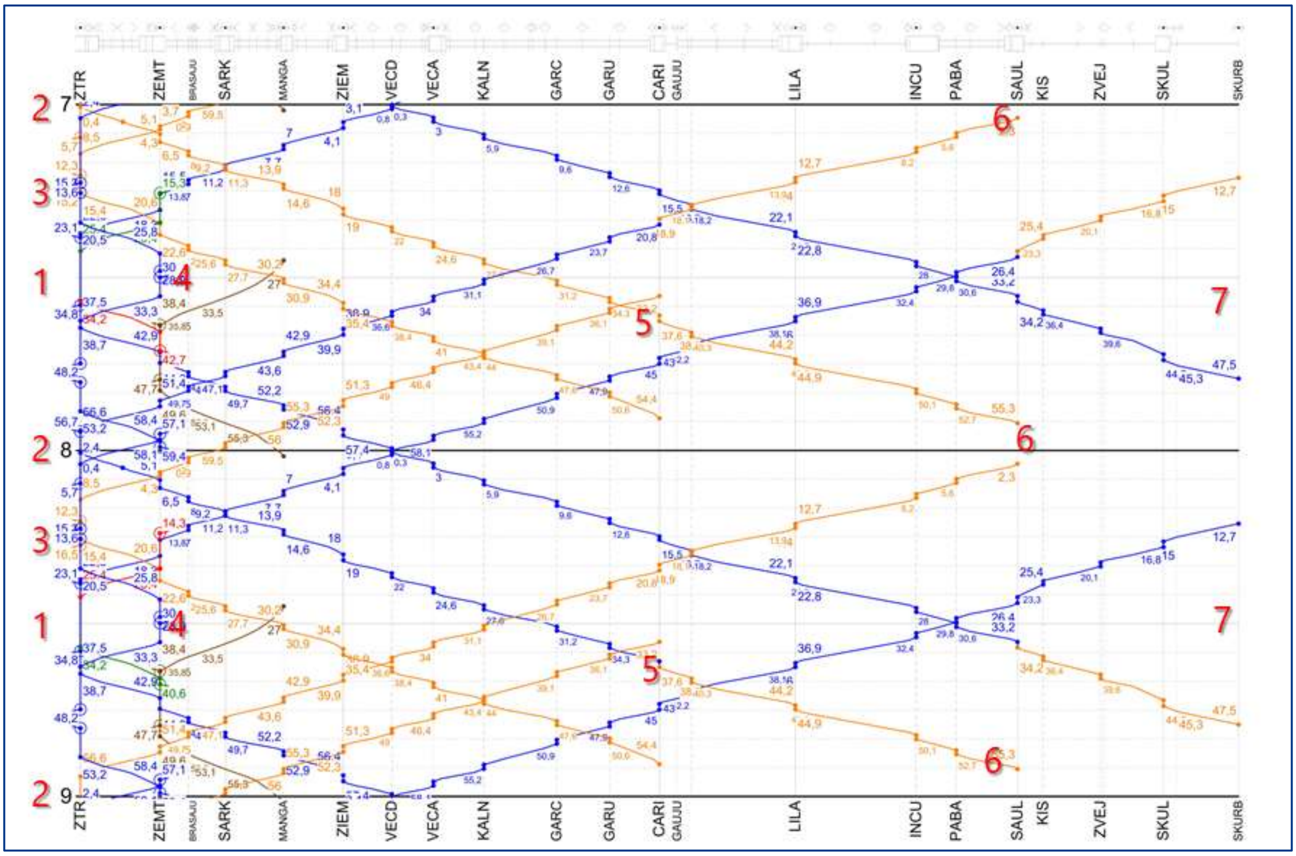


FIGURE 74: GRAPHICAL TIMETABLE OF THE CORRIDOR RIGA-SKULTE DURING PEAK-HOUR

Description of the peak-hour service pattern of suburban (CT/EV) and freight trains (see Figure 74 above):

1. In the **30-minute node** the hourly CT 1.30 (blue) between Riga (ZTR) and Skulte (RB) (SKURB) The CT 1.30 departs after and arrives before the faster RE/I.RE 30 (green and red) in Riga Central station (ZTR).
2. In the **00-minute-node** during peak-hour the CT 1.00 operates hourly (blue and orange) between Saulkrasti-Riga-Sloka.
3. In the **15-minute-node** and only during the peak-hour the CT1.15 operates hourly in an asymmetric pattern between Carnikava-Riga-Dubulti.
4. Regional services from/to Sigulda and Valga (shown in red and green) are branching of in Zemitāni as forerunner and follower in the opposite direction.
5. Peak-hour suburban service CT 1.15 are terminating in Carnikava (CARI) hourly with a turnaround time of roughly 30 minutes.
6. CT 1.00 is terminating hourly in Saulkrasti during peak-hour with a short turnaround time of 6 minutes.

7. CT1.30 is operating hourly on the whole line during peak-hour and is already extended to the new 1435/1520 mm station Skulte (RB) with a turnaround time of 26 minutes.

Service pattern on the corridor Riga-Skulte during off-peak:

During off-peak the service pattern on the corridor is much more relaxed giving the suburban services an enough time to turn around (roughly one hour) and to reduce possible build up delays during the peak-hours.

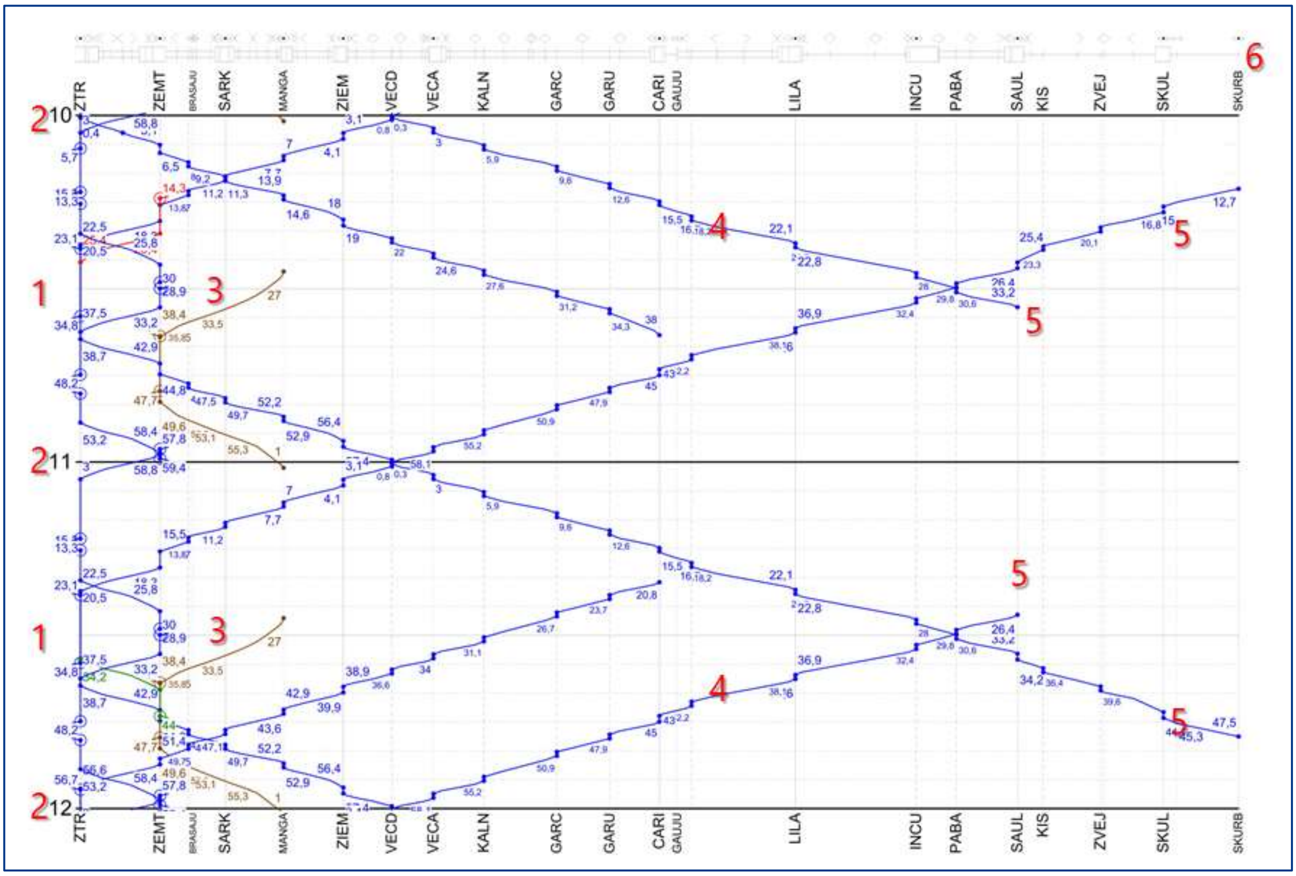


FIGURE 75: GRAPHICAL TIMETABLE OF THE CORRIDOR RIGA-SKULTE DURING OFF-PEAK

1. The **30-minute-node** in Riga Central station (ZTR) will be served unchanged over the day during peak-hour and off-peak. CT1.30 of the suburban line CT 1 will offer connections to fast regional and suburban services on all other corridors.

2. The **00-minute-node** in Riga Central station (ZTR) will be service unchanged over the day during peak-hour and off-peak, offering connections to suburban services on the other corridors.

3. During off-peak an hourly path for freight trains (FR2.0) on the track section Zemitāni (via Riga bypass) to the branch lines Brasa and Mangali is reserved. Only one slot per direction can used by a freight train. This allows to operate hourly freight trains in one direction or to switch the direction of freight trains 2-hourly. In the figure above the freight trains in both directions are shown.

4. CT 1.00 is only two-hourly a through service between Dubulti, Riga and Carnikava with a turnaround time of 40 minutes in Carnikava (CARI) from the 15-minute node to the 45-minute node.

5. During the off-peak the hourly CT 1.30 is terminating two-hourly in Saulkrasti and every two hours in Skulte. In Saulkrasti the service has a luxury turnaround time of roughly on hour. Every two hours the service is extended to Skulte. Then the trains turn around every 2 hours from odd three-quarter hour to the even quarter hour within 30 minutes.

6. The potential new intermodal 1435/1520 mm station Skulte (RB) is considered in the service pattern already. CT 1.30 terminates every two hours in Skulte or Skulte (RB). This extends the travel time on the corridor around 3 minutes.

5.5.5. Corridor Daugavgrīva - Riga – Sigulda (– Valga – Tartu)

To describe the suburban diesel line CT 12, two corridors (Daugavgrīva – Zasulauks – Riga and Riga – Sigulda) are shown together in Figure 76 below. For the corridor section Daugavgrīva – Bolderaja – Zasulauks (DAUGRI – ZASU) a complete expansion to double-track is assumed. Otherwise a 30-minute interval of suburban services and freight trains – additionally fixed in their timing through Riga Central station – is not possible. Further theoretical improvements with block signals to allow the required minimum train headway times, platforms for new stops, or the improved connection of Zasulauks for parallel entry and exit of passenger and freight trains were not considered yet.

The service pattern during peak-hour between Daugavgrīva and Sigulda via Riga is shown in Figure 76 below. The specifics of the chosen solution will be described below with reference to the numbers indicated in the figure.

Peak-hour service pattern between Riga and Sigulda

1. The regional service RE 30 (green) and the extensions as international service I.RE 30 (red) to Valga and Tartu is connected hourly to the **30-minute node in Riga Central station**. Services are terminating on track 1 and beginning on track 2 at the same time during peak-hour. During peak hour the RE 30 operating hourly between Riga (ZTR) and Sigulda (SIGU) to form up to 3 train pairs per hour and direction (together with the 30-minute interval of the CT 12) during the peak-hour as required. In the 30-minute node the RE 30 has connections to all other suburban and regional lines and corridors.

2. The diesel suburban line CT 12 is operating in a 30-minute interval between Daugavgrīva-Riga-Sigulda (blue and orange line) during the peak-hour and is connected to the **15-minute node in Riga Central station** with a longer dwell time in Riga to synchronise with the available slots on both corridors.

3. Limitations on the corridor Riga-Sigulda and limited capacity in Riga Central station lead to a longer dwell times for regional and suburban services in Zemitāni. All services are assumed to stop to stop at the proposed

new stopping points Teika and Alfa in both directions. This is advantageous to tap the full passenger demand potential but also contributes to shortening of the dwell needed to synchronize the slots at Zemitāni.

4. Additional dwell time is also foreseen for the CT 12 in the **45-minute node in Riga Central station**. Here the suburban diesel line is connected to the 45-minute node with a longer dwell time in Riga Central to synchronize with the available slots on both corridors (Riga – Sigulda / Riga – Zasulauks).

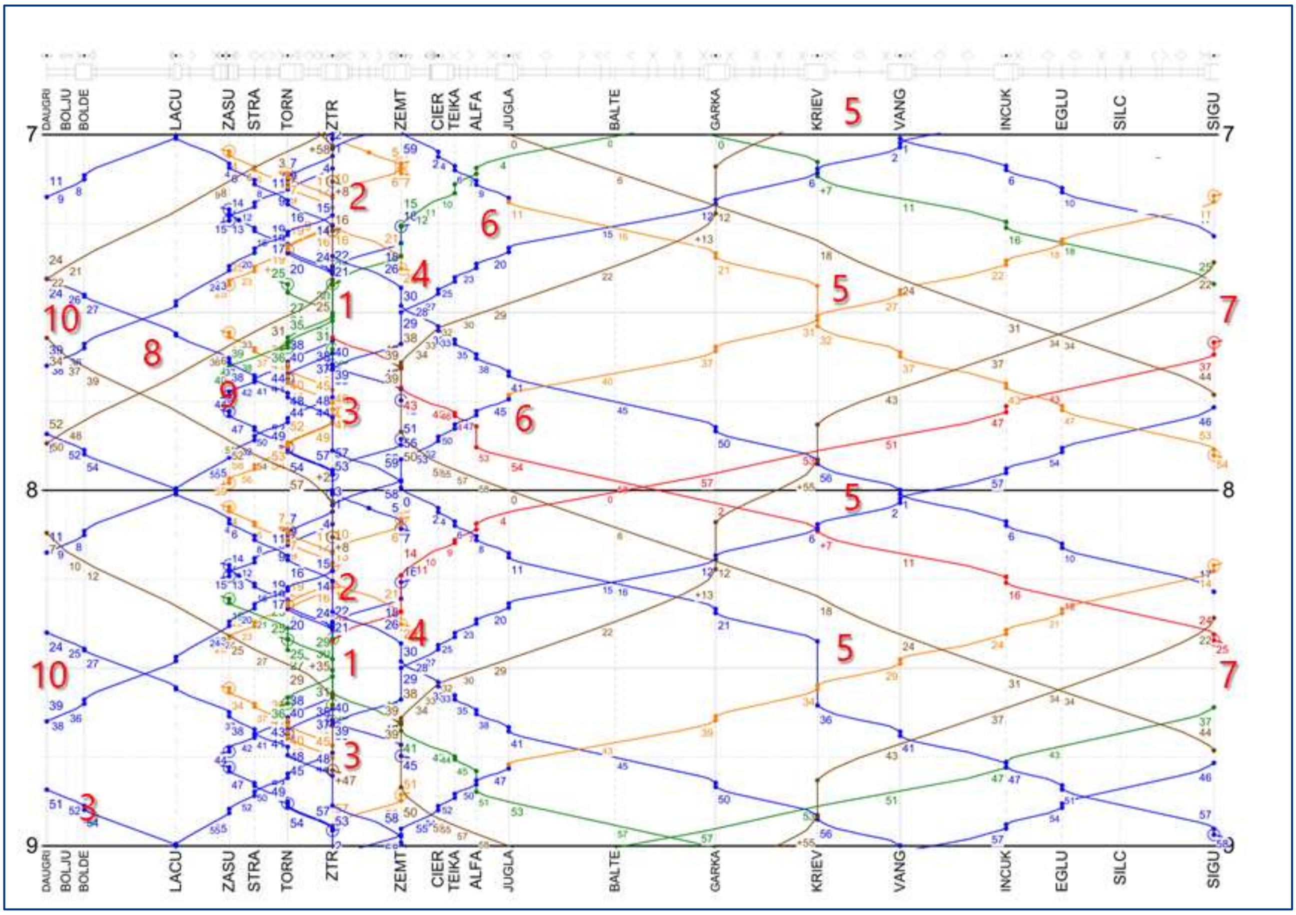


FIGURE 76: GRAPHICAL TIMETABLE CORRIDOR CT 12 DAUGAVGRĪVA-RIGA-SIGULDA PEAK-HOUR

5. The central limitation on the double-track section Riga-Sigulda is the single-track section between Krievupe and Vangaži. This single-track section is located more or less halfway between Riga and Sigulda. Travel time on this track section is roughly 1 hour between Riga and Sigulda forming 00- and 30-minute nodes in this symmetric fixed interval service pattern. This means that all services in both directions meet after 30 minutes on this single-track section and results either in tight operations of trains in both directions at the full hour or does not work at all at the half hour. Here the suburban services have a long dwell time to wait for services in the opposite direction. This longer dwell time has direct consequences for these trains missing their time window on the single-track section Sigulda-Valmiera-Valga. Therefore, double tracking of the short section Krievupe and Vangaži is highly recommended.

6. The suburban diesel line CT 12 is operating every 30 minutes between Daugavgrīva-Riga-Sigulda. During off-peak the service is terminating hourly in Jugla.

7. Suburban services are turning around in Sigulda around the 00- and 30-minute node within 20 minutes. Also, during peak-hours line RE 30 (green line) is terminating in Sigulda 2-hourly having one hour for turning around.

Service pattern of freight trains and line CT 12 on the section Riga Central – Zasulauks – Daugavgrīva

8. The available slot in Riga Central station fixes the timing of freight and passenger trains on the corridor Zasulauks-Daugavgrīva. This results in meeting of trains on today single-track sections. That is why the track section has been assumed to be completely in double-track.

9. To consider the spatial restraints in Zasulauks, meeting of passenger trains of the CT12 on the third platform in Zasulauks when entering and leaving the corridors has been avoided. But parallel running of freight and passenger trains in Zasulauks could not been avoided. In case that suburban and freight trains operate in parallel on the corridor Daugavgrīva-Zasulauks a double track access to Zasulauks should be possible. Then freight trains can use other tracks in Zasulauks while the CT 12 uses the third platform.

10. CT 12 service can turn around in Daugavgrīva around the 15- and 45-minute node within 12 minutes. When the additional stops between Lāčupe (LACU) and Zasulauks (ZASU) have been applied the simple turnaround on the next train in the opposite direction is not possible anymore. Then additional platforms in Daugavgrīva and rolling stock is required for operating the 30-minute interval of the CT 12.

Adjusted service pattern during off-peak (Figure 77)

1. During off-peak the RE 30/I.RE 30 operates every 2 hours between Riga-Sigulda-Valmiera and Valga. Currently services terminate and begin in different hours to relax the service pattern.

2. The CT 12 operates unchanged through the 15- und 45-minute node Riga Central in a 30-minute interval over the whole day between Daugavgrīva-Riga-Jugla.

3. During the off-peak the CT 12 terminates hourly in Jugla with at time for turning around of 30 minutes.

4. The CT 12 operates hourly between Jugla and Sigulda and is turning around in Sigulda around the 15- und 45-minute node within 30 minutes. Also, the RE 30 is operating every 2-hours beyond Sigulda.

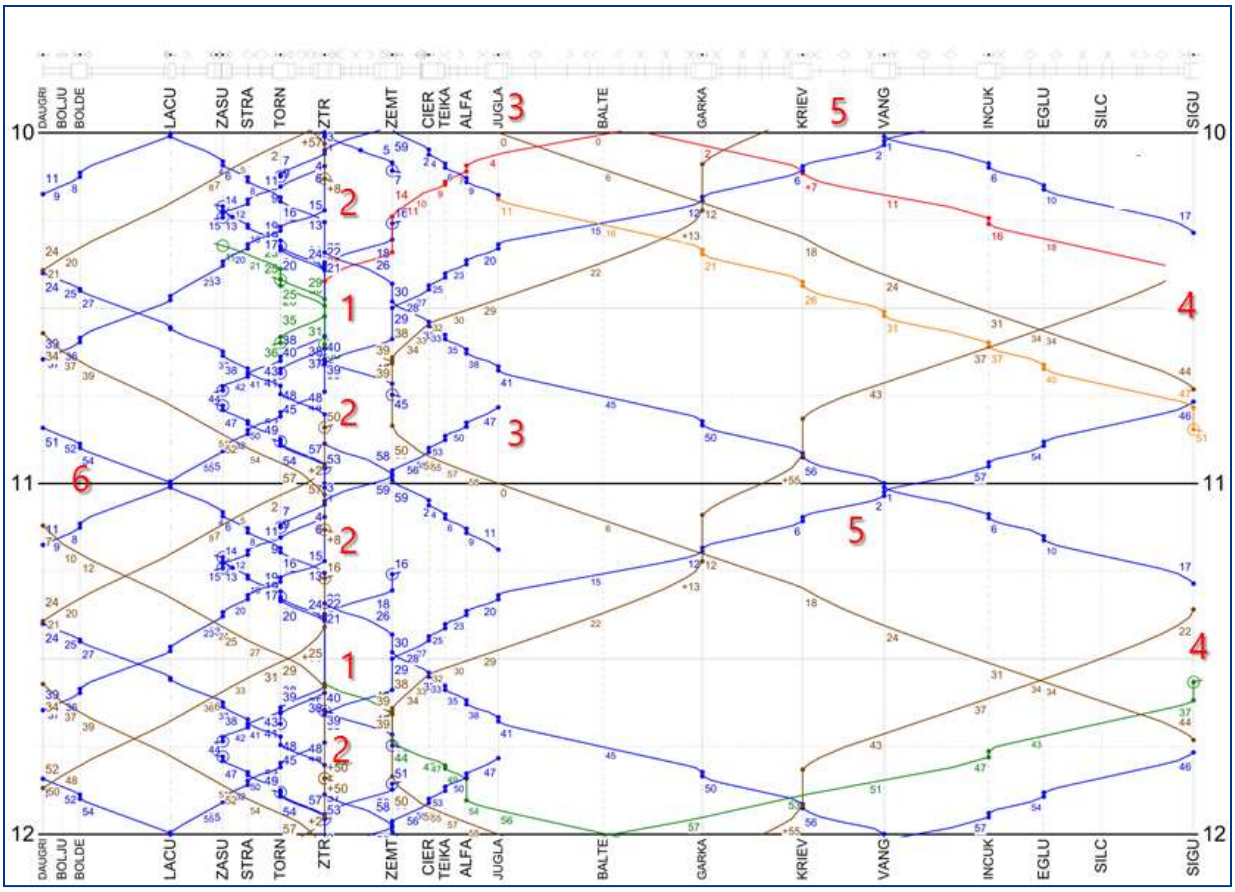


FIGURE 77: GRAPHICAL TIMETABLE CORRIDOR CT 12 DAUGAVGRĪVA – RIGA – SIGULDA OFF-PEAK

Suburban and regional services between Riga – Sigulda – Valga

On the single-track section Sigulda-Valga regional and peak-hour suburban services do stop at all R (RV) stopping pattern stations. This means even fast regional and internal service do stop at intermediate stations according to the stopping pattern of the slow trains (R/RV) on this line section. This is done because the number of passenger services per hour and over the day is too low (hourly or only 2-hourly services) to leave out stops. Additionally, leaving out stops would not result in a significant reduction of travel time on the corridor. Trains still have fixed stations and time windows to meet with trains in the opposite direction. Leaving out stops would only result in an earlier arrival at the meeting stations.

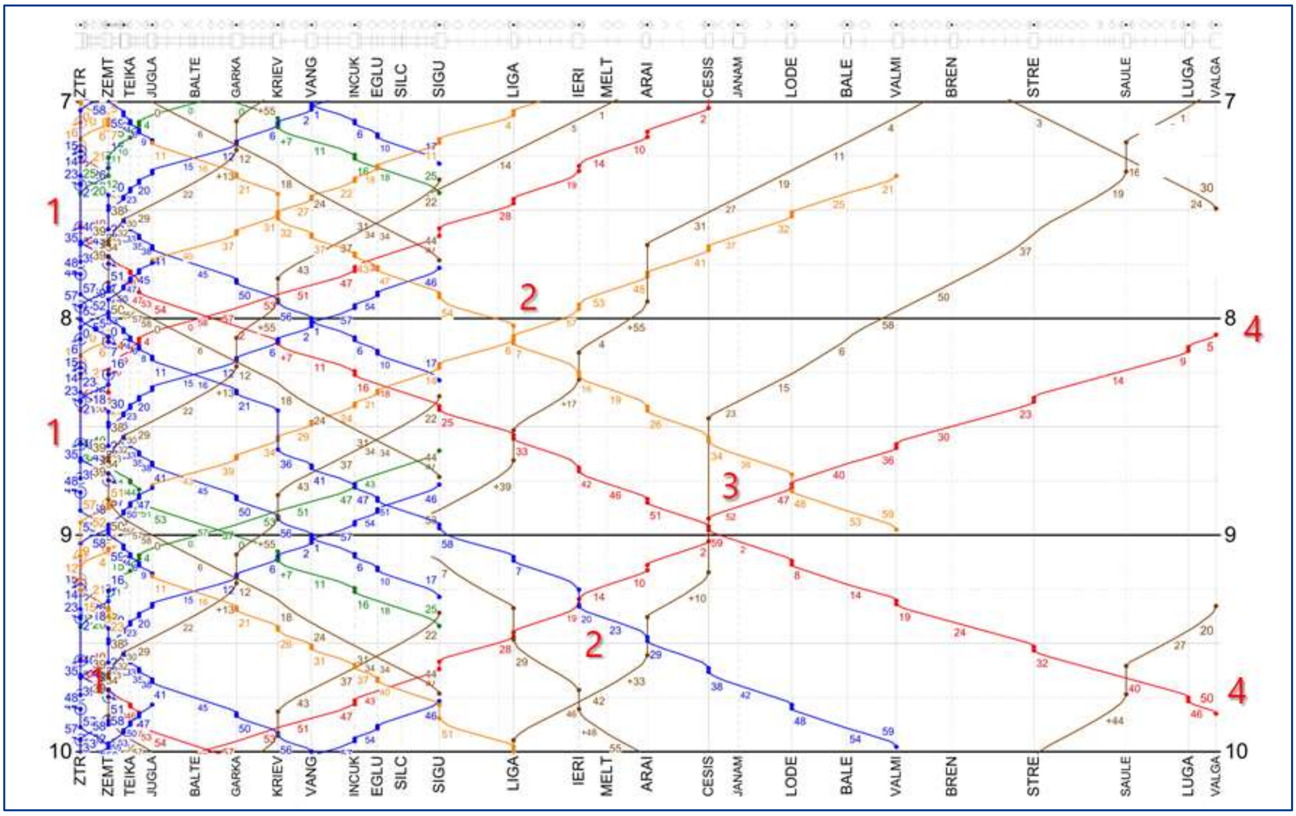


FIGURE 78: GRAPHICAL TIMETABLE REGIONAL SERVICES RIGA-SIGULDA-VALGA

1. The regional service in the corridor Riga-Valga is connected to the 30-minute node in Riga Central station offering connections to all other regional and suburban services on other corridors.

2. During peak-hour the suburban diesel line CT 12 is not only operating a 30-minute interval between Riga and Sigulda but is also extended hourly (orange line) to Valmiera. Here due to different meeting stations with passenger services in the opposite direction and the restrictions at the single-track section Krievupe-Vangaži the travel time of the peak-hour services differs every time. Overall the peak-hour CT 12 haven enough time to turn around in Valmiera.

3. Regional (green) and international services (red) meet in Cēsis. Trains in load direction are having the short dwell time.

4. International passenger services arrive and depart in Valga around the 00-minute node. This allows for an easy connection of the passenger trains slot to corridors in Estonia.

Freight traffic on the corridor

On the mostly double-track section Riga-Zemitāni-Sigulda hourly freight trains slot (brown) are possible. All freight train services have to stop in Zemitāni on track 8 and 9 to synchronize with available slot to enter the freight yard in Šķirotava. All freight train use the bypass.

Beyond Sigulda, the available number of freight train slot is significantly lower with numerous operational stops. This increases the travel time on the corridor and reduces the practical available number of freight train slots to 0,5 per hour and direction between Sigulda and Valga. The number of freight train slots can be even lower when the number of passenger services is stabilized to an hourly service over the whole day.

5.5.6. Conclusions

The timetabling exercise shows that the current 1520 mm infrastructure outside the railway core area is able to handle the proposed amount of traffic for passenger and freight services. It was possible to develop a conflict free timetable compatible to cyclic timetabling principles in Riga Central station and adjacent line sections.

Currently there are only two single-track sections in the network, which prevent further development of an attractive passenger service pattern and also impact possible freight train routes. Hereafter these bottlenecks will be described.

Single track section Krievupe – Vangaži

This line section is located on the Riga – Sigulda line. This rather short single-track section (length approx. 5 km) on a double track line turns out to be a major constraint for the operation of the proposed service pattern (shown in Figure 79 below). This results in additional travel times for passenger services waiting for their slot to pass the single-track section. This additional time is either provided as reserve in the timetable or as stopping time at the passing loops of

Vangaži or Krievupe station. Furthermore, this section limits the possibilities to provide attractive freight train path with short travel times and low energy consumptions.

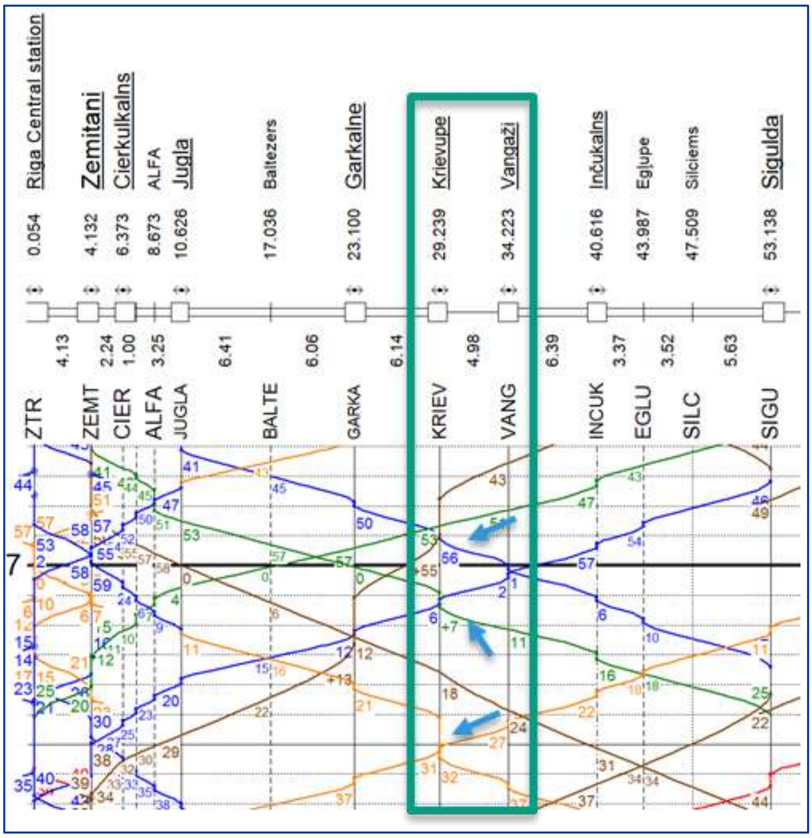


FIGURE 79: SINGLE-TRACK SECTION KRIEVUPE-VANGAZI

Thus, it is recommended to remove this single-track bottleneck with high priority before starting other infrastructure upgrades on the line (electrification etc.).

On the corridor Riga-Valga the service pattern changes between peak and off-peak hours. Especially the long-distance trains are connected with the suburban CT 12 services during peak-hours, which stop at every station. We suggest to investigate a more strict and fully symmetric service pattern to allow for shorter travel times and more reliable services (less strong dependencies in the single track sections). The resulting timetable pattern is shown in Annex 6.

Single track section Sloka – Tukums and Tukums-1 station

This line section is located on the Riga-Tukums-Ventspils line. This is a rather long single-track and mostly single-block section between Sloka and Tukums and limits the number of train services to 3 trains per hour even during peak-hour (shown in Figure 80 below). In a result more passenger services can not to be extended to Tukums even though it has a population of roughly 19.000 citizens. It also results in longer travel time for trains meeting in Station like Ķemeri even though it is not their planned stop. Also, due to meeting of trains on the single-track section a short turnaround of suburban peak-hour services (orange) is not possible This results in the 31th required electric rolling stock during the rush hour.

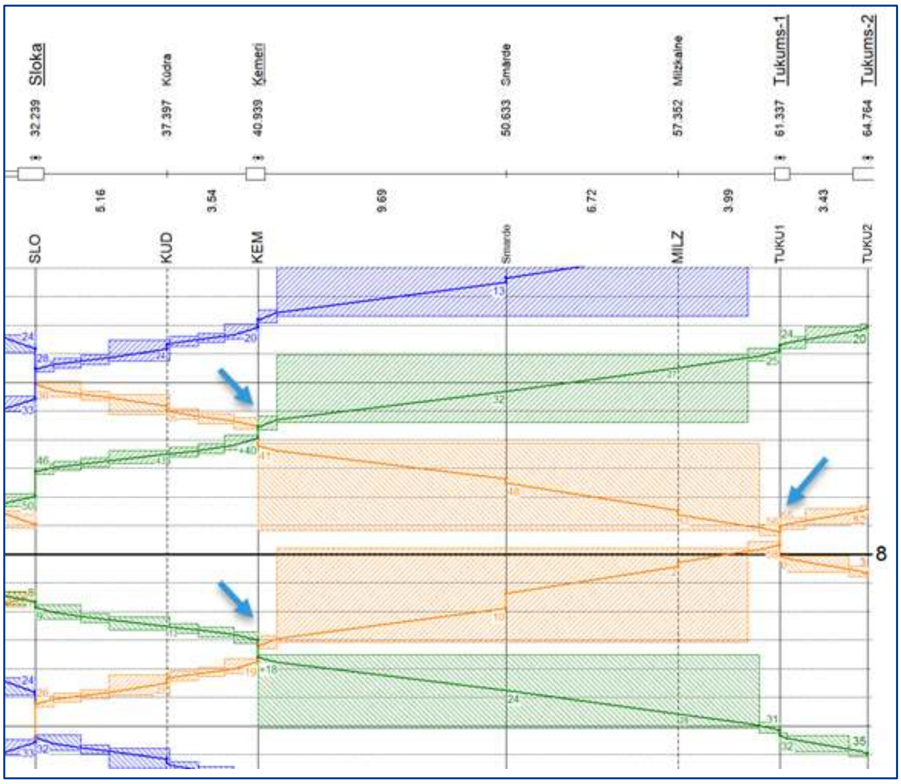


FIGURE 80: SINGLE-TRACK SECTION SLOKA-TUKUMS

If the double-track section could partially be extended until Smārde, unnecessary operational stop and additional travel time could be avoided. This could result in one less required electric rolling stock during peak-hour and faster regional services between Tukums and Riga.

Currently, only one electrified platform track is available in the station Tukums-1. To operate the proposed service pattern with running of all CT-services bound for Tukums to Tukums-2 a second electrified platform track is recommended. This measure shall be considered when upgrading the line section Sloka – Tukums for future needs. Benefit of meeting of two CT trains in Tukums-1 is, that interconnectivity to local public bus transport can be more easily provided (bus arrival before train arrives, bus departure after train to Riga departs).

5.6. Rolling stock circulation

In order to check requirements for the rolling stock maintenance and layover facilities and to check efficiency of the developed timetable a detailed rolling stock circulation plan has been developed (see annex 8).

The circulation plan was developed respecting the technically required minimum turning times of 9 minutes at the ends of each line. In Table 37 the turning times in each station of the suburban lines are summarized. Overall, the required minimum turnaround times could be provided. In some cases, the available turning times at one end of the line are below the required minimum for selected peak-hour services and selected locations.

Line	Station	Shortest turnaround time in off-peak hours	Shortest turnaround time in peak-hours	Remarks
CT 12	Daugavgrīva	11 minutes	11 minutes	
	Jugla	36 minutes	-	
	Sigulda	28 minutes	28 minutes	
	Valmiera	-	20 minutes	
CT 1	Tukums-2	9 minutes or 129 minutes if peak unit is used	51 minutes	
	Sloka	12 minutes	12 minutes	
	Dubulti	45 minutes	11 minutes	
	Riga Central Station	8 minutes	64 minutes	
	Carnikava	43 minutes	38 minutes	
	Saulkrasti	52 minutes	6 minutes	Adjusted stopping pattern could increase the time window as required
	Skulte	24 minutes	24 minutes	
CT 2	Jelgava	27 minutes	14 minutes	
	Ogre	38 minutes	6 minutes	Adjusted stopping pattern could increase the time window as required
	Lielvārde	65 minutes	6 minutes	
	Aizkraukle	5 minutes or 125 minutes, if spare unit from peak hour services is used	5 minutes	

TABLE 37: TURNAROUND STATIONS OF RIGA SUBURBAN SERVICES

In the following 4 cases the turning time is below the required one of 9 minutes:

1. The extension of CT 1.00 in peak hours to Saulkrasti requires a turning time of 6 minutes.
2. The extension of CT 2.00 in peak hours to Lielvārde requires a turning time of 6 minutes.
3. The extension of CT 2.30 in peak hours to Aizkraukle requires a turning time of 5 minutes
4. The additional peak hour services CT 2.15 and 2.45 require a turning time of 6 minutes in Ogre.

For these cases compensatory measures should be developed prior to practical implementation of the timetable. This mainly relates to the avoidance of stops at small stations for runs against the load direction (e. g. Aizkraukle – Riga in the afternoon/evening). Another, more long-term oriented solution would be the provision of shorter achievable run times by allowing higher maximum line speeds (infrastructure investment). Without those measures more vehicle units are needed for compensation.

Despite the tight and efficient circulation plan more electric trains are needed than available for stable operation of the timetable developed by the consultant. According to the proposed circulation plan, 32 electric multiple units in operation are needed to run the proposed timetable. But the current procurement only provides for 32 new trains including the reserve rolling stock. A typical amount of reserve rolling stock to cover for unforeseen incidents and maintenance layover would require at least a fleet reserve of 15%. This means a reserve fleet of 6 units would be required for a reliable service depending on a typical applied reserve of 15 % of the fleet size. The following approaches could help to solve the lack of units:

1. Ordering additional electric multiple units (up to 10 units; depending on the additional approaches)
2. Minor improvement of the infrastructure to reduce the travel time or skipping of stops in the direction of minor demand (saves up to 4 units; this is already assumed for the current circulation plan)
3. Shift of CT 1.15 and CT 1.45 in one direction by 30 minutes (saves one unit)
4. Major improvements to cut down the travel time to Tukums significantly (saves one unit)
5. Skipping parts of the peak hour services (e.g. CT 1.15)

There are two approaches (no 3 and 4 above) to reduce the number of rolling stock needed by 2 units in total without reducing the volume of trips in the timetable. One approach is a shift of the CT 1.15 and 1.45 in one direction by 30 minutes so that there will be sufficient turning time in Riga Central Station within half an hour instead of one hour (or instead of turning within 4 minutes). This saves one vehicle.

The other approach are improvements in the infrastructure in the section from Sloka to Tukums to shorten the travel time for the train that stops at every station from 29 minutes down to 25 minutes. Alternatively, a double track section between Sloka and Kudra (5 km) would result into less vehicles needed as well. A turning of trains within 9 minutes could be performed in Tukums instead of a turning within nearly one hour. This saves another vehicle.

No.	Traction / Traffic	Number of rolling stock	Average mileage per unit per year	Average fleet mileage per year	Remarks
1	Electric suburban rolling stock	32	172,387 km	5,516,381 km	Only 30 rolling stock for daily operation available and +2 in reserve planned by PV.
2	Diesel RE 20, RE 10, R 70	18	262,636 km	4,727,454 km	Longest circulation is 1,236 km/d
3	Diesel Corridor Valga RE 30, I.RE 30	14	192,262 km	2,691,672 km	Longest circulation is 750 km/day. To support the proposed service pattern, it is required to bundle rolling stock circulation for CT12, RE 30, I.RE30 to minimize number of rolling stock. With optimized timetable (principle indicated in annex 6), long-running RE services to Valga shall be separated from CT12 services.
4	Diesel CT12 between Daugavgrīva, Jugla and Sigulda				

TABLE 38: ROLLING STOCK CIRCULATION KEY FIGURES

To operate the proposed services on the currently non-electrified lines a fleet of at least 32 units plus 15% reserve would be required to operate the proposed timetable. The related key figures for rolling stock circulation are depicted in Table 38 above.

To support usage of the fleet according to the main market segment operation of diesel services is split into two rosters. To operate the developed timetable, it is necessary to provide a rolling stock schedule for RE trains to Valga and suburban services Daugavgrīva – Jugla/Sigulda (CT12). This can be avoided by further optimisation of the timetable. The related principles are highlighted in annex 6. This would allow justifying capacity and interior of the trains to the respective market segments (long distance and suburban) and also ease efficient usage of propulsion technology, as long as Riga -Valga line is not completely electrified (battery or electrically powered CT12 services, hydrogen or diesel services for long distance trains to Valga).

To provide the trains with extra fuel during the daytime in case of diesel or hydrogen operation the longest circulations require a fuel refilling facility in Daugavpils in addition to an indisputable one closed to Riga Central station. Furthermore, it should be possible to refill a train in Riga Central station within a time window of 60 minutes This period includes the time from the platform of the passenger station until its return to the platform. The alternative would be to replace a train with an already refilled train subject to final planning of the maintenance schedule. This might require one additional rolling stock for daily operation (subject to detailed planning of the maintenance schedule and rolling stock circulation planning for daily operation).

5.6.1. Layover facilities

The current circulation plan was developed to show the minimum amount of train runs for an optimized circulation. It contains already additional trains as public services as necessary outside the peak-hour and in the early morning and late evening to balance the rolling stock locations as needed to fulfill the interval requirements. This principle is indicated in Figure 81 below (cases marked with 2 and 3 in Figure 81) based on the developed circulation plan. In the peak hours, passenger services opposite of load direction are necessary to provide inbound and outbound peak-hour services. In general, it is possible to operate peak-hour services over the whole day (cases marked with 4 in Figure 81). Rolling stock is having different circulations every day. Every few days every rolling stock have assigned circulations like No. 19 shown in Figure 81 below for maintenance between the peak-hours in Riga.

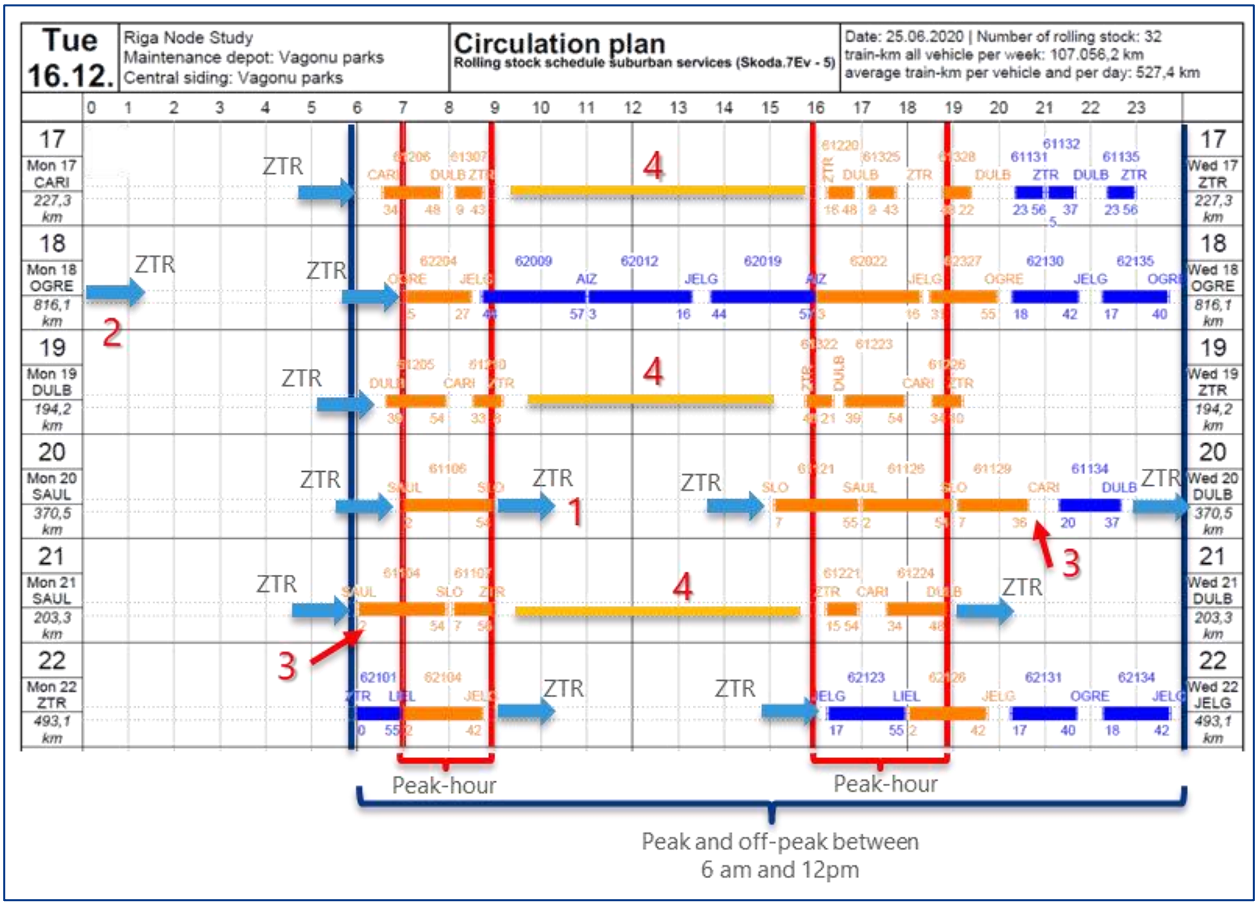


FIGURE 81: HANDLING OF STABLING AND EMPTY RUNS IN THE CIRCULATION PLAN

To avoid additional empty-runs (e.g. runs marked with 1 in Figure 88 above) or runs with low passenger demand, it is suggested to park the trains overnight in or next to a station where they start and end their last scheduled run of the day. In a customer oriented and efficient timetable, a certain amount of trains will always be parked at decentral locations since the first and last runs of the day typically start/end at locations outside the city centres to provide for commuters and late returning in the evening. This results into track capacities for overnight layovers at various stations. According to the developed circulation plan it can be assumed that one third of the electric fleet and one fourth of the diesel fleet would have a night layover next to Riga Central station.

Table **39** shows the needed layover capacities for the nightly layover for the electric units for Riga suburban services. The needed layover capacities for the units on the currently non-electrified lines are depicted in Table 40. As basis for further considerations on train maintenance during daytime and to indicate required parking spaces the number of layovers during the peak hours is also depicted.

In principle, it is possible to increase the number of layovers in Riga Central station by adding additional empty runs or by adding additional commercial runs in times with low demand. In case it is required to park more trains next to Riga Central station a special investigation is needed if all conflicts between the regular runs and the deadhead runs between the station and the depot at Riga Central station can be solved. Currently such a strategy is not recommended. It should be possible to design sufficient driver duties starting and ending at the branch offices where a major part of the fleet starts and ends their runs of the day. Also, it should be considered that one additional empty run of rolling stock requires significantly more energy than using other transport means (road transport or public transport).

For the electric units as well as for the Diesel units a weekly circulation plan with at least one layover next to Riga Central station can be constructed with the current daily circulation plan. To perform scheduled maintenance there is no need to cut regular runs in Riga Central station for an exchange of units. In other words; additional empty runs for a more centralized layover concept with far more trains with a layover near Riga Central station are not needed on a daily basis for regular maintenance reasons.

For the diesel units there are two separate circulation plans. One is for the CT 12 and the RE/I.RE 30 trains. And the other for the RE 10, RE 20 and R70 trains. This is because the circulation of CT 12 and RE/I.RE 30 are connected to save units. Since there is an alternative suggestion for a timetable structure that asks for investigation, where the circulation of CT 12 and RE/I.RE 30 can be optimized separately (see chapter 5.5.5 and Annex 6). The layover during the day in Dobele could be skipped in favour of an additional layover next to Riga Central station by avoiding a double traction between 9 am and 3 pm.

The nightly layover outlined inTable 40 is based on analysis of the circulation plan developed by the consultant which is designed to avoid additional runs or runs against load direction in times of low demand. According to PV approx. 50 % of the fleet (18 rolling stock) for operation on non-electrified line section (DMU or bimodal) should have their nightly overlay closed to Riga Central station. This will result in additional empty runs or a service pattern with less runs in load direction in early morning and late evening hours.

Corridor	Abbreviation	Station	Layover between peak-hours (9 am-4 pm = 7 h)	Nightly layover
	ZTR	Riga Central station	7	8
Westcoast Corridor Tukums-Sloka-Riga-Skulte	TUKU2	Tukums-2	1	3
	SLO	Sloka	1	1
	DULB	Dubulti	-	2
	CARI	Carnikava	1	1
	SAUL	Saulkrasti	-	3
	SKURB	Skulte	1	2
Southeast Corridor Jelgava-Riga-Aizkraukle	JELG	Jelgava	1	6
	OGRE	Ogre	1	2
	LIEL	Lielvārde	1	2
	AIZ	Aizkraukle	-	2

TABLE 39: LAYOVER OF SUBURBAN ELECTRIC UNITS

Corridor	Abbreviation	Station	Layover between peak-hours (9 am-4 pm = 7 h)	Nightly layover
	ZTR	Riga Central station	6	9
Westcoast	VENT1	Ventspils 1	2	2
Southeast	LIEP	Liepaja	1	2
	DOB	Dobele	1	-
	GLUD	Gluda	1	1
	GULB	Gulbene	1	1
	KRU	Krustpils	-	1
	RKZ II	Rēzekne II	1	1
	ZIP	Zilupe	1	1
	ZTDA	Daugavpils	2	3
CT 12, RE Valga	DAUGRI	Daugavgrīva	-	1
	JUGLA	Jugla	-	2
	SIGU	Sigulda	1	4
	VALMI	Valmiera	2	2
	VALGA	Valga	2	2

TABLE 40: NIGHTLY LAYOVER OF ROLLING STOCK FOR SERVICES ON NON-ELECTRIFIED LINES

5.6.2. Conclusions

The required electric and diesel rolling stock and the assumed on top reserves are shown in Table 41 below. For the operations of suburban services 32 electric rolling stock are required to be in simultaneous operation during the peak hours according to the circulation plan developed by the consultant. For operation of regional and cross border services as specified by the consultant in the developed master timetable up to 32 diesel rolling stock would be required to be in daily operation. On top of the required minimum fleet size daily in operation a reserve of 15 % was assumed to cover for maintenance and unforeseen incidents. Furthermore, additional 6 rolling stock are indicated to cover for extension of services around Daugavpils subject to further decisions.

	Riga Suburban EMUs	Regional/ Cross border DMUs	Remarks
Scheduled for daily operation	32	32	According to PV a maximum of 30 of 32 EMU are available for daily operation
Reserve for extended RE service around Daugavpils/Krustpils	N/A	6	
Maintenance Reserve (approx. 15%)	5	6	
Total	37	44	

TABLE 41: ESTIMATED FLEET SIZES

Electric rolling stock

The number of electric rolling stock for daily operation during peak hours currently foreseen by PV is too small to allow stable op. Originally according to PV 30 of 32 newly procured Škoda electric rolling stock could be used for daily operations. With the current stage of the circulation plan based on the current status of the Master Timetable at least 31-32 electric rolling stock are required for operations during the peak-hour. Including the assumed 15% reserve at least 37 electric rolling stock would be required to run the daily operations. This means 5 EMUs would be required as reserve units for stable operation in addition to the newly procured Škoda fleet. To achieve this, the preferred option would be to procure additional rolling stock. Using at least 5 old EMUs (class ER2M, ER2T) to provide the necessary reserve, will not be a future proof solution since the fleet has reached the end of economical viable service life and should only be considered as interim solution for a short time period.

Centralized stabling concept for Riga suburban services

The current circulation plan was developed to show the minimum amount of train runs for an optimized rolling stock circulation. It contains already additional trains as public services as necessary outside the peak-hour and in the early morning and late evening to balance the rolling stock locations as needed to fulfill the interval requirements (see section 2.4.1).

The provided timetable and rolling stock circulation could be further developed to allow a more centralized stabling of suburban trains in or closed to Riga Central station as currently practiced by PV. According to PV approx.. 50% of the trains shall be stabled closed to Riga Central station. This requirement is reflected in the analysis of maintenance and layover facilities in chapter **Error! Reference source not found.**.

The current practice is focused on avoidance of additional infrastructure costs (PV has to pay track access charges for using stabling tracks on the public network as service facilities) and allowing centralized staffing of suburban trains from Riga Central station.

Keeping thus current practice would result in additional empty- or service-runs and less capacity for freight trains, especially over the Daugava River bridge. Alternatively, passenger services could terminate earlier (evening, end of peak hour) in Riga Central station to avoid additional runs back to Riga from satellite destinations outside Riga. This would ultimately result in a reduction of services below the minimum required quantity-structure for each line section. This is not recommended since it does not provide the best value to the passenger and is undermining the strategic goals.

Another option would be to provide additional empty-runs from the satellite destinations back to Riga, if a more centralized stabling concept is executed. This solution would lead to

- Extra cost for empty runs, though providing them as service runs would be advantageous to the passengers
- Additional shunting/direction changes in Riga Central station. It also has to be emphasized that, if all services are terminated in Riga Central at the end of the peak hour within a short time (e.g. one hour) there will be additional bottlenecks due to longer platform occupation times for terminating services and additional empty runs to the depot. The same applies for the start of afternoon peak hour.
- Loss of freight trains slots during early morning (before start of peak hour) and in the evening (end of peak time) resulting from additional empty runs (especially related to Jelgava and Tukums direction which impact available spare capacity on Daugava River bridge).

In addition to that, not all peak-hour services can terminate in Riga at the same time since all station tracks are occupied and there are no tracks left for extended dwell times or separate terminating and beginning services. Earlier beginning/later termination of peak hour would mean peak-hour service would operate the whole day.

A modified version of the stabling concept for electric suburban trains with more centralized stabling in Riga (50% of the units for daily operation will be stabled in Riga) is depicted in Table 42. The modified concept is based on the original solution outlined in Table **39** above. For comparison the differences to the original solution are highlighted.

Location/ Corridor	Station		Minimum layover according to developed circulation plan		Modified solution with centralized stabling concept		Remarks
	Abbreviation	Name	Layover between peak-hours (9 am-4 pm=7 h) units/day	Nightly layover units/day	Nightly layover units/day	Difference compared to original concept	
Siding in Riga	ZTR	Riga Central station	7	8	17	+9	Half of the fleet would have the layover outside and the other half in Riga
Siding outside Riga			7	24	15	-9	
Westcoast Corridor Tukums-Sloka-Riga-Skulte	*TUKU2*	*Tukums-2*	*1*	*3*	*1*	*-2*	*Additional empty-runs reduce capacity over the Daugava River bridge*
	SLO	*Sloka*	*1*	*1*	*1*	*1*	
	DULB	*Dubulti*	*-*	*2*	*1*	*-1*	*Additional empty-runs reduce capacity over the Daugava River bridge*
	CARI	*Carnikava*	*1*	*1*	*1*	*1*	
	SAUL	*Saulkrasti*	*-*	*3*	*1*	*-2*	
	SKURB	*Skulte*	*1*	*2*	*2*	*2*	
Southeast Corridor Jelgava-Riga-Aizkraukle	*JELG*	*Jelgava*	*1*	*6*	*2*	*-4*	*Additional empty-runs reduce capacity over the Daugava River bridge*
	OGRE	*Ogre*	*1*	*2*	*2*	*2*	
	LIEL	*Lielvārde*	*1*	*2*	*2*	*2*	
	AIZ	*Aizkraukle*	*-*	*2*	*2*	*2*	

TABLE 42: NIGHTLY LAYOVER – STUDY TO INCREASE CENTRALIZED STABLING IN RIGA

This principle could be also applied during daytime between the peak-hours, which would lead to additional empty runs One example including additional empty runs is shown in Figure 82 based on the developed optimized circulation. Additional empty-runs are marked with reference number 1 (daytime between peak hours).

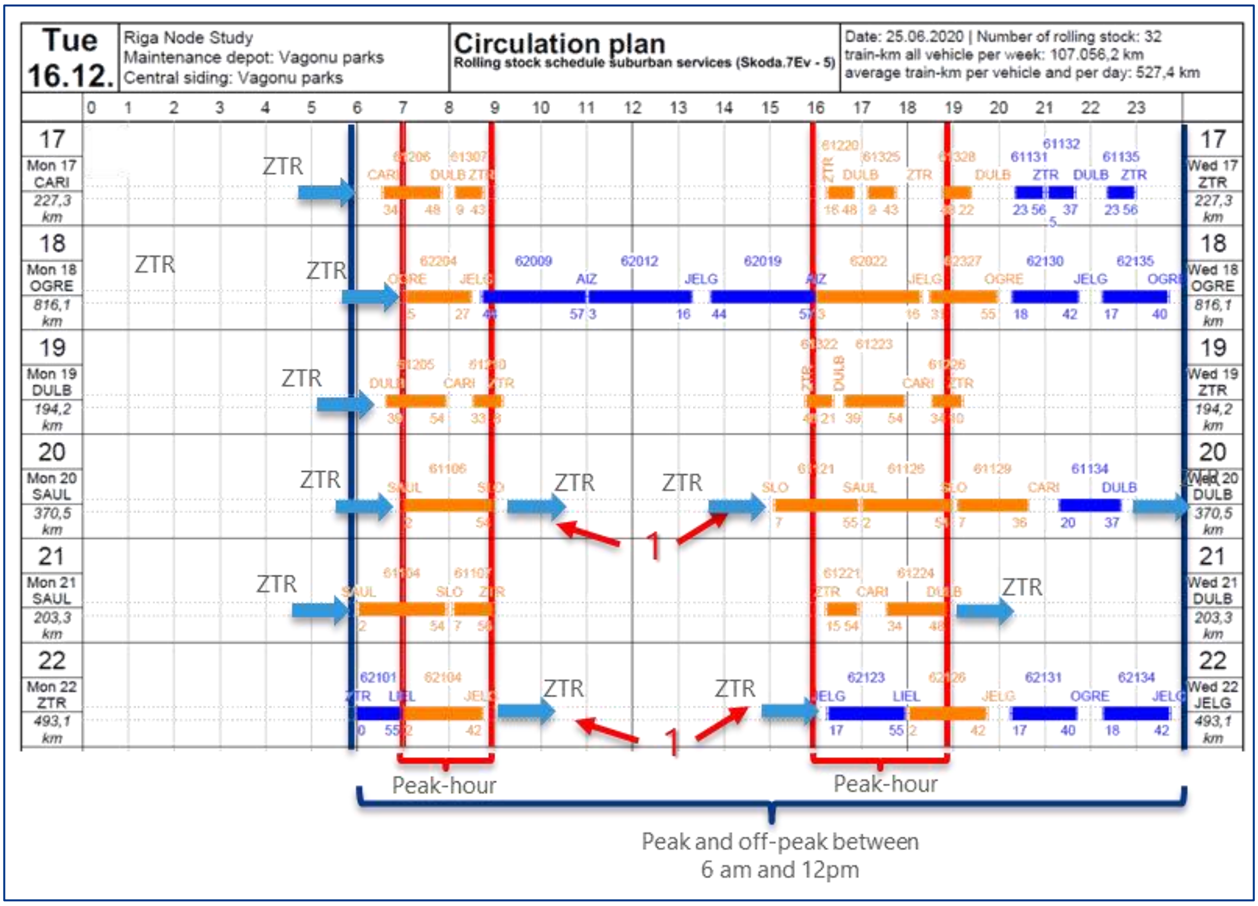


FIGURE 82: POSSIBLE ADDITIONAL EMPTY-RUNS BETWEEN THE PEAK-HOUR FOR SUBURBAN SERVICES

Rolling stock for services on currently not electrified lines

According to PV approximately up to 41 rolling stock for operation on non-electrified lines are planned on a long-term perspective. For operation of the currently planned regional express trains and the proposed services CT 12 service pattern (extended service Jugla/Sigulda – Daugavgrīva) at least 32 units would be required to be in simultaneous daily operation. Including necessary reserve 38 units will be required. For further extension of the service pattern additional 6 units should be available. Including necessary 15% reserve the total fleet size can be estimated to be at least 44 units. The traction to be used will depend on further approach on electrification program and application of alternative propulsion technology (e.g. usage of battery powered or bimodal diesel-electric trains as well as hydrogen fuel cell technology).

Analysis of circulation plan reveals that it is possible to provide a sufficient number of layovers in Riga to ensure all trains can be properly maintained. Thus, choosing a centralized depot location for operation of these services in Riga is a future proof decision.

Nevertheless, additional small facilities for cleaning/refuelling at Daugavpils, Ventspils, Liepaja would be advantageous to provide the necessary flexibility in rolling stock scheduling. This should be subject to further optimization by the operator. Main reason for that is that some of the diesel trains cross the maximum running distance of 800-1,000 km per day for refilling of diesel trains. Analysis of the currently available trains with alternative propulsion reveals that a similar range boundary would also apply for hydrogen refilling.[72] Furthermore, it should be ensured that all trains are in working order, if layover does not take place in Riga (interior cleaning, water refilling, waste and sewage disposal).

[72] https://www.pv-magazine.de/2020/07/28/spatenstich-fuer-weltweit-erste-wasserstofftankstelle-fuer-passagierzuege-in-niedersachsen, retrieved 30-07-2020

6. Target Infrastructure in Railway Core area

6.1. Background and approach

With introduction of Rail Baltica the 1520 mm infrastructure in the railway core area shall be altered to provide the necessary space for Rail Baltica. The resulting infrastructural measures shall support the upgrade of the relevant 1520 mm line sections to up-to-date infrastructural standards (e.g. avoidance of pedestrian crossings, fencing, noise protection, grade separated platform access). Details on planned track layout changes related to redesign of Riga Central station and implementation on Rail Baltica in the railway core area are outlined in chapter 834.1.1 and 4.2 of this report.

The results of the operational analysis show, that the capacity limit will be reached with the proposed train service pattern. This is due to the main bottleneck Daugava river bridge and the at-grade crossings at Riga Central station and Torņakalns station. To ensure feasibility of the proposed service pattern, to allow the required exploitation of the main bottleneck and to provide the targeted higher standard several alterations of the 1520 mm track layout have been studied. The resulting recommendations are outlined in the following sections. Proposed measures include:

- Improvement of station entry and exit speeds to reduce track occupation time in critical areas
- Alteration of track layout to accommodate freight trains with a length of 850 m
- Upgrades to the existing signalling and interlocking system
- Integration of additional passenger stations
- Provision of additional crossovers
- Ensure functionality of proposed maintenance and layover facilities
- Improve flexibility to handle disturbed operation

The main focus of the proposed measures is to complement the already proposed 1520 mm track layout alterations also considering the updated requirements as elaborated in this study based on analysis of existing studies.

6.2. Torņakalns station

As highlighted in chapter 4 of this document the future 1520 mm track layout of Torņakalns station will be impacted by

- Necessary relocation and widening of 1520 mm platforms. Currently the platforms are located on the south side of the station. In the future the platforms will be located further north.
- Construction of cut-and cover on the south side of the station. The 1435 mm Rail Baltica tracks will underpass the tracks of the Riga Central – Jelgava line. This implies partly realignment of existing switch area on the south side of the station as well as replacement and widening of the existing road overpasses on the south side of the station to provide space for Rail Baltica tracks and to allow implementation of the cut-and-cover.

This is addressed by the current ongoing study of Rail Baltica alignment alternatives. The analysis carried out in this study indicated three potential areas for further layout improvements to provide added value to the planned redesign and to accommodate future traffic:

- Lengthening of at least one station track for 850 m freight trains
- Increasing entry and exit speeds for heavily used routes
- Provision of additional parking tracks for passenger rolling stock
- Provision of 1520 mm cut-and-cover solution

These will be explained in detail below.

Lengthening of at least one station track for 850 m freight trains

The results of timetabling study indicate that it is most beneficial for exploitation of line capacity if freight train pass Torņakalns station due to the slow acceleration of the freight trains. Thus, an additional 850 m siding for overtaking of freight services by passenger services to Zasulauks or Jelgava is of limited use.

Main target of an additional 850 m freight siding is to allow direct freight services from Jelgava direction towards Bolderaja to provide additional services to the port of Riga (e.g. from Jelgava, Siauliai and Liepaja, probably also Ventspils) directions.

Given the spatial constraints around Torņakalns station the only option to provide such functionality is to extend the freight sidings at the north side of the station. Therefore at least track 5 would need to be upgraded to provide for 850 m long freight trains. Upgrade of track 6 is proposed as option to provide for run-around of the locomotive independent of passenger traffic on tracks 1-4. This would also require separate pull-out sidings for the locomotive on both ends of the station. The principle is indicated in Figure 83 below. Initial analysis shows that this will require extension of the tracks on east and west side of the station. This will lead to a wider cross-section in the cutting west of Friča Brīvzemnieka iela bridge and shifting of switch area towards Daugava river bridge, which will require modification of road underpasses/viaducts over Mūkusalas iela and Jelgavas iela.

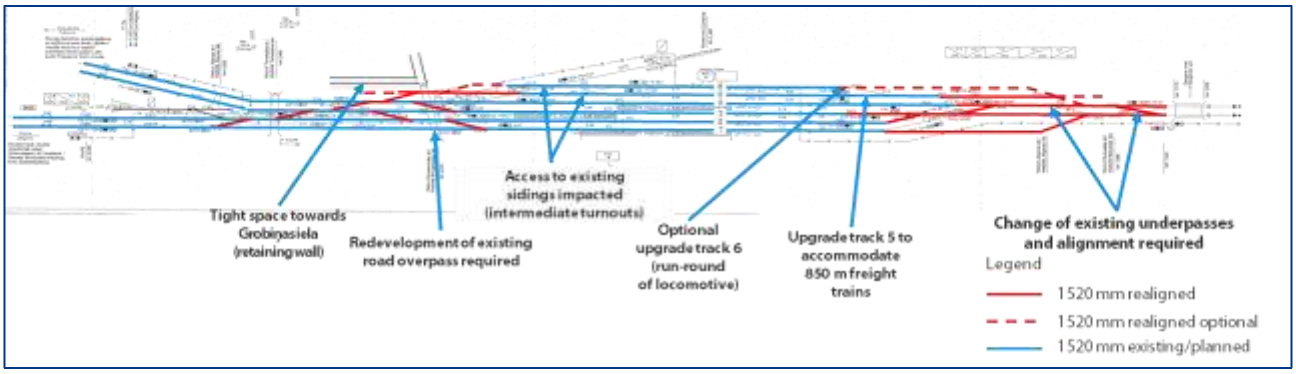


FIGURE 83: TORŅAKALNS STATION - LAYOUT PRINCIPLE WITH 850 M FREIGHT SIDING

Due to the high amount of at-grade-crossing conflicts - Freight trains arriving from Jelgava have to cross main tracks for suburban trains to Jelgava, from Zasulauks and to Zasulauks. Thus, this option is only useful outside the peak hours and during night-time.

A second option would be to adjust operational rules and signalling to allow turning of a long freight train in track 5 with 2 locomotives (double traction or attachment of second locomotive). This would mean a freight train entering from the south side (from Jelgava or Zasulauks) would continue to the buffer stop on the extension of track 5. The principle is depicted in Figure 85). For the low amount of movements to be expected as regular traffic (most traffic to Bolderaja can be expected to be operated from/to Šķirotava) and as a fallback option this principle would be sufficient. Since it beneficial at least as fallback option in case of line blockages this option should be further studied during technical design.

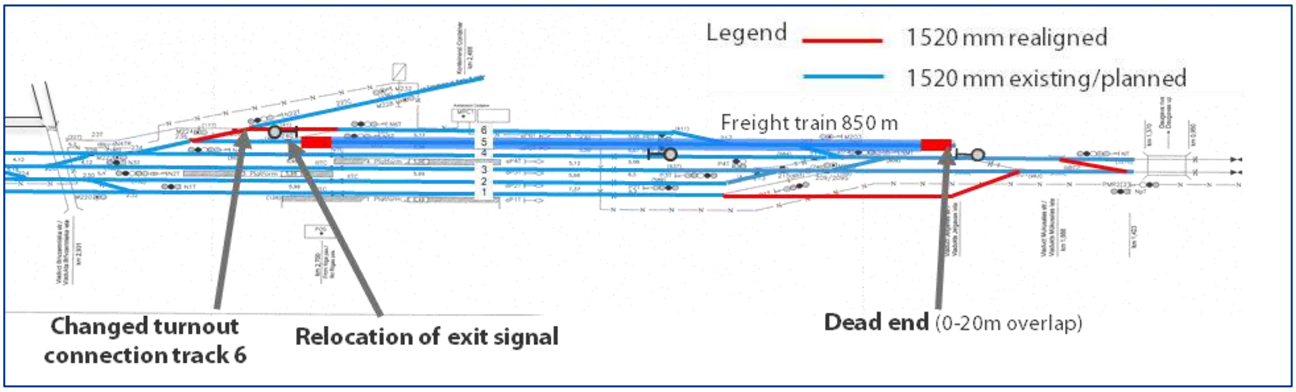


FIGURE 84: TORŅAKALNS STATION - LAYOUT PRINCIPLE WITH 850 M FREIGHT SIDING

As a conclusion lengthening of tracks for 850 m freight trains at Torņakalns is not recommended due to the spatial constraints and limited need to stop freight trains for traffic regulation. To support traffic Jelgava – Torņakalns – Zasulauks – Bolderāja the signalling and track layout shall be adjusted to allow turning of a freight train with 2 locomotives as shown in Figure 84.

Increasing entry and exit speeds for heavily used routes

Increasing entry and exit speeds is intended to provide additional margins of the timetable which allow covering smaller delays. It will contribute to timetable stability. This is especially beneficial since all crossovers at Torņakalns are implemented as at-grade solution. For the expected dense traffic shortening of the occupation time of entry and exit routes at Torņakalns will also contribute to timetable stability. The current and proposed turnouts allow only 40 km/h to 50 km/h in the diverging track depending on the route. This means all trains from/to Jelgava need to travel at reduced speed from/to the station boundary (signals NT, NPT on Daugava river bridge). Furthermore, the distance between the entrance signal at the west side on the route from Jelgava (signal PB) and the first turnout diverging to the main tracks of the station (turnout no. 210) is rather long (630 m). This is a disadvantage, if passenger trains from Jelgava are to use tracks 3 and 4. Therefore, it is suggested to shorten this distance by intermediate signals probably combined with redefinition of station boundaries, if possible, to minimize the need to travel a section with reduced speed. On the east side, where most of the crossover movements will occur according to the developed master timetable, the double slip switch should be resolved to two simple switches in order to allow for higher entrance and exit speeds and to reduce maintenance costs (wear and tear, spare parts, more complex refurbishment and inspections).

These measures are incorporated into the proposed optimized track layouts described below.

Provision of additional parking tracks

Analysis of available parking capacity around Riga Central station reveals, that additional parking tracks are required, to guarantee that the intended number of passenger trains can be parked closed to Riga Central station.

Providing parking tracks at Torņakalns station by redeveloping the yard area west of the main tracks could thus provide a deserved relief. However the proposed solution with direct access from Riga Central station will require re-levelling to ensure that the parking tracks are at the same height level as the main tracks. By implementing three additional parking tracks up to 8 EMUs or DMUs could be parked at Torņakalns. Parking tracks have to be aligned such, that the existing interlocking container does not need to be moved.

The location and length of the additional parking tracks is indicated in Figure 85 below.

Optimized track layout for bidirectional running over Daugava river bridge (without 1520 mm cut-and-cover)

The optimized track layout for bidirectional running over Daugava river bridge is shown in Figure 85 below. It incorporated the improvements discussed above. This solution is tailored to the needs outlined in the developed master timetable 2026/36.

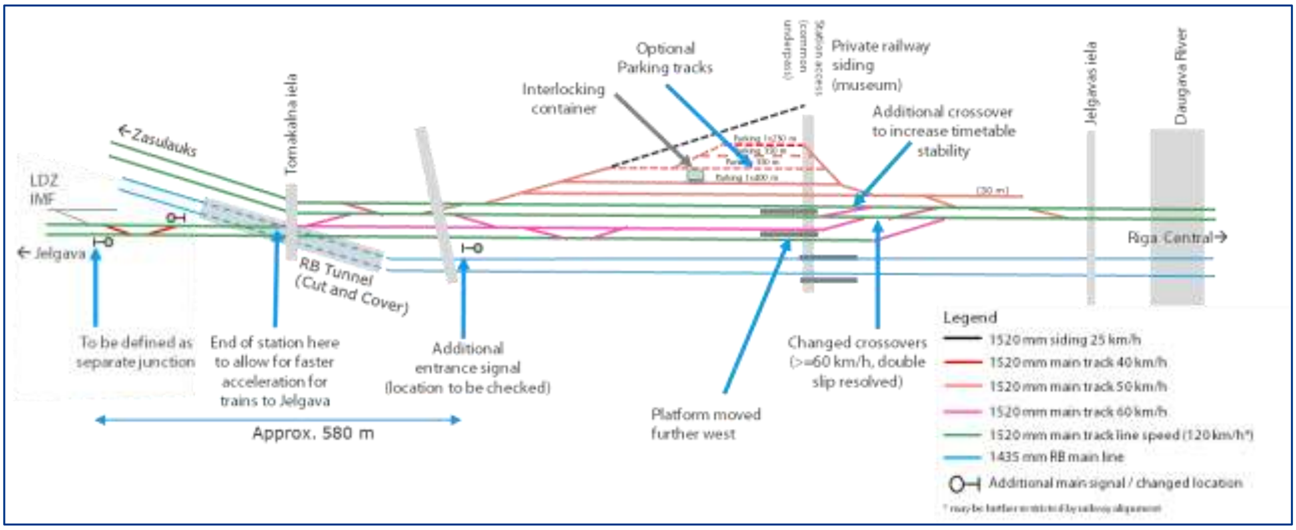
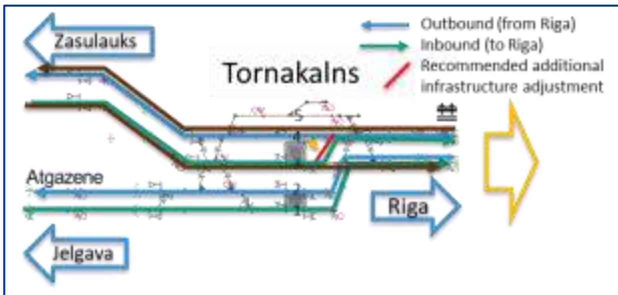


FIGURE 85: TORŅAKALNS STATION – OPTIMIZED TRACK LAYOUT WITHOUT CUT-AND-COVER SOLUTION

Therefore, the track layout incorporates one additional crossover at the north side of the station to allow for simultaneous departures from track 3 to Riga while trains from Riga arrive at track 2. This improvement significantly reduces the amount of potential crossing conflicts and is thus highly recommended to improve timetable stability.

In Figure 86 the amount of potential crossing conflicts (delay of one train will be propagated to conflicting train) is highlighted. On the left side of the figures the operational regime and the location of the additional crossover are highlighted. On the right side the picture the resulting reduction of potential crossing conflicts is indicated.

If bidirectional running over Daugava river bridge is applied, up to 13,5 trains can be timetabled in the peak-hour. As can be seen, the number of crossing-conflicts can be reduced by an additional crossover at the east side of the station from five to one. The additional cut-and-cover (track layout as indicated in Figure 88below) would not reduce the potential amount of crossing-conflicts furthers for the timetable structure provided in the master timetable.



Reduction of potential conflicts in case of smaller delays

Infrastructure	Affected services	Conflicts per hour (peak)	Conflicts per hour (off-peak)	Max. train pairs per hour (peak)*
Original layout	CT, FR, RE	5	1	12
With crossover	RE 20, FR	1**	1**	12
Cut and cover	RE 20, FR	1**	1**	12

*Suburban+Regional passenger+Freight trains
** freight trains (brown line) right-hand running only to access track X in Riga Central station

FIGURE 86: REDUCTION OF AT GRADE CROSSING CONFLICTS IN TORŅAKALNS FOR BIDIRECTIONAL RUNNING OVER DAUGAVA RIVER BRIDGE

Optimized track layout for right hand-running over Daugava river bridge (with 1520 mm cut-and-cover)

Provision of 1520 mm cut-and-cover solution

All junctions and crossovers in the railway core area are provided at-grade. This leads to an high amount of restriction for timetabling. As a result, the capacity boundaries for the line section Riga Central - Torņakalns will be reached, which is mainly caused by the high amount of at-grade crossing conflicts at Torņakalns station and Riga Central station. One main bottleneck is the need of the trains from Zasulauks to cross the traffic flow in opposite direction to Jelgava either when entering the station at the south side or when leaving the station at the north side. In the peak hour up to 6 trains per hour will need to pass Torņakalns station towards Jelgava, and up to 8 trains will pass the station from Zasulauks direction. This high occupation level will lead to potential crossing conflicts since the buffer time between two potentially conflicting movements is limited (see Figure 87 below). Thus, small delays of trains in one direction are likely to cause additional following delays.

To reduce the amount of crossing conflicts, a cut-and cover for 1520 mm on the south side of the station would be beneficial. This allows for more flexibility in future timetabling and operation. Since a cut-and-cover is implemented for Rail Baltica anyway an additional 1520 mm track could be implemented parallel to the RB main line tracks under-passing the main line to Jelgava. The initial solution highlighting the principle to establish a cut-and-cover for 1520 mm is highlighted in Figure 88 below. This variant was derived from the proposed track layout assuming double track from Torņakalns to Zasulauks (or Marupite River junction, if 3rd track Marupite – Zasulauks is implemented as suggested in chapter 6.4).

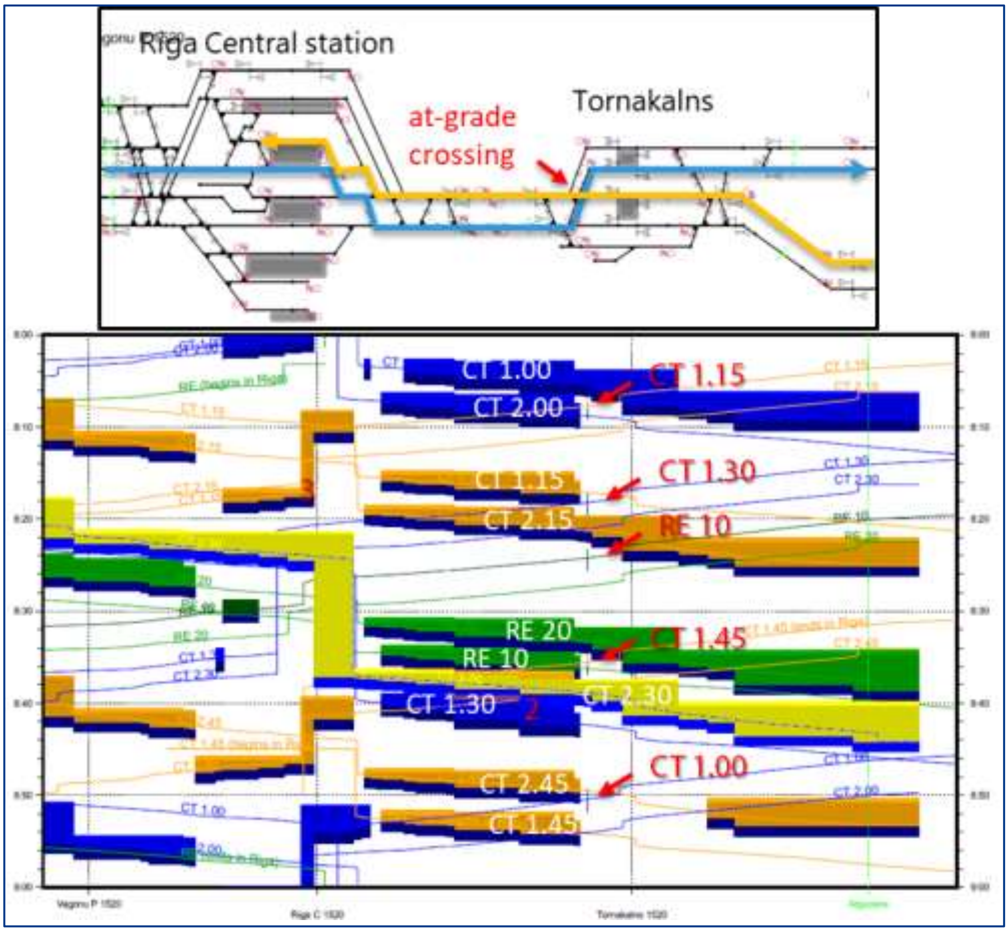


FIGURE 87: POTENTIAL AT-GRADE CROSSING CONFLICTS IN TORŅAKALNS STATION (RIGHT HAND RUNNING OVER DAUGAVA RIVER BRIDGE)

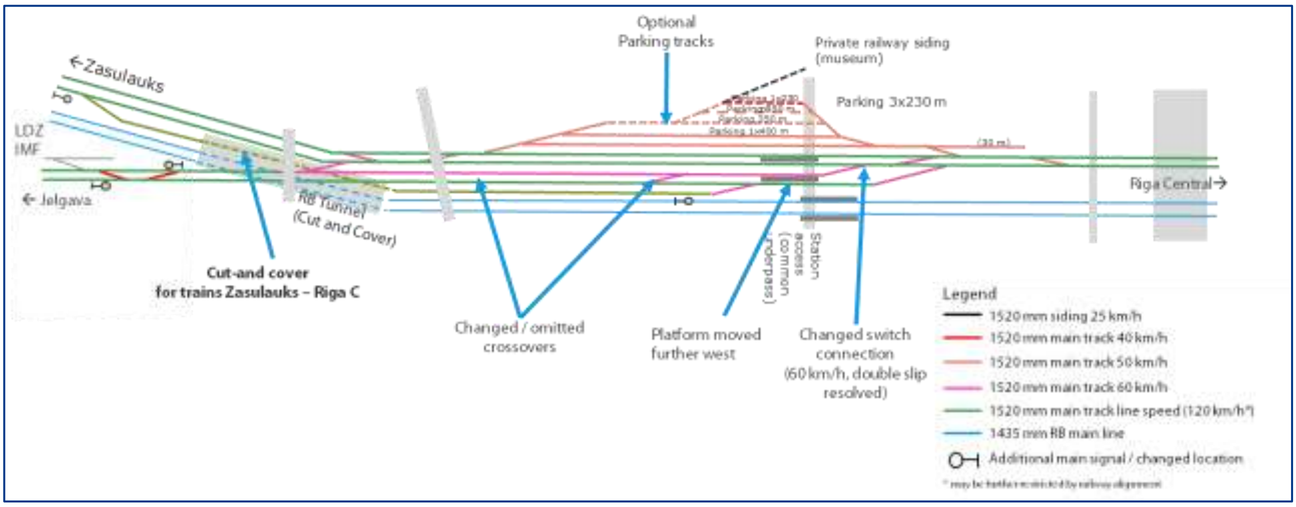
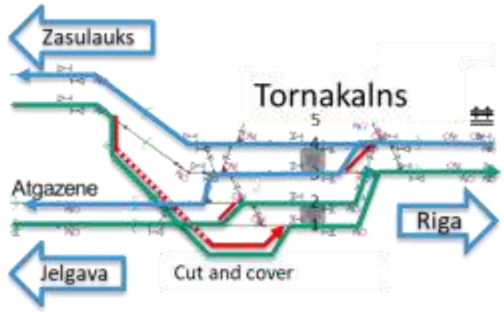


FIGURE 88: TORŅAKALNS STATION – INITIALLY SUGGESTED LAYOUT WITH CUT-AND-COVER SOLUTION



Reduction of potential conflicts in case of smaller delays

Infrastructure	Affected services	Conflicts per hour (peak)	Conflicts per hour (off-peak)	Max. train pairs per hour (peak)*
Original layout	CT, FR, RE	5	1	9
Cut and cover	RE 20, FR	1	1	9

* Suburban+Regional passenger+Freight trains

FIGURE 89: REDUCTION OF CROSSING-CONFLICTS BY 1520 MM CUT-AND-COVER IN TORŅAKALNS

As can be seen, the number of crossing-conflicts can be significantly reduced by the proposed cut-and-cover at the south side of the station.

Results from initial timetabling studies indicate, that up to 9.5 train pairs per hour can be timetabled for the proposed line concept, if bidirectional running over Daugava River is not applied as part of timetabled operation. This number of trains cannot be easily increased due to the remaining crossing-conflicts in Riga Central station. This means no freight train and only one hourly CT service to Daugavgrīva can be implemented during peak hours if right-hand-running over Daugava river bridge is applied. This confirms that the proposed timetable structure with symmetry node in Riga Central station will be a good solution to maximize utilisation of existing infrastructure.

In the proposed master timetable, the amount of potential crossing conflicts is minimised by introducing timetabled bidirectional running on both main tracks over Daugava river bridge along with the introduction of the symmetric timetable. With this timetable structure it was possible to provide for all required paths in the peak hour (see above). If the line concept (origin and destination of trains) or the timetable structure is changed, additional bottlenecks will occur, which need to be solved. This is confirmed by the results of the timetabling study. In the first version no left-hand running over Daugava river bridge was introduced. It was not possible to develop a stable timetable fulfilling all requirements as discussed above.

Therefore, it is recommended to implement the cut-and cover solution in order to provide more flexibility for later changes of the train service pattern and to ease coping with disturbed operation. To respect space constraints and to integrate the recommended solution to provide a third track for freight trains between Zasulauks and Torņakalns as well as to support left-hand running over Daugava River bridge the optimized track layout depicted in Figure 90 shall be used as basis for check of its technical feasibility.

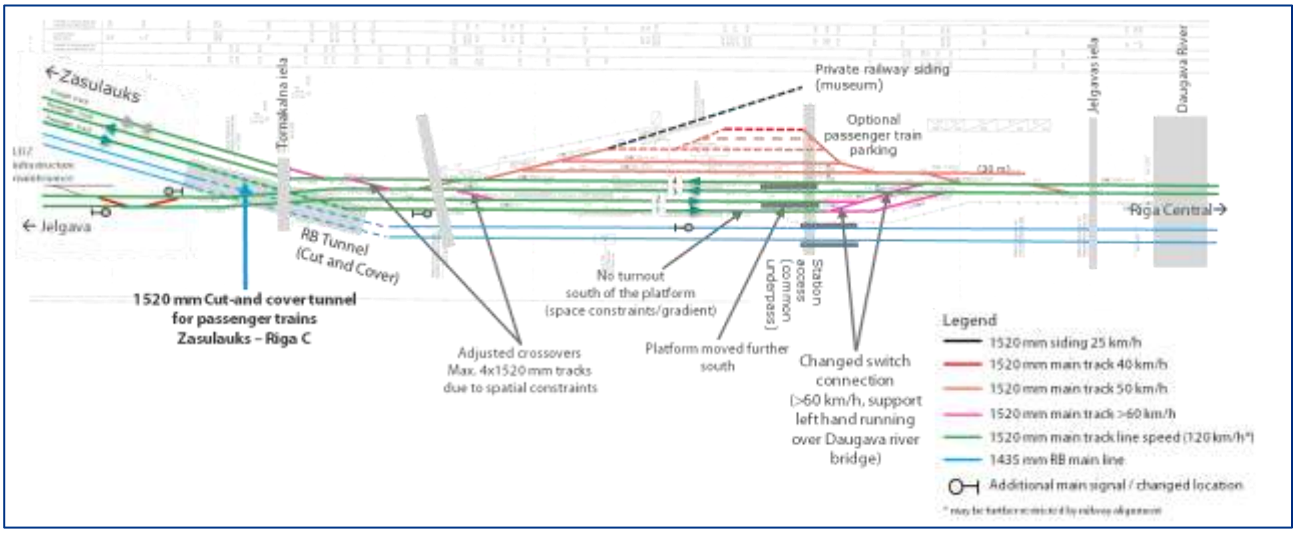


FIGURE 90: TORŅAKALNS STATION – OPTIMIZED LAYOUT WITH CUT-AND-COVER SOLUTION

6.3. Section Riga Central station – Torņakalns

This line section is the section with the most traffic and – together with the station entrances on both side one of the ruling potential bottlenecks. To exploit this bottleneck, bidirectional running over Daugava river bridge is part of the master timetable 2026/36 as developed in this study.

Bidirectional running over Daugava river bridge is already supported by the current interlocking system. To fully support the proposed master timetable the block sectioning on the left-hand track shall be equivalent to the sectioning on the right-hand track. This applies for both directions (Riga Central - Torņakalns and Torņakalns – Riga Central. If the signalling system is upgraded as part of reconstruction of Riga Central station or at a later time it needs to be ensured, that the capacity is not compromised (e. g. if protection section will be required resulting from future interlocking system upgrades).

6.4. Section Torņakalns – Zasulauks

In the line section Torņakalns – Zasulauks Rail Baltica will be implemented in parallel south of the existing alignment. Because of this realignment of 1520 mm running lines and removal of the southern freight passing loop track (former track 4) of Zasulauks station is required. Precondition for Rail Baltica implementation is also the replacement of the existing level crossings by overpasses or underpasses for 1435 mm and 1520 mm gauge.

For 1520 mm, a new passenger stop at Stradiņi shall be implemented. Last but not least a redesign of Zasulauks station is required to allow double tracking of the line to Bolderaja-1 in order to accommodate a 30 min passenger service to Daugavgrīva in addition to the freight services.

The proposed track layout is presented in Figure 92 and Figure 95 below. This does include the following measures:

- Implementation of passenger platforms as island platform at Stradiņi. The platforms shall be located such, that access to the platforms can be provided via the proposed new Ventspils road overpass. Implementation of island platform is beneficial to support bidirectional running on short notice.
- Provision of an extended freight passing loop east of Zasulauks station. Currently a freight passing loop already exists north of the running lines. It is proposed that this shall remain and be upgraded to accommodate freight trains with 850 m length. Analysis of the master timetable indicated that it is beneficial, if freight trains towards Bolderaja can use a diverging route latest before reaching Stradiņi passenger stop to shorten minimum required headway times between passenger and freight services In the developed master timetable this is necessary due to the required tight train sequence and the meeting of freight trains and passenger trains from/to Bolderaja in Zasulauks (see Figure 92 below). Furthermore, this third track will provide an additional buffer which could be used until double tracking to Bolderaja is implemented during construction stage, subject to detailed phasing of construction works. Analysis of timetable structure indicates that the eastern turnout for this third track shall be located west of Stradiņi passenger station. This

might require extension of the track as far as Marupite river bridge in order to use a straight track section to provide the necessary turnout and crossovers. The passing loop shall be equipped for bidirectional running.

- Redesign of the west head of Zasulauks station. To accommodate the future traffic from/to Bolderaja an additional crossover is required to allow trains from Bolderaja to enter the main line on the east side of the station. This crossover shall be designed for a turnout speed of at least 60 km/h.

- Relocation of 1520 mm passenger platforms in Zasulauks station. To accommodate the additional crossovers at the west side of the station, the passenger platforms are to be moved towards Lielirbes iela road overpass. The existing at-grade pedestrian crossings are to be replaced by an overpass. This solution can be integrated with Lielirbes iela road overpass road overpass. However, the road design should be more attractive and support interchange to public transport as well as a decent quality of stay for the passengers.

- Provision of crossovers (marked as option 1 in Figure 95 below) on the line towards Imanta east of Zasulauks station. These crossovers will support single track working and shall thus be implemented prior to start of construction works for Rail Baltica in line section Zasulauks – Imanta. In case the PV rolling stock depot is kept, it could be considered to use the eastern crossover to provide a second entrance from Imanta to the depot on the west side of the depot.

- Provision of an additional crossover to allow trains from Tukums to enter track 1 and 2 of Zasulauks station (marked as option 2 in Figure 95 below). This crossover shall be located closed to Zasulauks station, as far as the curved alignment of the main line on the west side of Zasulauks allows.

- Upgrade of passenger platforms for Depot station. The existing stop at Depot station shall be only kept, if the PV rolling stock depot will operate in the future or if the future redevelopment in the area will provide enough potential passengers (e.g. new residential zones and/or workplaces and decent access to the station by foot and bicycle. Otherwise the stop could be closed, since the area is served well be the adjacent stations (Zasulauks and Zolitūde) and access from main road network to the station is not attractive. If it is kept, the platforms and platform access shall be upgraded. To support bidirectional running of trains on short notice an island platform would be beneficial, subject to technical feasibility.

With the proposed third track/passing loop west of Torņakalns station the length of the station tracks shall be optimized for the proposed suburban passenger services (train length 110 m with future extension to 220 m for double traction in the long term). In addition to that a reserve for implementation of overlaps in a future signalling system shall be foreseen. Overall, these requirements are satisfied if a track length of 360 m is provided (distance between exit signals in both directions).

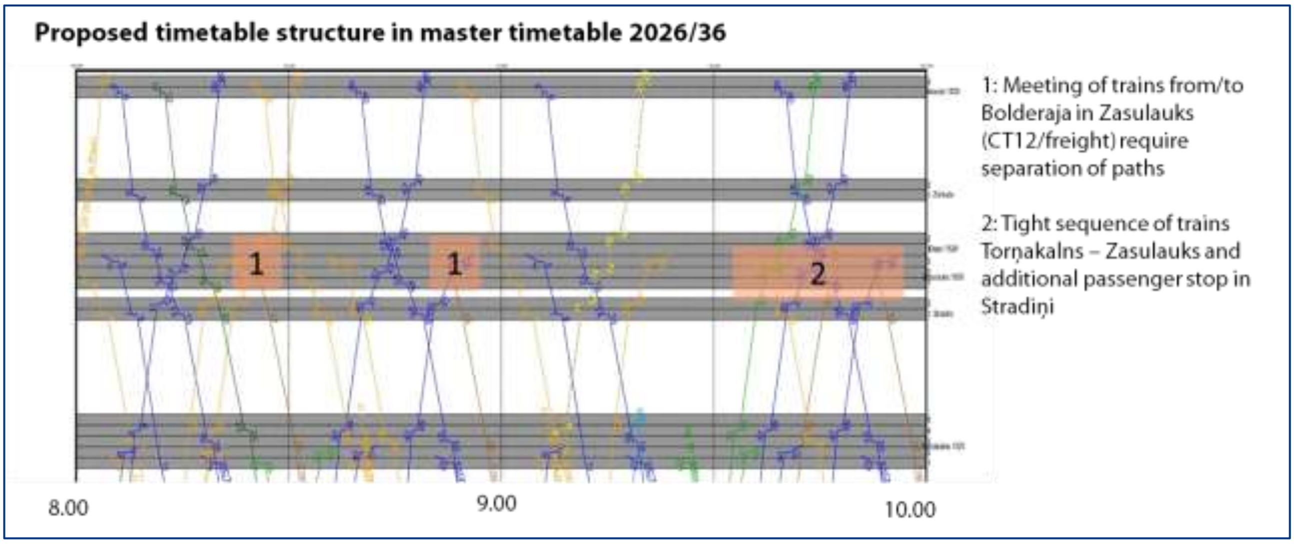


FIGURE 91: POTENTIAL BOTTLENECKS TO BE ADDRESSED IN TRACK LAYOUT OF SECTION TORŅAKALNS-ZASULAUKS

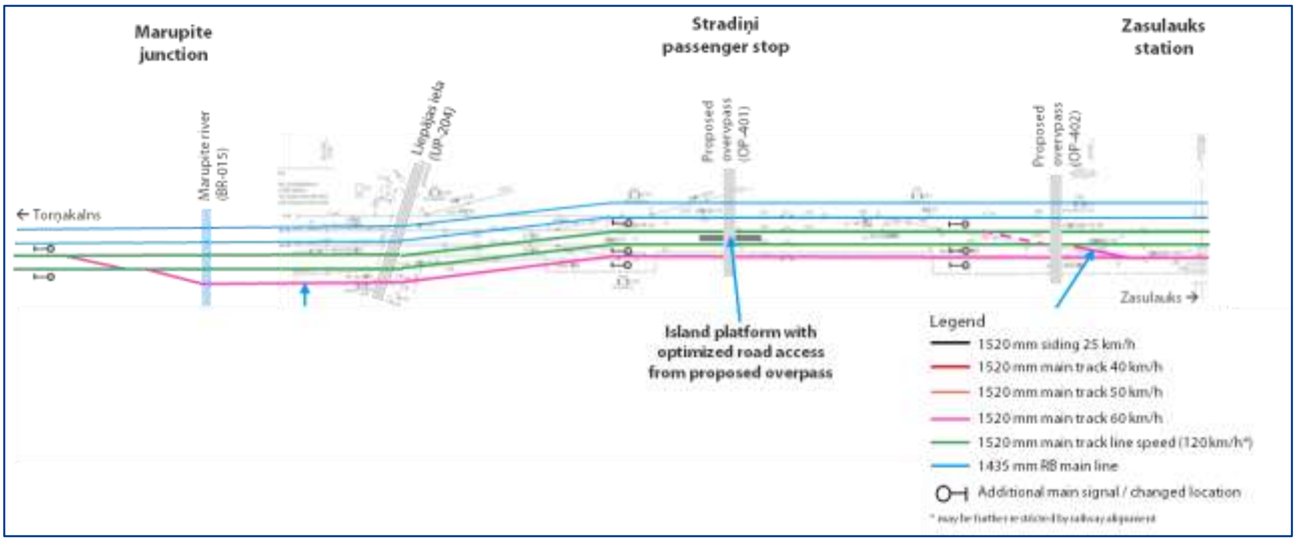


FIGURE 92: SUGGESTED TRACK LAYOUT FOR SECTION TORŅAKALNS – ZASULAUKS (3RD TRACK ONLY FOR SECTION MARUPITE RIVER JUNCTION - ZASULAUKS)

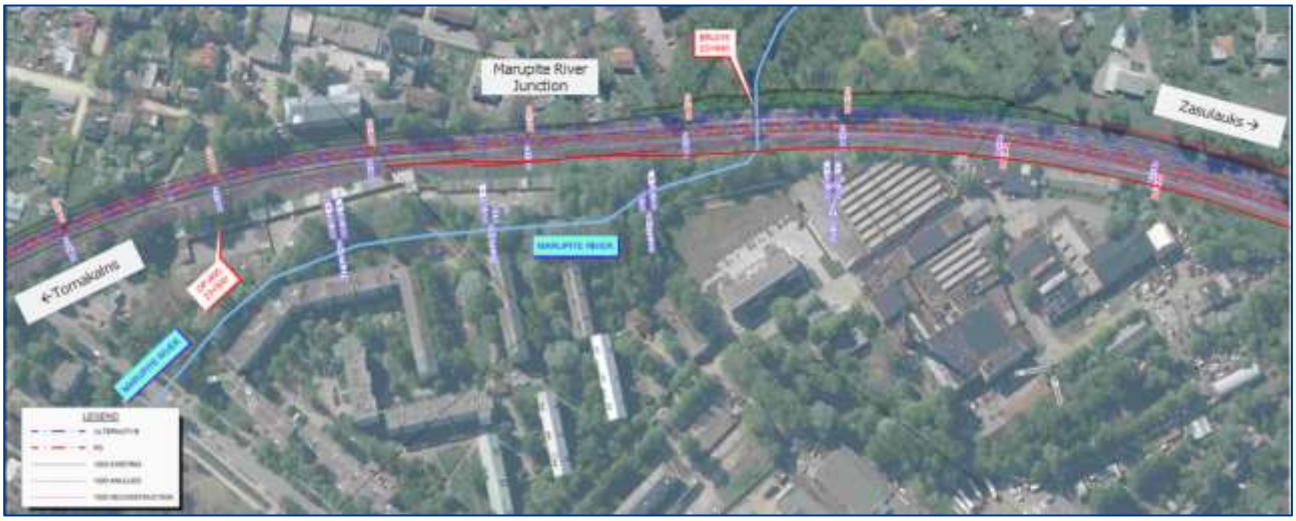


FIGURE 93: LOCATION OF MARUPITE RIVER JUNCTION

In case the Torņakalns cut-and-cover for 1520 mm trains to Riga is implemented, the 3rd track shall be extended to Torņakalns station. The proposed track layout for this case is highlighted in Figure 94 below. The corresponding track layout of Torņakalns station is depicted in Figure 85 in chapter 6.3.

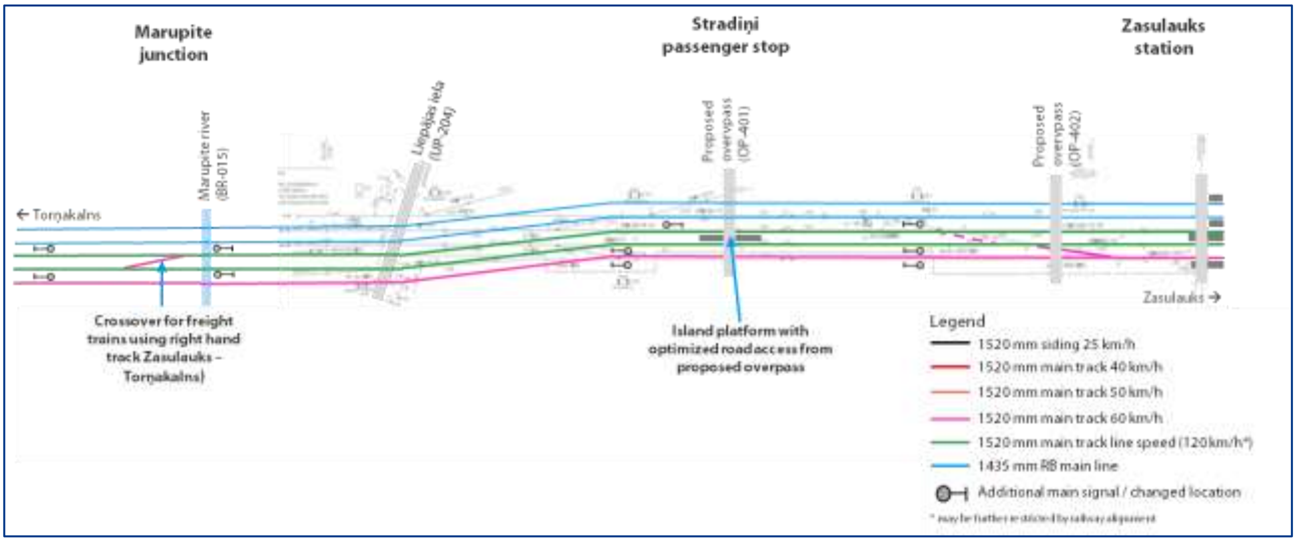
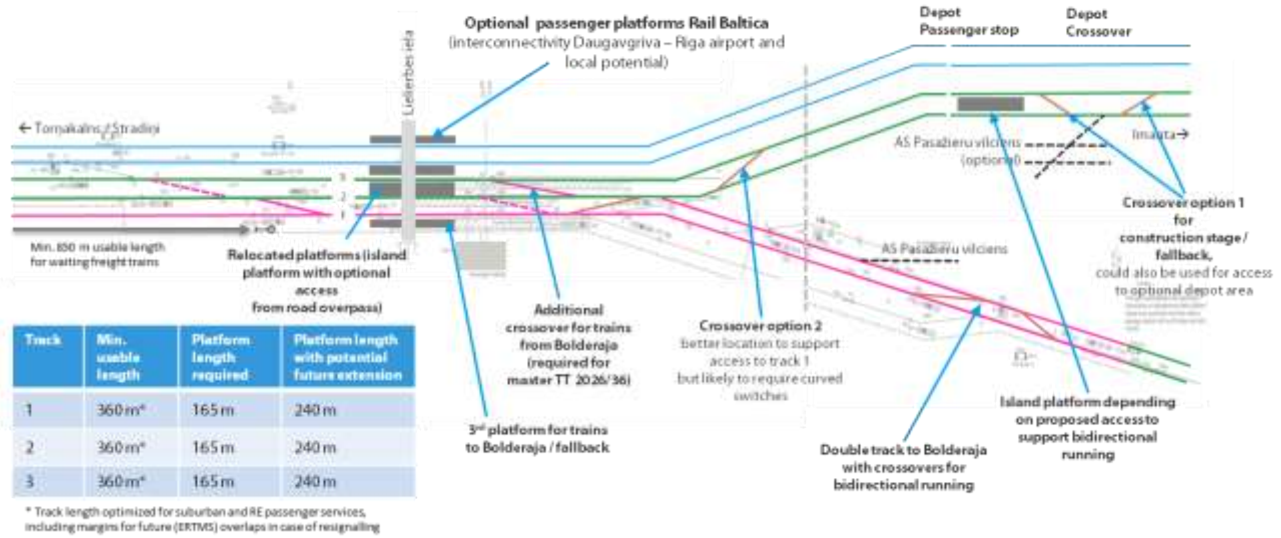


FIGURE 94: SUGGESTED TRACK LAYOUT FOR SECTION TORŅAKALNS – ZASULAUKS 3RD TRACK ON COMPLETE SECTION)



Track	Min. usable length	Platform length required	Platform length with potential future extension
1	360 m*	165 m	240 m
2	360 m*	165 m	240 m
3	360 m*	165 m	240 m

* Track length optimized for suburban and RE passenger services, including margins for future (ERTMS) overlaps in case of resignalling

FIGURE 95: ZASULAUKS STATION - PROPOSED TRACK LAYOUT

6.5. Line section Zasulauks – Imanta

- On the line section Zasulauks – Imanta the 1520 mm running lines are partly relocated to accommodate Rail Baltica and to provide space for 1520 mm passenger platforms. Imanta shall be implemented as interchange station between regional trains of both gauges allowing e.g. for rail connection Riga airport – Jūrmala with interchange at Imanta. The following enhancements are to be made from operational viewpoint to the proposed track layout:

- The existing stop at Depot station shall be only kept, if the PV rolling stock depot will operate in the future. Otherwhise the stop could be closed, since the area is served well be the adjacent stations (Zasulauks and Zolitūde) and access from main road network to the station is not attractive. If it is kept, the platforms and platform access shall be upgraded. To support bidirectional running of trains on short notice an island platform would be beneficial, subject to technical feasibility.

- To support more flexible bidirectional running Zolitūde station could be also implemented as island platform.

- If Zasulauks depot is kept, it must be ensured that the southern bypass track in the depot areas remains fully operational as electrified track to support future operation. Furthermore, the existing parking sidings east of the workshop shall be kept in full scale to ensure the site can be operated. A second access to the depot shall be provided on the west side of the depot (see also chapter **Error! Reference source not found.**).

- West of Imanta station two emergency crossovers shall be implemented. While these will be required during phased realignment of 1520 mm tracks on section Zasulauks – Imanta (see also section **Error! Reference source not found.**) keeping them would also be beneficial for operation in target stage since distance between the two adjacent stations with emergency crossovers (Zasulauks and Priedaine) is approx. 10.7 km with up to 5 passenger stops in between.

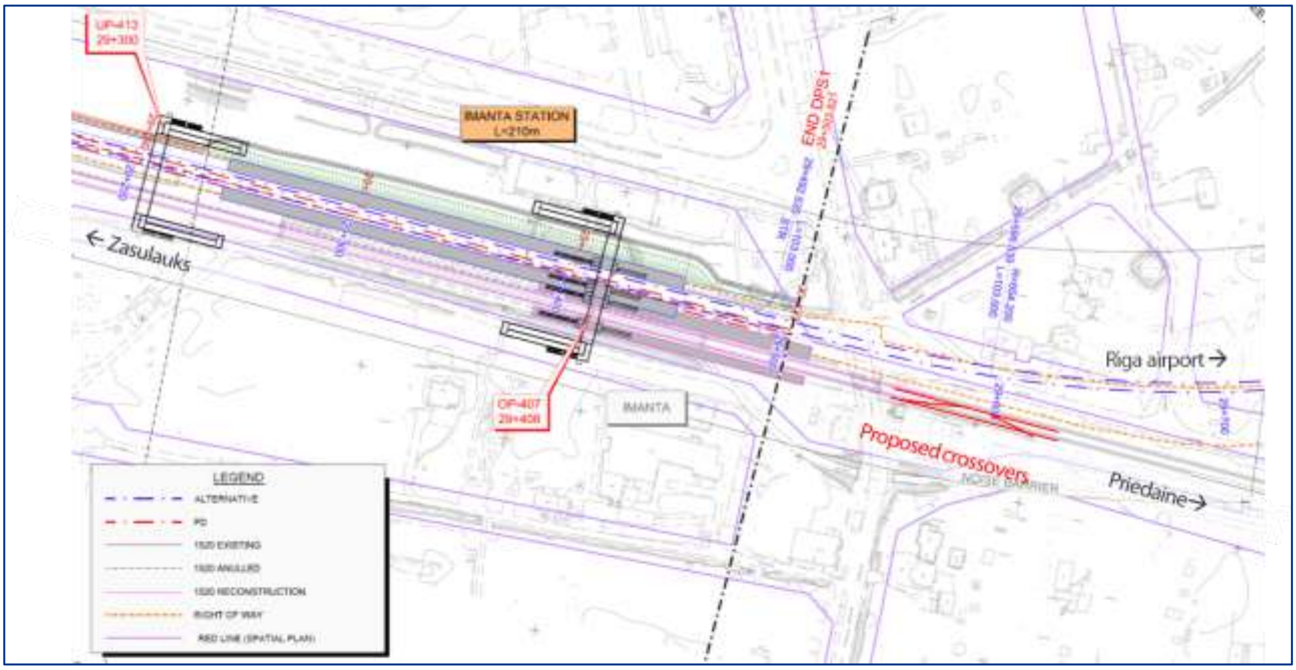


FIGURE 96: IMANTA STATION – LOCATION OF PROPOSED CROSSOVERS

6.6. Riga Central station

As outlined in chapter 4.1 of this report the overall track layout within the construction boundaries of Riga Central station was already fixed at the beginning of the study by RB Rail and EDZL. Thus, all analysis conducted in this study is based on the agreed track layout for 1520 mm and 1435 mm. The results of the timetabling study confirm, that a cyclic passenger timetable can be constructed fulfilling all requirements for the medium term (2026/36) as well as for the foreseeable demand for 2036. However, the workability of the developed solution could be further improved by:

- Providing infrastructure for simultaneous platform track occupation by two trains
- Providing suitable turnout speeds to shorten route node occupation times and to accelerate traffic.
- Upgrading infrastructure of Riga Central station to ease passage of freight trains

While the first measure is targeting at providing a more stable passenger timetable and to create a more attractive interchange situation for the passengers changing trains in the proposed node the second measure and third measures are targeting to allow more freight train paths during peak and daytime hours and to increase operational stability. In the following sections these measures will be discussed in more detail.

6.6.1. Turnout speeds and speed on station tracks

As outlined the new track layout was designed for 50 km/h station speeds. This requires 1/11 turnouts. However, in the current track layout and in the track layout inside the construction boundaries for Riga Central station and in the switch area at the east side of Riga Central station several 1/9 turnouts remain. According to railway operational rules these turnouts could only be passed on diverging track with a maximum speed of 25 km/h. According to track speeds applicable as per LDz network statement the maximum speed on the main routes for passenger tracks is 35 km/h. With such speeds the proposed quantity structure cannot be implemented (occupation times of route notes and block sections will be too long). The main limitations can be described as follows:

- On the densely occupied west side of Riga Central station trains from and to track 9 are limited to 25 km/h maximum speed. In the master timetable this route is used for passenger trains on hourly basis (CT 2.30 direction Jelgava – Aizkraukle).
- On the east side exit routes from track 1,2 and 3 towards Zemitāni and Aizkraukle will be restricted to 25 km/h as well. As per master timetable this relates e.g. to the RE trains to Sigulda and Valga (RE30/IRE30) as well as to peak hour services as R70 to Madona.
- On the east side, entrance routes from Aizkraukle (main line) to tracks 1,2, III, IV, 5, X will be limited to 25 km/h. According to the master timetable such entrance routes are used by CT2.00 and R70 from Madona.
- Empty coaching stock movements from and to Vagonu parks stabling area are affected as well and will also be restricted to 25 km/h on the complete route length from the platform to Vagonu parks.

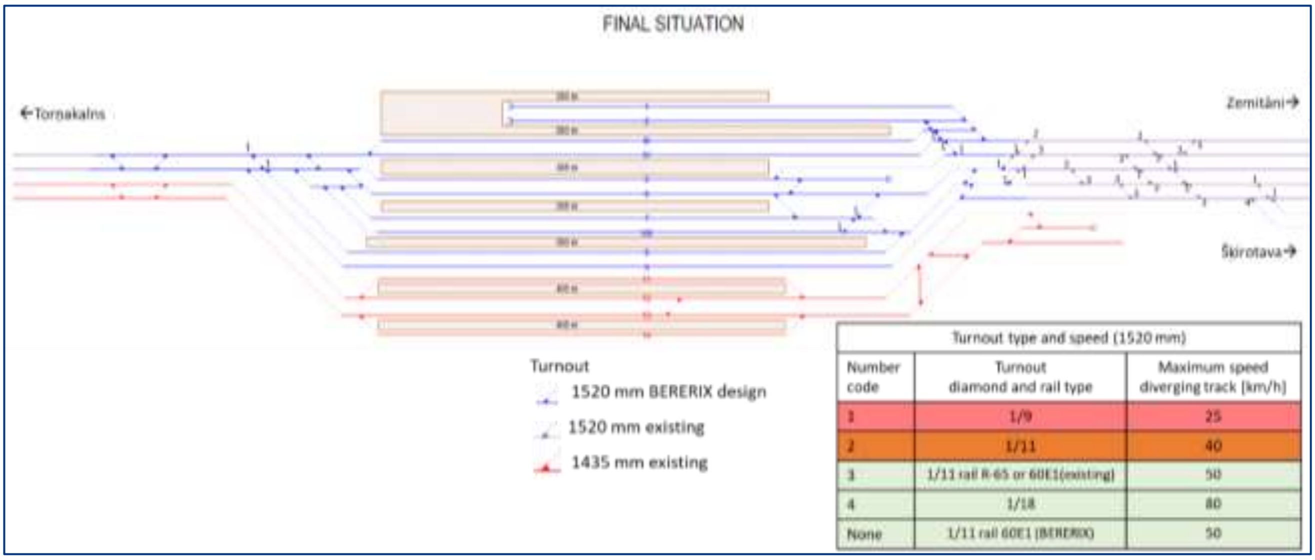


FIGURE 97: CURRENTLY PLANNED TURNOUT SPEEDS FOR FINAL STAGE OF RIGA CENTRAL STATION[73]

[73] Source: Elaboration by RB Rail (A. Čigaka) based on track layout from BERERIX and information from LDz

Thus, it is highly recommended

- to ensure: that 1/9 turnouts which remain in the track layout can be operated with at least the current speed as per LDZ network statement (35 km/h) also after approval of new track layout by change of operational rules or agreeing on a related deviation from operational standards for Riga Central station, if possible speed shall be increased to 40 km/h (at least for passenger trains).
- to replace existing 1/9 turnouts by 1/11 turnouts wherever possible to allow harmonized speeds and to smoothen operation. This especially applies to remaining turnouts east of the construction boundary for Riga Central station.

In addition to that, it is recommended to check, whether the curved sections in the track layout can be adjusted to provide for higher speeds on routes with straight turnouts. This would allow further acceleration of operation in case the signalling system and the operational rules are adjusted to allow for more flexible application of speeds inside the station boundaries. Currently the maximum speed is defined on a per track basis in the operational rules since the signalling system does not allow for different reduced speeds.

These measures are essential to allow the proposed service quantities and to support the proposed principle of a cyclic timetable with Riga Central station as symmetry node.

6.6.2. Double occupation of platform tracks

In the currently proposed solution for Riga Central station the provided through platforms are significantly longer than most of the trains using these platforms (RE and CT EMU/DMU with typically 110 m train length). In the current track layout, there are not enough platforms to accommodate all trains during the 30-minute node. All in all, seven platforms are available while theoretically eight platforms would be required.

Introducing double platform track occupation would allow to accommodate two trains behind each other on one platform track. Therefore, the track needs to be divided into two sections. The train ahead is to be protected by a main signal, which is to be located in the middle of the platform. This solution is widely used in Central and Western Europe (e.g. Germany, Netherlands). Typically, trains are entering the platform at reduced speed, depending on applicable operational rules either from entry signal or from beginning of the platform.

Implementing such solution does provide various benefits and is adding much more flexibility to future operation:

- It allows to provide for a more attractive platform occupation with dedicated platforms for suburban trains, allowing changing tracks at the same platform. One example is illustrated in Figure 98 below. This solution would allow all suburban lines including CT12 (Sigulda – Jugla - Daugavgrīva) to take part in the 30-minute node. This approach would strengthen cross-city connections over Daugava river bridge, since interchange between all suburban trains in the same direction (east or westbound) can be performed conveniently without the need to climb stairs or use staircases and escalators. The resulting platform occupation would allow to introduce dedicated platforms for east and westbound suburban trains which eases routing for the passengers and contributes to easy usability of suburban trains.

- Alternatively, it would allow to provide more through running RE trains (e.g. Valga – Sigulda – Ventspils).
- It allows to exchange rolling stock in Riga Central station by splitting through running services (e.g. RE20 Daugavpils – Liepaja) as emergency or regular measure. The new trainset for the departing train would wait at the first position. The second train would arrive at the second position. Passengers would change train sets at the same platform by walking along the platform without the need to climb stairs or escalators.

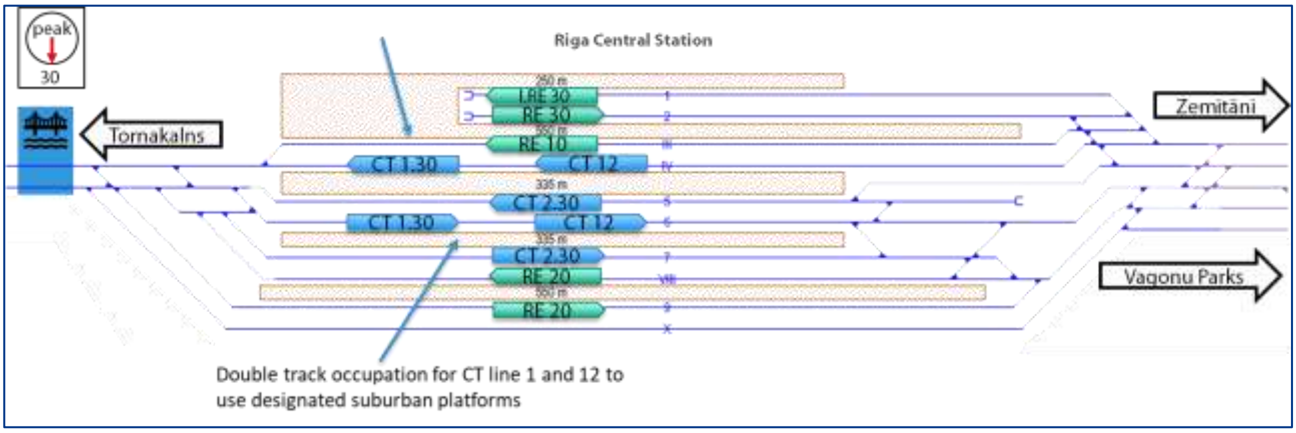


FIGURE 98: TRACK OCCUPATION IN RIGA CENTRAL STATION WITH DOUBLE TRACK OCCUPATION AND DEDICATED SUBURBAN PLATFORMS FOR EAST AND WESTBOUND TRAINS

The abovementioned use cases illustrate the added value of double track occupation to provide an attractive, reliable and efficient passenger service. Thus, it is recommended to check the feasibility of double track occupation by adoption of the signalling system and related update of operational rules in Latvia, which currently do not foresee this type of operation. Finding a generic solution for Latvian conditions might be required anyway if train coupling and sharing at Jelgava and Krustpils shall be implemented to provide more direct connections from and to Riga without using additional paths, which are not be available during peak hours. Necessary investigations include:

- Definition of technical solution (signal aspects, application of ALSN, definition of safety overlap)
- A detailed safety assessment to prove that sufficient protection of the train in front when the second train is entering the platform track also including the risk of signal misreading's by the driver
- Effort to adopt the existing signalling system to provide for double platform occupation

Based on this a decision can be made when to implement the double platform occupation (either as part of reconstruction or at a later stage when the interlocking is modernized, or the train protection system is replaced).

Regarding reconstruction works in Riga Central station availability of this principle would be also very beneficial for stage 2 of reconstruction, when all the traffic flow needs to be accomodated on just 5 through platform tracks (e.g.

phase 4A/4B as outlined in chapter **Error! Reference source not found.**) since the timetabling study indicates that n ot all traffic can be handled within the framework of the proposed master timetable (see discussion about RE 20 from/to Krustpils in chapter **Error! Reference source not found.**).

Thus, it is highly recommended to further investigate technical and operational feasibility of this approach and to consider implementation of this approach in line with required software changes to support construction phasing.

Last but not least this approach would make it easier to reserve one of the platform tracks for more flexible freight and night train operation.

6.6.3. Reduce restrictions for freight operation through Riga Central

In the current track layout of Riga Central station two dedicated tracks are provided for the passage of freight trains. Riga Central station and the adjacent track sections must be properly designed for handling of freight trains which are expected to operate on the relations Jelgava – Šķirotava (trains from/to Liepaja and Lithuania) and Bolderaja (traffic flows between Šķirotava and western port area). In the future track layout only track X is available as dedicated freight track. Trains leaving this track for Torņakalns (and further on Bolderaja/Jelgava) need to cross the running line for trains to Riga Central station to Jelgava. Overall, the Daugava river bridge is heavily occupied with up to 12 passenger trains per direction in the peak hour and up to 8 passenger trains outside the peak hour. Resulting from this freight trains from/to Šķirotava are required to stop in Riga Central station to synchronize with the available slots over Daugava river bridge and from/to Šķirotava. Timetable analysis shows that not all required freight train paths can and should use track X in order to minimize crossing conflicts at the east and west side of Riga Central station. In addition to that, waiting times of the freight trains at track X are rather long (up to 16 minutes). For the developed master timetable, the number of freight train paths, which could be operated via track 10 will be limited to approx. 3 train paths (sum for both directions) outside the peak hour.

To increase flexibility of freight timetabling it is suggested to upgrade one additional station track to accomodate westbound freight trains. To achieve this, two options were studied:

- Option 1: upgrade track layout to increase usable length of track III to 850 m
- Option 2: upgrade track layout to increase usable length of track 5 to 850 m.

In both cases these tracks shall be available as platform tracks for passenger services, but free slots shall be useable for freight trains.

In the current and proposed infrastructure, the usable length of track III is not suitable to accommodate freight trains with a maximum length of 850 m (only 650 m are available according to proposed track layout for Riga Central station). To overcome this bottleneck, it is recommended to change the layout of the switch area on east side of Riga Central station so that freight trains stopping in track 3 do not block arrivals and departures in the dead end platform tracks 1 and 2. The layout of the crossovers proposed in this area is designed for simultaneous arrivals and departures on tracks 1 and 2. This shall remain in the future track layout, since the results of the timetabling study confirm that this feature will be required. The proposed solution is depicted in Figure 99 below. To achieve the aimed for improvement of track layout to accommodate 850 m long freight trains in track III without compromising simultaneous arrivals and departures at tracks 1 and 2, an additional bridge over Lāčplēša iela needs to be constructed and the crossovers east of on the east side of Riga Central station need to be shifted further east as indicated in Figure 99 below.

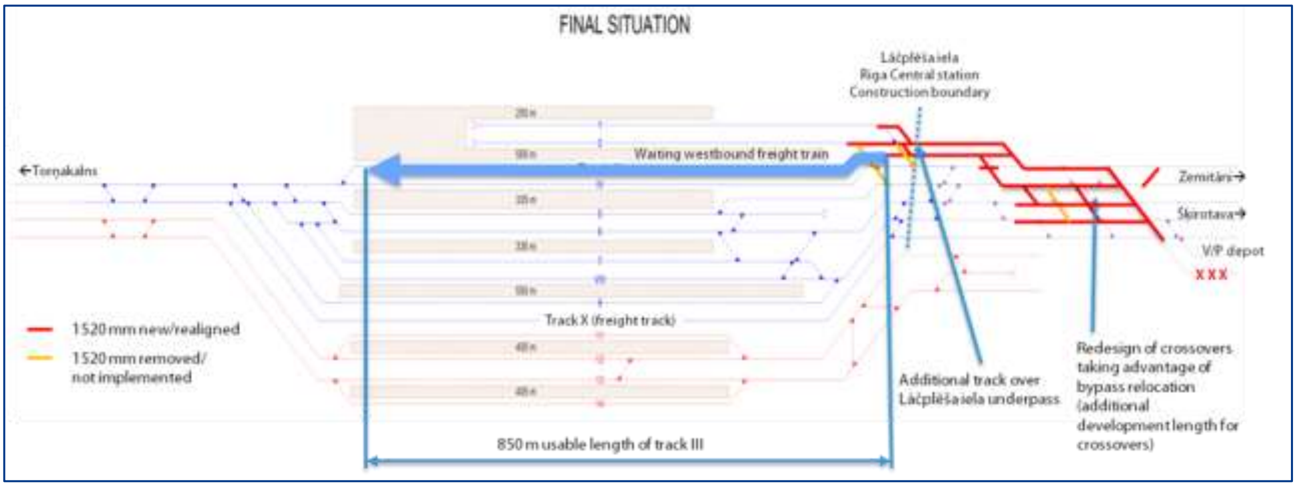


FIGURE 99: PROPOSAL EXTEND USABLE LENGTH OF TRACK III FOR 850 M FREIGHT TRAINS (OPTION 1)

The second option (upgrade of track 5 to 850 m usable track length) is depicted in Figure 100 below.

The advantage of this proposal is, that it can be implemented more easily and likely at lower cost since no additional overpass over Lāčplēša iela is required. Furthermore, the required amount of changes of the switch area on the east side of Riga Central station is much lower. Disadvantage is that the turning siding for suburban trains at platforms 5 and 6 cannot be provided. On the operational side freight trains through track 5 would not interact with traffic to Sigulda and would enter Riga Central station on a straight route (if using the main line from Šķirotava and not the bypass). Overall, track 5 would be the better candidate to provide 850 m track for freight trains.

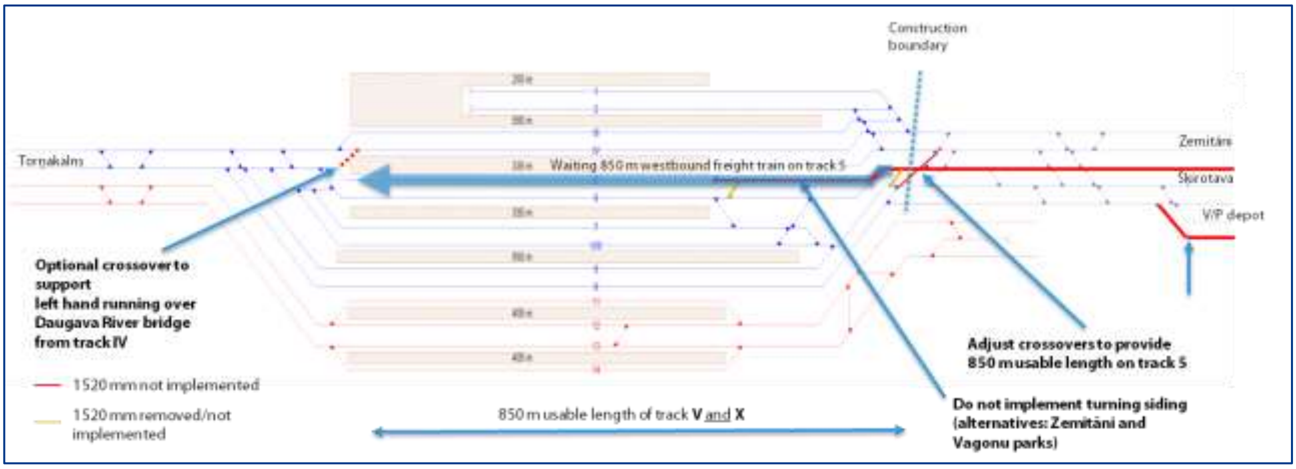


FIGURE 100: PROPOSED SOLUTION TO EXTEND USABLE LENGTH OF TRACK 5 FOR 850 M FREIGHT TRAINS

The results of the timetabling study indicate that usage of these tracks for freight trains will result in the need to free up track capacity by shifting trains to other platforms. Therefore, double occupation of platform tracks would be beneficial to free up the necessary track capacity.

Due to the tight time windows over Daugava River bridge it would be best, if any time losses due to required stop of freight trains and/or slow turnout speeds could be minimized. This means:

- Ease provision of necessary traction power by using modern rolling stock and by electrification of line section Šķirotava – Bolderaja
- Increase turnout speeds to allow higher maximum speed on station tracks
- Change operational rules to utilize maximum speed of track design (e.g. more flexible station limits, different speeds for entrance and exit routes)
- Provide flexible pathing with different runtimes according to train weight and length
- Provide 2 tracks suitable for 850 m freight trains in Riga Central station

By these measures it can be ensured that freight trains can use the envisaged paths and chances get higher to realize at least 2 freight train paths per direction in the off-peak and to allow for one stable freight train path per hour per direction also in the peak hour, subject to further timetable stability analysis and optimization.

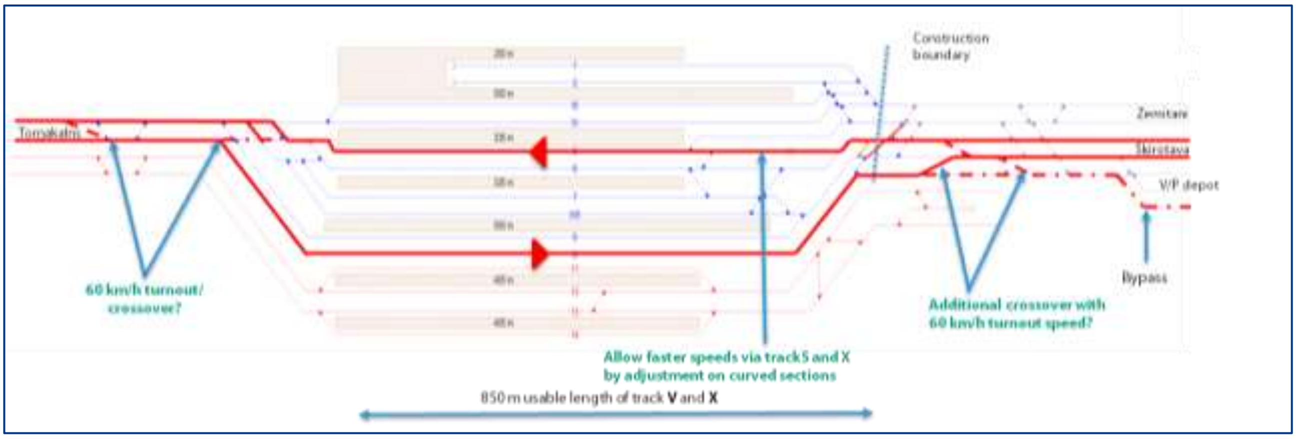


FIGURE 101: OPERATIONAL PRINCIPLE TO PROVIDE TWO FREIGHT TRAIN PATHS SIMULTANEOUSLY THROUGH RIGA CENTRAL STATION AND TO INCREASE SPEEDS

6.7. Riga Central station – Šķirotava

6.7.1. Introduction

As already highlighted in chapter 4.2 track layout in this section will as well be impacted by reconstruction of Rail Baltica. According to most restrictive alignment alternative 2 currently under discussion, which is used as basis for this study, it would be necessary to relocate the southern Vagonu parks bypass and to remove some of the parking tracks. Additionally, Vagonu parks is the most promising location among the already assessed sites to implement the maintenance depot for regional passenger trains. This raises the questions about

- Future necessity of the bypass?
- Which area is urgently required on the south side of the Vagonu parks maintenance facilities and how the lost capacity for parking tracks can be compensated in the light of the growing 1520 mm fleet?
- Where shall the platforms of Vagonu parks station be located?

6.7.2. Necessity of the southern bypass at Vagonu parks

To check necessity of the 3rd track Riga – Šķirotava, the master timetable was developed without using a 3rd track between Riga Central station and Šķirotava. Overall a conflict free timetable could be implemented without scheduling freight trains over the bypass Thus, the bypass would have mainly a relief function to support operation in case of disturbed operation. Based on this the usability of the 3rd track was analysed.

In Figure 102 the proposed routing of freight trains between Šķirotava and the Daugava river bridge is shown. Additionally, the major bottlenecks are highlighted. It can be concluded that the bypass does not significantly contribute to avoidance of the main bottleneck which is the capacity of the dedicated freight track X and the need to cross contraflow traffic when leaving track X towards Daugava river bridge. Due to the need to stop in Riga Central station and due to the availability of free slot over Daugava river bridge, track X can only accommodate 3 trains per hour (2 eastbound, one westbound). That means to provide the additional westbound train must be routed through a platform track in Riga Central station.

The bypass could be occasionally used to allow a delayed eastbound freight to pass Riga Central station and to wait at the bypass for the next free slot into Šķirotava J parks or to allow a westbound freight to wait in the bypass before entering track X. This increases flexibility in daily operation and will contribute to overall timetable stability. For instance it would contribute to maximize the throughput over the bottleneck if freight trains can pass track X (applies to both directions) thus minimizing the occupation time of the route node on the west Side of Riga Central station.

Therefore, the bypass shall be kept operational from current state of affairs to allow stable operation of the freight service pattern and to minimize the use of platform tracks in Riga Central station by freight trains.

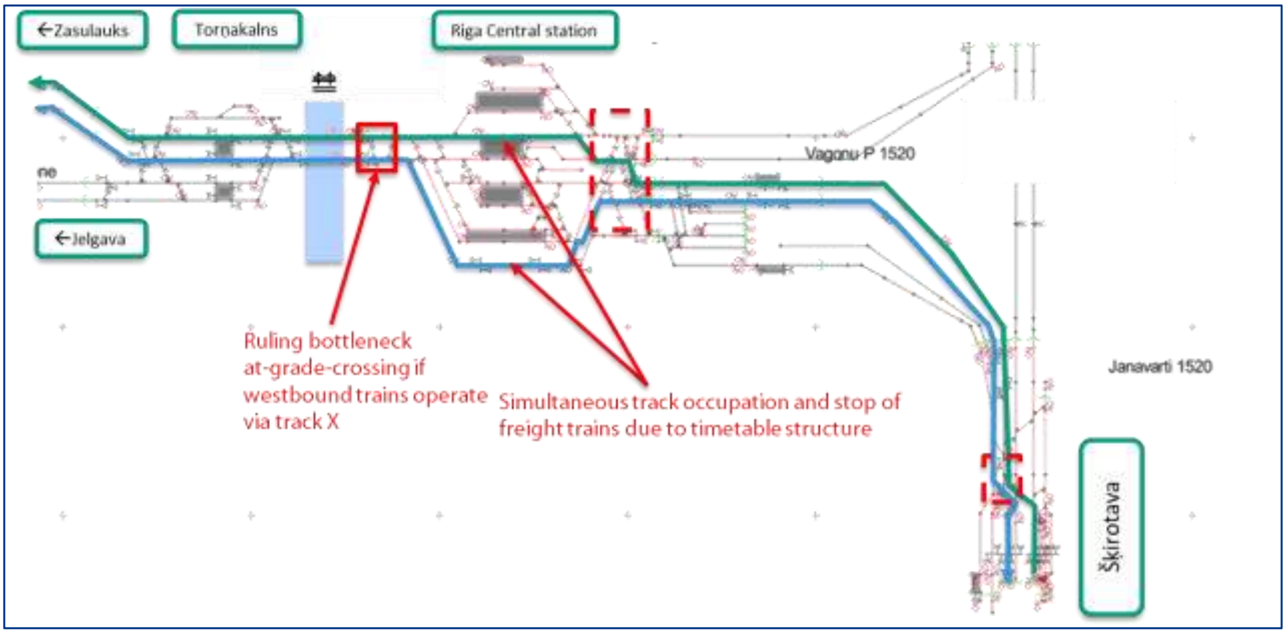


FIGURE 102: PROPOSED FREIGHT ROUTES ŠĶIROTAVA – TORŅAKALNS

In addition to the freight traffic analysis the positive impact of a third track for passenger services was checked. For passenger traffic, the bypass could be potentially useful for two specific use cases, which are both related to mixed traffic operation of RE and CT services in the 30-minute-node:

- Allow an arriving westbound RE20 (Daugavpils -Riga), which follows the slower CT2 Aizkraukle - Jelgava to get faster into Riga Central station, if CT2 is slightly delayed.
- Allow a departing RE20 to depart at Riga Central station in parallel with eastbound CT2.30 (Jelgava – Aizkraukle), thus compensating minor delays, e.g. caused by waiting for connecting services. This would minimize the delay of CT2.30 which follows the faster RE20.

The related routing of passenger services and the infrastructural requirements are highlighted in Figure 103 below. For the first use case a fast crossover at the west side of Šķirotava station would be required, to avoid additional conflicts with contraflow traffic and to minimize additional travel time required to traverse to the 3rd track. Furthermore, these solutions require the 3rd track to be located between the two running lines for the slower CT trains. Thus, the platform for eastbound trains at Vagonu parks would have to remain on the south side at the bypass. The bypass shall be aligned to allow a decent maximum speed (100 km/h).

Based on the current results of the study this solution is not recommended due to the additional investments required and the limited effect due to the short distance between Riga Central station and Vagonu parks and the need to take a slower route through Šķirotava station for the train which shall benefit (especially westbound RE20).

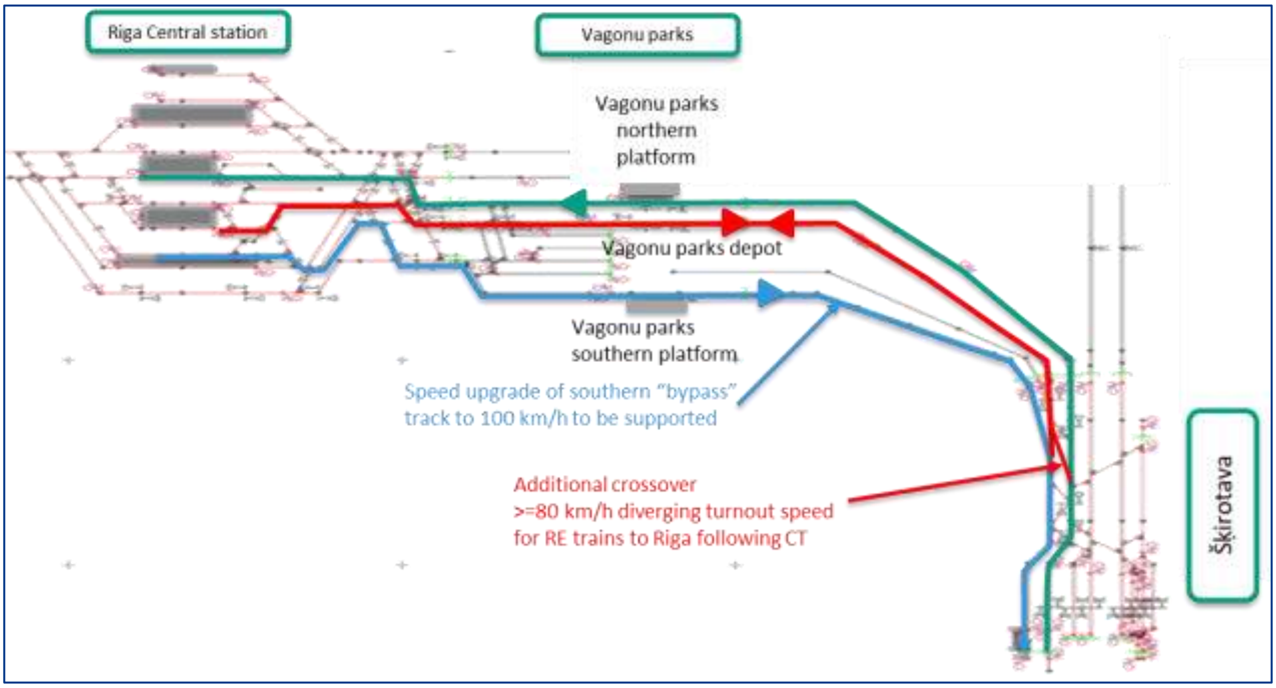


FIGURE 103: PRINCIPLE OF PASSENGER OPERATION TAKING ADVANTAGE OF 3RD TRACK RIGA – ŠĶIROTAVA

Based on this discussion it can be concluded that the bypass track south of Vagonu parks shall be kept and that it should be developed in a way that the bypass can be used for freight traffic.

6.7.3. Required space at the south side of Vagonu Parks station

Analysis of available parking capacity at Vagonu parks confirms that it is essential to provide a replacement solution, if the currently electrified parking tracks are removed. If the PV maintenance depot is implemented in Vagonu parks, no suitable alternatives exist within the area. Thus, tracks need to be newly constructed at alternative locations including access to main line and electrification. Closed to Vagonu area parks there are two alternatives:

- Option 1: separate track group north of the main line

- Option 2: extension and modernisation of existing former EV parking sidings.

For both options it is difficult to provide a direct connection to the maintenance facilities at Vagonu parks. At least they provide additional capacity closed to the maintenance facilities thus easing dispatching of train drivers and cleaning staff (interior cleaning).

According to the suggested integrated solution supporting the needs of both operators in the area (PV and L-Ekspresis) the area at the south side of the depot would be used by L-Ekspresis, preferably for parking and maintenance of the night trains. If this solution is chosen a detailed track layout study shall confirm the spatial requirements.

6.7.4. Location of platforms for Vagonu parks station

Concluding from timetable analysis it is recommended to relocate the platform to the north side of Vagonu parks station. To increase operational flexibility, it could be considered to provide an island platform between the running lines. The existing pedestrian overpass connecting Mazā Matīsa iela and Lauvas iela needs to be redesigned anyway to with implementation of Rail Baltica. This does include accessibility for persons with reduced mobility. This overpass should also be used to provide access to the platform at Vagonu parks station.

Relocation of the platform will free up space for Rail Baltica construction south of Vagonu parks station.

6.8. Riga Central station – Zemitāni station

The track layout of Zemitāni station is not directly impacted by implementation of Rail Baltica. Nevertheless, the station will see increased passenger traffic in the future (CT 12 Sigulda – Jugla – Daugavgrīva, increased RE/IRE service Riga – Valga (-Tartu). Thus, it is worth studying what could be improved and which facilities are required to support the developed train service pattern.

Based on the developed master timetable the following statements on track capacity can be made:

- At least four of the existing through platform tracks will be required to operate the proposed service pattern.
- Due to the at-grade-crossings at the north side of the station the north and southbound freight traffic flows shall be separated. In the proposed track occupation three tracks are used for freight trains on the relations Riga – Brasa (- Mangali) and Riga - Sigulda.
- To relief Riga Central station in case of an emergency and during construction stage it is beneficial to provide additional platform capacity for terminating trains.

The track occupation of Zemitāni station during peak-hour is provided in Figure 104 below to support the statements above.

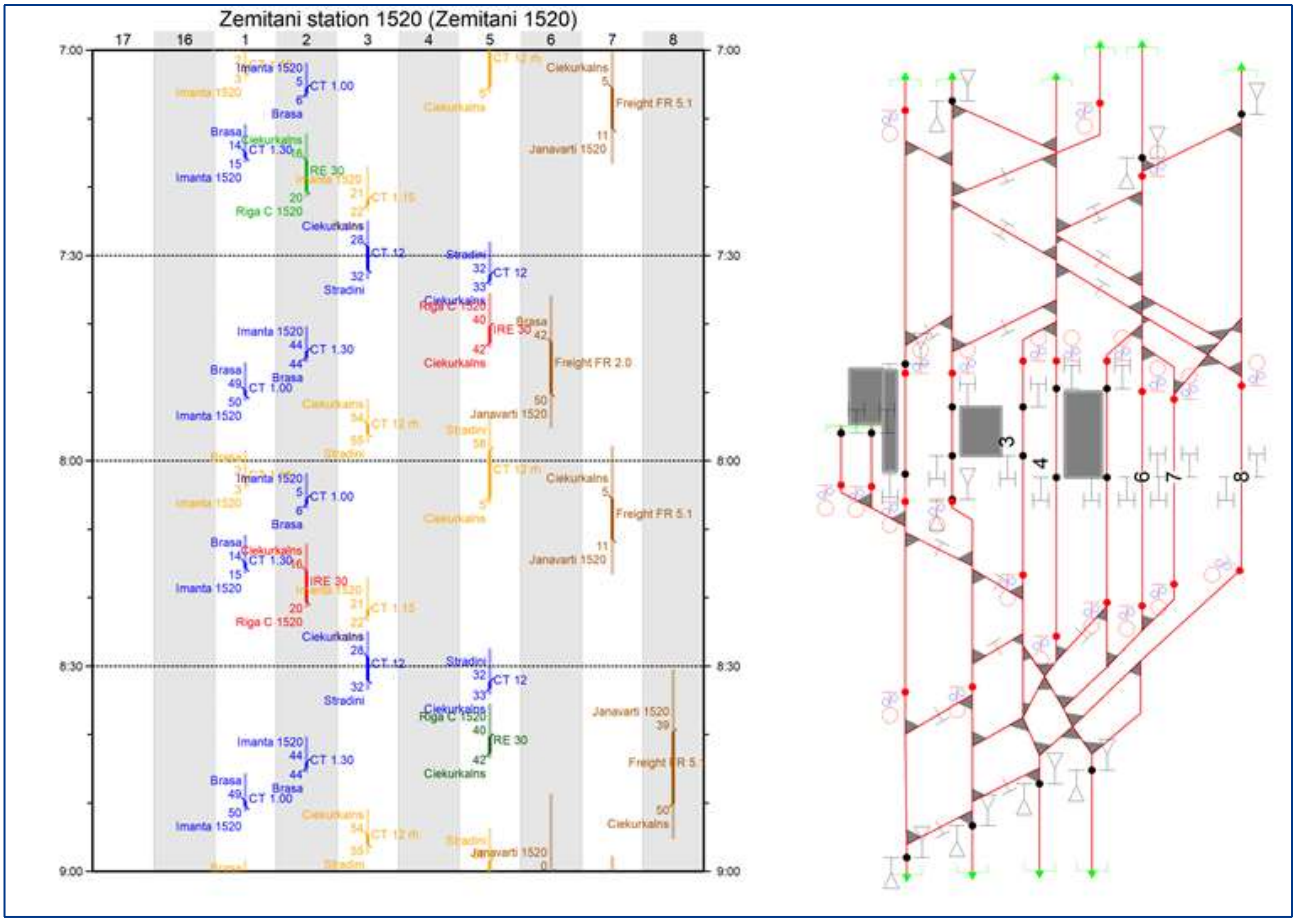


FIGURE 104: TRACK OCCUPATION ZEMITĀNI STATION ACCORDING TO THE MASTER TIMETABLE

Based on the results of the timetabling study and on study of the existing track layout, two variants were developed to address the following issues:

- The entrance and exit speeds for trains on relation Riga – Sigulda shall be improved to provide additional run time reserve or to speed up services.
- Overall long entrance and exit routes lead to long track and turnout occupation times. Thus, the distances for cruising at reduces speed shall be minimized subject to technical feasibility
- In addition to that the existing space between tracks 7 and 10 could be used to provide for additional parking of empty coaching stock for passenger services.
- Provide necessary track length for handling of 850 m long freight trains to ensure that freight train length will meet market requirements (more block trains instead of single wagonload).

To realize these improvements two track layout variants were developed, which mainly differ in proposed speed for routes with diverging turnouts (50 km/h or 60 km/h ; see Figure 105 and Figure 106)

- Variant 1: allow for min. 60 km/h entry and exit speeds on diverging passenger routes from/to Riga Central station; support 50 km/h entry and exit speeds diverging routes from/to Brasa and Sigulda
- Variant 2: allow for min. 60 km/h entry and exit speeds on diverging passenger train routes from/to Riga Central station; support 60 km/h entry and exit speeds diverging passenger train routes from/to Sigulda

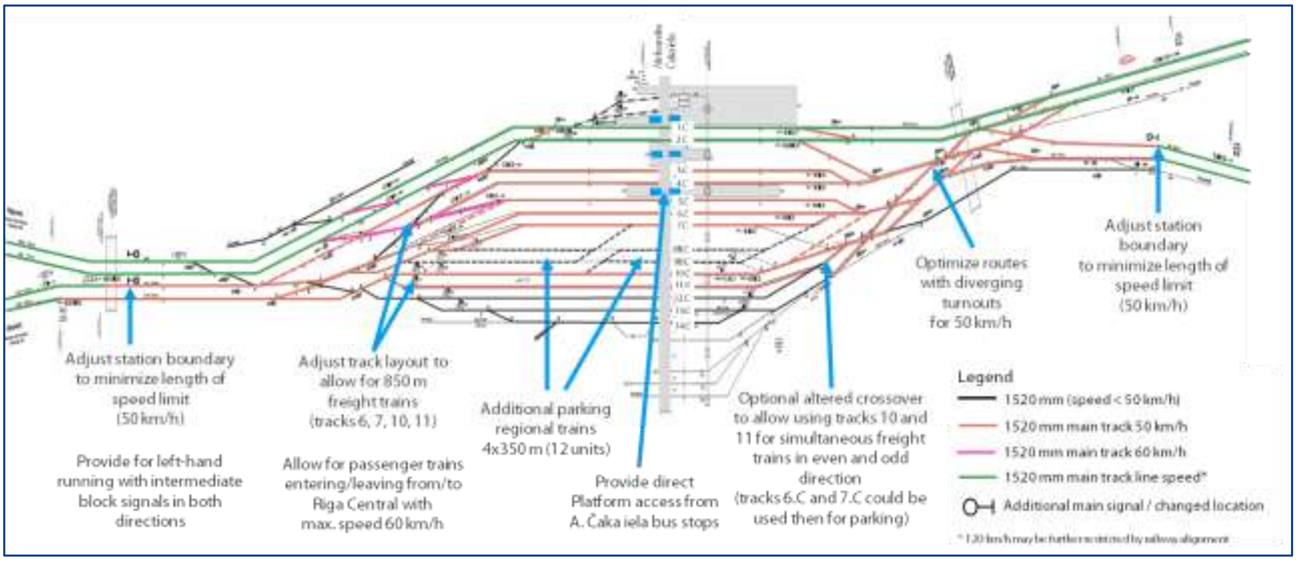


FIGURE 105: PROPOSED TRACK LAYOUT ZEMITĀNI STATION – VARIANT 1

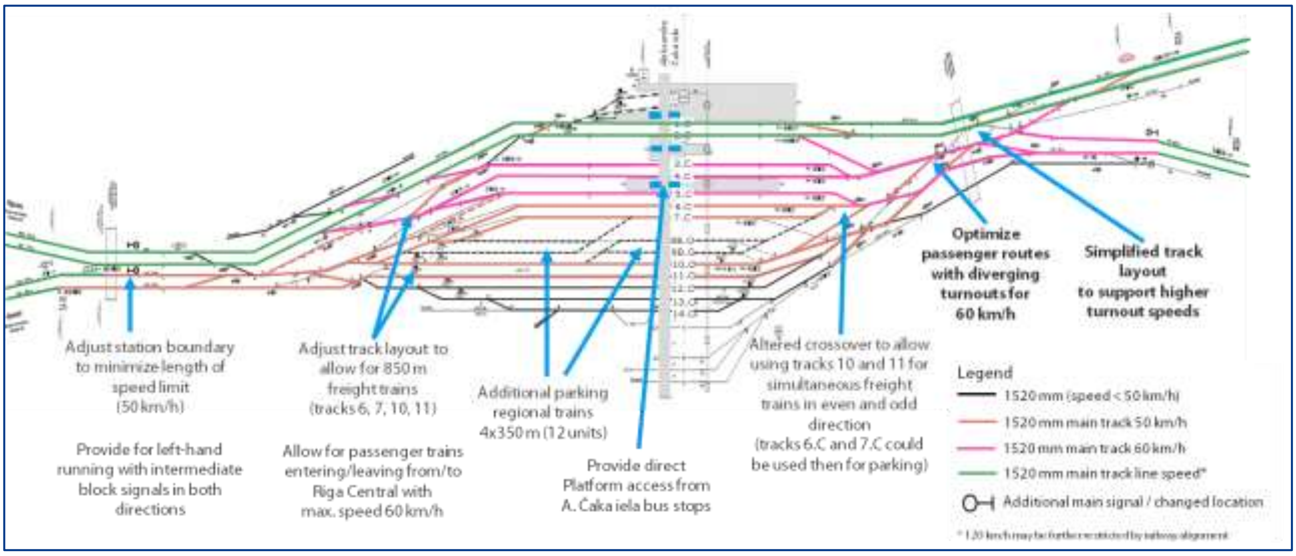


FIGURE 106: PROPOSED TRACK LAYOUT ZEMITĀNI STATION – VARIANT 2

Regarding the option to provide additional stabling capacity between tracks 7 and 10 it must be noted that it is difficult to provide road access to the parking tracks since the sidings east of the main tracks are required to support serving local private railway sidings. Currently these private railway sidings are in use. Thus, there is no suitable option to provide parking for passenger trains on the east side of the station. The unused railway sidings closed to Aleksandra Čaka iela overpass are not suitable for this purpose (limited available clearance for electrification of sidings under the bridge, space constraints, interference with local freight shunting).

Despite the overpasses of major roads in the area, there is no direct access from the platforms to the city public transport system provided at Zemitāni station. This situation should be most urgently improved to support the expected traffic growth. The most viable option is to provide direct access from all passenger platforms to the bus stops on the bridge by additional staircases and elevators. Currently these bus stops (Zemitānu stacija) are served by trolleybus lines 18 and 23, and bus lines 5,49 and 370. In line with these measures it must be ensured that the quality of stay for interchanging passengers is on a high level. Furthermore, it should be checked whether the public transport offer on the roadside shall be improved (for instance better connection to the northern and eastern parts of the city center).

Finally, the signalling on the double track section between Riga Central station and Zemitāni should be improved to provide for signaled bidirectional running. This would increase flexibility, in case of failures and delays.

6.9. Upgrade of line section Zasulauks - Daugavgrīva

To accommodate the proposed service pattern for the line CT12 as proposed in the with 2 train pairs/hour together with freight partial double tracking of the line is required. Results of the timetabling study indicate that ad second track must be provided between Zasulauks and Bolderaja-1, which is the reception yard and junction station to serve the Western port area at Krievu Sala.

In addition to that it is recommended to extend double tracking also for the line section Bolderaja-1 – Bolderaja. This allows flexible services to the local shunting yard there as well as flexible auxiliary movements (light engine movements, wagon exchange between both yards) and contributes to increased stability of the passenger timetable. The section Bolderaja – Daugavgrīva shall remain single tracks.

The future track layout shall be designed to allow a maximum speed of at least 80 km/h on the complete line. With this infrastructure parameters it shall be feasible to serve all proposed stops as suggested in chapter 2.4.2 (Dzirciems, Nordeķi/Slokas iela, Lāčupe, Silicate iela and Daugavgrīva.

The terminus station at Daugavgrīva shall be designed such, that two platform tracks are provided (dead-end tracks would be enough for the proposed multiple unit service). For freight trains serving the loading points at Daugavgrīva at least one freight bypass track is required at the proposed location of the passenger station.

An overview of the future track layout illustrating the abovementioned principles is provided in Figure 107 below. It must be noted that not all freight sidings and crossovers for freight traffic in the stations are incorporated into the layout.

The required track layout changes for Zasulauks station are described in chapter 6.4.

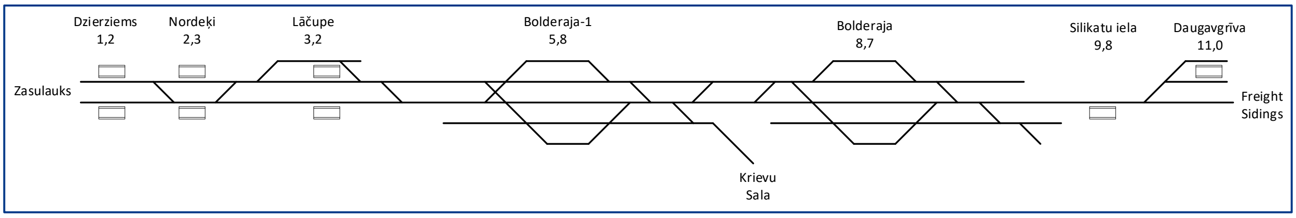


FIGURE 107: FUTURE TRACK LAYOUT FOR LINE SECTION ZASULAUKS – DAUGAVGRĪVA

The platforms shall be designed for at least 110 m length to ensure that the proposed rolling stock for Riga suburban services (Skoda EV) in case of electrification. A usable length of 110 m would also allow to use the proposed high capacity rolling stock for diesel services which allows for flexible extension of regional train services from other destinations (e.g. Sigulda) to Daugavgrīva and replacement of low capacity EMU in daily operation by a longer reserve rolling stock. For the initial years of operation subject to final rolling stock concept and electrification considerations 80 m platform length compatible with low capacity DMU/bimodal train might be sufficient. If possible the space to extend to 220 m in the future shall be reserved to allow double traction to be implemented at a later stage, if required e.g. to support through running of train services in the peak hour beyond Riga Central station.

6.10. Conclusions

The proposed track layout improvements on the line sections parallel to Rail Baltica (Šķirotava – Riga Central station – Torņakalns -. Imanta) and for Riga Central station are aiming at providing the best possible and reliable service in the future for passenger and freight operation. This does include:

- maximum flexibility for timetabled freight trains over Daugava river bridge (provide up to 2 freight train paths during peak hours depending on train length and weight and subject to timetable stability analysis)
- provision of 2 trains/hour between Riga Central station and Daugavgrīva to gain the full traffic potential and to establish rail transport mode as serious alternative to using urban public transport
- ensuring full functionality and attractivity of Riga Central station, also in the long term within the boundaries of the already proposed track layout
- provide the proposed peak hour service interval of 15 minutes of suburban trains on the relations Riga – Aizkraukle, Riga – Tukums and Riga Jelgava as well as
- simultaneously allowing the full-service pattern for cross-country regional express trains.

In the first years of operation the main effects of these solutions will be limited to the peak-hours. In the long term these measures will also support extension of the 15-minute service pattern for suburban trains and increased services on cross-country regional express connections connecting the regional centres with the capital of Riga.

The proposed measures include:

- Additional measures for redesign of Torņakalns station (additional crossovers, providing cut-and-cover, improving turnout speeds). The outcome of the study indicates that implementation of 1520 mm cut-and-cover option can only be skipped by the proposed bidirectional running over Daugava river bridge as foreseen in the master timetable. This is subject to confirmation of timetable stability not in scope of this study. Thus, implementation of cut-and cover is recommended to provide more flexibility for development of the future service timetable.
- Provision of third track on the line section Torņakalns – Zasulauks . This track is to be mainly used by freight trains to Daugavgrīva.
- Implementation of proposed Stradiņi passenger top on the line section Torņakalns – Zasulauks with platform access from planned Daugavpils iela road overpass
- Additional crossovers with improved speed in Zasulauks station to provide for future 30-minute service interval to Daugavgrīva. This does require shifting of the proposed platforms towards Lielirbes iela bridge.
- Upgrading track III in Riga Central station to increase capacity for 850 m freight trains in peak-hours
- Enhancement of the interlocking system and update of operational rules to support double platform occupation on all through platforms in Riga Central station
- Provision of necessary crossovers for stepwise implementation of the target track layout in Torņakalns, Zasulauks and Imanta. These shall remain as emergency crossovers after implementation of the target track layout is finished.

These measures shall be either implemented or at least be considered as future options when redesigning the future 1520 mm track layout to accommodate Rail Baltica. Most of the abovementioned measures are to be seen as compensating measures to ensure that the main bottleneck – the double track section over Daugava river bridge and the western approach to Riga Central station – can be exploited by increasing timetable stability. This is essential to provide the targeted train service pattern for passenger trains without compromising required capacity and flexibility for freight services.

The following measures are not directly related to Rail Baltica construction and Riga Central station redesign and could be thus implemented separately as part of further infrastructure modernization:

- Modernisation of Zemitāni station. Most importantly, the accessibility of the existing platforms as well as interconnectivity to Riga public transport shall be improved, e.g. by providing direct platform access from A. Čaka iela road overpass. This would strengthen the position of the station as eastern gateway to the city. As part of further modernisation, the entry and exit speeds shall be improved. Since Zemitāni station has also a relief function during Riga Central station reconstruction it shall be preferably modernized after Riga Central station is finished.

- Complementary measures to improve usability of the 3rd track Riga – Janavarti ("Vagonu parks bypass"), namely additional fast track connection at west side of Šķirotava station
- Additional measures to provide additional stabling capacity for 1520 mm passenger trains to support growing fleet size (around Vagonu parks, at Zemitāni station).
- Double tracking of line section Zasulauks station (excluding) – Bolderaja to provide for freight services and 2 train pairs per hour to Daugavgrīva. As supporting measure redesign of the stations might be considered.

Regarding future track layout of the line section Riga – Janavarti the following recommendations are to be made:

- If Vagonu parks is upgraded to accommodate the future PV maintenance depot, the impact on Rail Baltica on the available parking tracks shall be minimized.
- Timetable analysis indicated that the southern bypass for Vagonu parks area will be only useful for a few specific use cases due required timetable structure and the track layout of Riga Central station and Šķirotava station. If possible, it shall be kept as fall-back option and to provide a buffer functionality for freight trains.
- The platform for eastbound trains shall be relocated to the north side of Vagonu parks passenger station in order to gain space for Rail Baltica.

In case Zasulauks depot must be kept operational (not recommended) then the depot area shall not be impacted by relocation of 1520 mm tracks. The southern bypass track needs to be kept ensuring functionality of the depot.

7. Infrastructure development outside railway core area

Due to the monocentric structural development of Latvia (booming and growing capital region vs. weak regional structures in the countryside) it is important to interconnect the regional centres with the capital region by fast and convenient modes of transport. This can be achieved by attractive travel times and more regular frequencies. The future requirements for RE train service are outlined in Table 11 in chapter 2.5.5). In the same chapter also the benefits of speed upgrades are highlighted.

To support future infrastructure development this concept was further developed to provide a consistent development vision for infrastructure to support RE services based on the developed master timetable.

The possibilities for future speed upgrades will depend on capabilities of used rolling stock, technical parameters of railway alignment signalling technology and available train protection system. Furthermore, the necessary investments shall be balanced against the expected traffic. Based on these considerations it is proposed to upgrade the network to allow operation of RE services with maximum speed of 140 km/h on all corridors, except Krustpils – Zilupe. This does include the following measures:

- Upgrade of station tracks to allow maximum speed on the running line
- Upgrade of existing level crossings to allow maximum speed of 140 km/h. Larger crossings could be gradually replaced by overpasses to increase safety, for all level crossings this cannot be justified
- Keeping existing alignment as far as possible, further alignment improvements could be considered in case of required fundamental renewals to homogenize the speed profile (also relevant for energy-efficient operation) and to allow shorter travel times in the long term.
- Initially use existing ALSN system with later upgrade to ERTMS subject to joint decision of the Baltic states
- Upgrade signalling system (support speed improvements in stations)
- Allowing to use more environmentally friendly battery powered, hydrogen or bimodal trains passenger rolling stock, which according to current market situation, provide lower power and acceleration than conventional trains (though this might change in the future)

This is also supported by the following facts:

- On most relations the typical service interval envisaged is 2 hours with exception of relation Jelgava- Riga – Daugavpils. This service frequency does not provide the necessary cost-benefit-ratio for bigger alignment changes
- The updated electrification will likely be focused first on more heavily utilized routes (namely Riga – Daugavpils, Riga - Krustpils) to provide for an acceptable cost-benefit-ratio
- Conducted analysis indicates that the effects of operation at higher speeds are limited on many sections where 160 km/h cannot be reached without alignment changes

For the line section Krustpils – Zilupe only 120 km/h are foreseen because of the existing alignment and the timetable structure resulting from interconnecting or branching-off from Riga-Daugavpils services. To provide an attractive service timetable only few sections need to be upgraded to double track from passenger service perspective.

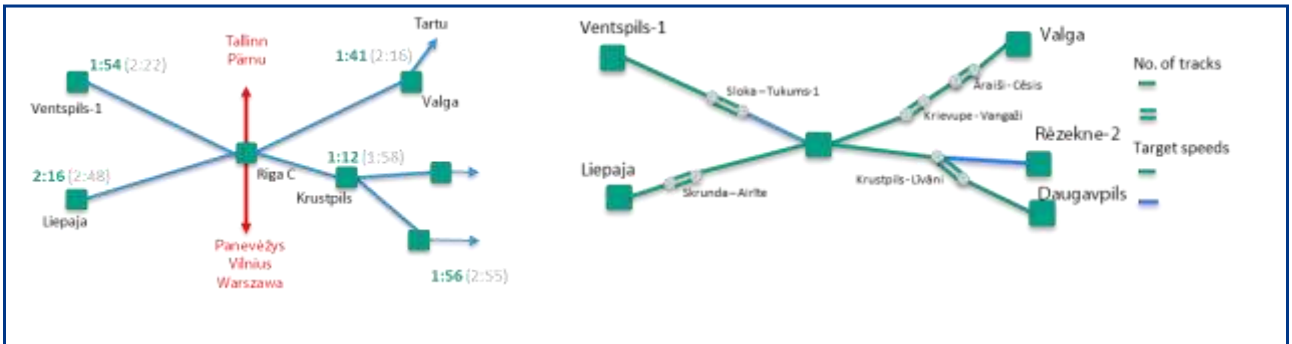


FIGURE 108: OVERVIEW ON PROPOSED TRAVEL TIMES AND PROPOSED TARGET SPEEDS FOR RE-SERVICES

The detailed travel times and the required infrastructure upgrades to allow meeting of regional express trains in opposite directions without losing too much travel time are outlined in Table 43 below. The related timetables for the preferred solutions are provided in annex 12. The indicated travel times are based on the assumption to keep the existing alignment and only to allow higher speeds on sections where it is physically possible with respect to geometry of curved line sections. Calculation of speeds was undertaken using the existing infrastructure model for the master timetable. The location of the curved sections was taken from alignment information provided by LDz. For the line section closed to Riga Central station (Riga, Riga – Torņakalns– Zasulauks, Riga -Zemitāni, Riga – Janavarti the currently applied maximum speeds are assumed. Speed upgrades in this area will mainly be used as runtime reserves to increase timetable stability.

For travel time calculations the following rolling stock was used:

- 140 km/h: diesel multiple unit PESA.218Ma with maximum speed 140km/h
- 160 km/h: Škoda 7ev with maximum speed of 160 km/h.

Line	Section	Envisaged travel time (h.min)			Required track layout upgrades	
		Speed 120km/h	Speed upgrade 140 km/h	Speed upgrade 160 km/h	Meeting points single track sections	Recommended infrastructure upgrade
RE10	Ventspils – Tukums		1.05		Spāre	Not double tracking required, upgrade track layout of Spāre station to accelerate meeting of trains.
	Tukums – Sloka		0.20		---------	Double tracking Sloka – Tukums recommended to provide for hourly CT to Tukums and 2 hourly RE
	Tukums – Riga Central		0.49		Sloka	Limited effects of speed upgrades due to mixed traffic (CT/RE) Speed upgrades in densely populated areas can be skipped where necessary
	Total Ventspils – Riga		1.54			
RE20	Liepaja – Dobele		1.34		Skrunda	Double tracking Skrunda – Airīte (excluding of Venta river bridge is subject to detailed analysis closer to implementation stage); partial upgrade to 140 km/h on straight sections
	Dobele – Riga		0.42			
	Sub-Total (Liepaja – Riga)		2.16			
	Riga – Krustpils		1.12	1.05		
	Krustpils – Daugavpils		0.44	0.41	Līvāni	Double tracking Krustpils to Līvāni (for both 140 and 160 km/h)
	Total travel time (Riga -Daugavpils)	2.14	1.56	1. 45		
	Krustpils – Rezekne II	1.20	1.16		Stirniene	--
	Rezekne – Zilupe	0.50	0.34		Ludza	--
	Total travel time Riga-Zilupe		3.46			
RE30	Riga C – Sigulda		0.34			Double tracking Vangaži - Krievupe
	Sigulda – Valga		1.07		Between Āraiši and Cēsis	Double tracking from Āraiši to Cēsis
	Total travel time (Riga-Valga)		1.41			

TABLE 43: OVERVIEW ON INVESTIGATED SPEED IMPROVEMENTS AND RELATED TRACK LAYOUT UPGRADES

The indicated double tracking measures Figure 108 and Table 43 are recommended to ensure fast travel times of the passenger services and do not consider the required capacity for freight. The results of the timetabling study show that on the investigated sections closer to Riga Central station the line capacity is sufficient to handle the proposed amount of freight (on the line sections outside railway core area). For the line section Krustpils – Daugavpils double tracking might be considered as additional measure to provide capacity for efficient and stable operations of freight services.

The line section Riga -Krustpils - Daugavpils could be upgraded to 160 km/h once a new train protection system is implemented and the line is electrified. This would also require change of existing operational rules to allow operation with 160 km/h operational speed over level crossings or removal of existing level crossings. For other line sections upgrade to 160 km/h is to be seen as long-term vision.

8. Summary and Conclusions

8.1. Goals and fundamentals of the study

The Study is aimed at elaboration of a detailed operational study for Riga railway node for 1435 and 1520 mm gauges, for short (2026) medium (2036) and long (2046) term, incl. construction of a completely new cyclic timetable (master timetable 2026/36) for Riga suburban services and regional train services. This shall also incorporate an outlook on further development of 1520 mm services and general track layout principles for the Latvian national 1520 mm network to provide a consistent development strategy.

The results of the Study will allow to plan relocation of 1520 mm infrastructure caused by Rail Baltica and enable required mid / long term optimisations of infrastructure, including dimensioning of required maintenance and layover facilities. Optimisation of 1520 mm infrastructure shall be carried out in phases, however, already the initial phase made with relocation for Rail Baltica will deliver significant benefits and must be upwards compatible to avoid wasting investments.

The Study involved LDZ, PV, EDZL, ATD as well other stakeholders and is coordinated by RB Rail on behalf of the Ministry of Transport of Latvia. It was based on existing planning documents (especially RB operational plan) and on information provided by the stakeholders related to operational requirements, traffic demand, current infrastructure as well as rolling stock.

8.2. Future passenger service pattern

The future 1520 mm passenger services shall be based on a fixed interval timetable following a more offer-oriented approach (get new market segments for Rail, adopt to changing needs of clients (trip-chains)). The developed master timetable indicates that this principle can be implemented on the already existing infrastructure outside Riga node area and with the already proposed changes inside Riga node area (redesigned Riga Central station and sections parallel to Rail Baltica).

The cyclic timetable shall be adopted to all passenger traffic, which does include the following principles:

- Riga suburban services with up to 15-minute intervals for the lines with the highest demand (Aizkraukle – Dubulti/Sloka, Riga Central – Jelgava).
- Regional express train services (RE) to the national and cross-border destinations outside Riga Central station, which shall be based on 120-minute service interval (up to 60 minutes interval in peak times and omitting some of the services off-peak subject to development of passenger demand).

- Optimized train stopping pattern (all stops of a route served without exceptions by all trains, differentiation between fast RE and slow suburban trains in Riga suburban area, outside Riga suburban area all trains stop at the remaining stations).

The provision of an attractive and fast cross-country RE train service is required to connect the regional centres with the capital of Riga in a competitive way compared to other transport modes (car, bus). Therefore, the travel time shall be significantly reduced. Related infrastructural measures shall be developed with respect to lower amount of traffic on the rural line sections outside Riga suburban area which will not in every case justify major infrastructure upgrades. The study results indicate that significant travel time improvements can already be reached by moderate upgrades of the maximum speed to 140 km/h and without major changes of existing railway alignment. Further upgrades, including bigger changes to geometry of curved line sections, shall be considered as long term service vision in case of major reconstruction, signalling or electrification works (160 km/h on corridor with highest demand Riga – Daugavpils, homogeneous speed profile Dobele – Liepaja with 140 km/h or 160 km/h and upgrade of corridor Riga – Valga to 160 km/h, subject to cross-border passenger service pattern to Tartu and Võru and proposed infrastructure upgrades on the Estonian side).

The study also indicates that a cyclic timetable with meeting of passenger lines in Riga Central station once per hour (around the minute 30) is the best way to interconnect to Rail Baltica and to provide attractive interchange connections between the 1520 mm train services. This allows covering new market potentials by provision of fast cross-country connections (not only for the major share of passengers from and to Riga but also between regional centres) and by connecting the regional centres to Rail Baltica without long waiting times for the passengers in Riga Central station.

To fully support a symmetry node around minute 30 in Riga Central station, further activities are required to cut travel times of 1435 mm long-distance trains on the section Kaunas Central – Riga Central by 5-7 minutes (part of ongoing CPTD). But even, if this could not be achieved, the benefits are within the 1520 mm network and for interconnectivity from and to Rail Baltica long-distance services towards Tallinn direction.

The proposed 1520 mm timetabling principle is compatible with infrastructure on all cross-country rail corridors, further improvements on these corridors are recommended to cut travel times (max. speed at least 140 km/h or 160 km/h; partial double tracking to avoid additional operational stops).

The workability of this principle was proven by the developed master timetable for the time horizon 2026/36. This master timetable also includes additional services on the line section Riga Central station – Daugavgrīva, for which a 30-minute interval is proposed in the target stage to gain the full market potential. If the master timetable is successful further increase of services can be provided using spare slots outside the peak hours and by increasing train capacity during the peak hours.

Regarding passenger services for 1435 mm the study is based on the service pattern outlined in the RB operational plan, including the latest improvements by RB Rail (sprinter services Vilnius – Tallinn via Riga bypass, additional regional train services Bauska – Salaspils – Riga airport – Bauska).

8.3. Assessment of infrastructure in railway core area

In Riga node area 1520 mm infrastructure will change significantly with implementation of Rail Baltica parallel to the 1520 mm tracks on the line section Šķirotava – Riga Central – Torņakalns – Imanta and the reconstruction of Riga Central station with changed track layout to provide space for Rail Baltica.

As basis for this study the Rail Baltica alignment as approved in value engineering phase of DTD and the final track layout for Riga Central station which was fixed end of January 2020 are considered. Alignment approved in value engineering phase of DTD is considered as basis for the study. For 1520 mm line sections parallel to Rail Baltica the most restrictive alignment alternatives were chosen for assessment (alternative 1 for Torņakalns – Imanta, alternative 2 for Riga - Šķirotava).

The results of the timetabling study indicate, that the capacity limit will be reached or exceeded with the proposed amount of passenger and freight train services as required by the stakeholders (freight capacity requirements established by infrastructure provider LDz) for Riga Central station and the line section Riga – Torņakalns. This is mainly due to following limitations:

- Design of switch areas on east and west side of Riga Central stations which lead to numerous potential at-grade-crossing conflicts which restrict flexibility for timetabling and daily operation
- Highly occupied double track section over Daugava River bridge
- Limited turnout speeds due to spatial constraints and existing infrastructure
- Currently required slow operational regime of freight trains with additional allowances for brake test on the open line, slower acceleration of diesel trains and overall length of freight trains

While first assessment shows that the developed passenger service pattern is a good way to exploit available capacity with the given quantity structure the possibilities to operate freight services are rather limited during daytime and especially in peak hours.

Because of this, supporting infrastructure measures are recommended to ensure that the potential bottlenecks can be exploited in the best possible way in order to:

- improve timetable stability
- support timetabled bidirectional running over Daugava river bridge (required to exploit capacity and applied in the master timetable)

- to provide more flexibility for timing of freight trains during daytime
- to allow for proposed half-hourly service to Daugavgrīva and
- to support positive long-term demand development and future changes in the service pattern, which cannot be foreseen.

The following improvements of the existing and planned track layout are recommended based on the results of the timetabling study:

- Double tracking of entire section Zasulauks – Bolderaja-1 to support 30-minute passenger service interval to Daugavgrīva peak and off-peak
- Changes of track layout in Zasulauks station to support double tracking to Daugavgrīva in the future
- Third track for freight trains between Torņakalns and Zasulauks station
- Keeping the bypass track south of Vagonu parks to provide the necessary buffer functionality to speed up operation of freight trains in Riga Central station (via the dedicated freight track X)
- Improved track layout for Torņakalns station, preferably with 1520 mm cut-and-cover to allow running trains from Zasulauks direction towards Riga independent from trains Riga – Jelgava
- Possibility to support direction change of long freight trains of relation Jelgava – Torņakalns – Bolderaja in Torņakalns (fall back operation, selected additional services)
- Improved track layout of Riga Central station to ease passage of up to 850 m long freight trains and to avoid additional bottlenecks due to restrictive turnout speeds
- Upgrade or replacement of existing EBILOCK 950 interlocking and signalling system and adaption of operational rules to support occupation of platform tracks by two successive trains at the same time.
- Provision of additional 1520 mm crossovers for single-track working during construction of Rail Baltica (to be kept afterwards) and support bidirectional running on all line sections in railway core area (e.g. also including Zasulauks – Imanta – Priedaine).
- Implementation of newly proposed Stradiņi passenger stop.
- Implement sufficient space for improved passenger platforms with grade-separated access on all existing and newly proposed stations (Torņakalns, Zasulauks, Stradiņi, Depot, Vagonu parks)
- Keeping of all through platforms and improvement of entry and exit speeds at Zemitāni station

- Electrification of line section Šķirotava – Bolderaja as part of a redesigned electrification program to ease operating conditions for long and heavy freight trains and to minimize local emissions in the densely populated city areas

Additionally, the following operational improvements are required to exploit the available capacity:

- Timetabled bidirectional running over Daugava river bridge as foreseen in the proposed master timetable with related changes of track layout in Torņakalns
- Minimization of empty coaching stock movements over the potential bottleneck sections (Riga Central – Torņakalns – Zasulauks). This does include a decentralised layover concept for passenger rolling stock (nightly layover of rolling stock in Riga shall be minimized to avoid empty runs against peak load direction)
- Provision of runtime supplements outside railway core area to cover for delays and to support punctual arrival at the boundaries of the railway core area
- Additional organisational measure to minimise required times for train clearance, especially in but not limited to Riga Central station
- Additional measures to minimize impact on speed limitations for passage of diverging turnouts on runtime of trains (support shortening of sections to be passed with reduces speed by additional lineside marker boards, change in operational rules, redefinition of station boundaries etc.). In the long term the flexibility of ERTMS the best solution. Nevertheless, the results of the study indicate that entry and exit routes to be passed with reduced speed can be shortened, subject to further feasibility study.

These measures will support the proposed passenger service quantity structure during peak time and will contribute to necessary pathing flexibility for freight trains to allow stable operation without major delay of freight services in case of small disturbances in passenger traffic. Furthermore, it is ensured that operation can be continued in case of incidents in the most occupied areas (Riga Central station, Daugava River bridge).

Subject to the outcome of timetable stability analysis additional measures might be required to allow stable operation of the required amount of trains, especially in the peak hours.

In addition to the proposed track layout improvements it is recommended to electrify Riga Central station with single voltage, preferably 25 kV. Otherwise the required quantity structure cannot be achieved due to limited platform track capacity in Riga Central station. An interim solution with two voltages for 1520 mm shall be avoided in Riga Central station. The required system separation sections 25 kV AC / 3kV DC in case of staged electrification shall be located such, that freight traffic Šķirotava – Bolderaja (-Krievu Sala/Daugavgrīva) can be operated with single voltage from the beginning and that operation in the core area is not limited (e.g. east of Šķirotava, west of Imanta, south of Torņakalns, north of Brasa triangle or better Ziemeļblāzma, subject to further feasibility study for final construction phasing of electrification.

8.4. Next steps

Based on the results of the study further planning activities and decisions are required in order to finalize the target track layout for 1520 mm and 1435 mm. This does include:

- **Decisions on future service pattern 1520 mm as basis for dimensioning of the infrastructure based on three steps**:
    - Fundamental strategic decision on the fixed interval symmetric timetable as general planning basis for passenger services and infrastructure development
    - Fundamental decision on future passenger service pattern to Bolderaja/Daugavgrīva and implementation timeline as basis for further decisions on future track layout
    - Since the capacity limit on the west side of Riga Central station is reached with the proposed quantity structure, these decisions must be underpinned by a simulation-based timetable stability analysis to proof workability of the developed concepts in daily operation and to reveal potential hidden bottlenecks which need to be addressed by the targeted track layout. This can be based on the developed RailSys model, which must be further calibrated for that purpose in close cooperation with LDz timetabling experts. This analysis must also include a more detailed elaboration of the necessary changes in timetabling and daily operation principles allowing to increase infrastructure utilisation to the proposed service quantities.
- **Decisions and further investigations on 1520 mm Depot solution**
    - Evaluation of feasibility of common solution for usage of Vagonu parks area by PV and L-Ekspresis including necessary negotiations between involved stakeholders (PV, L-Ekspresis and LDz)
    - Final site selection based on the results of Vagonu parks evaluation
    - Final technical design and procurement for new depot facilities (by PV and LDz depending on Future service pattern 1520 mm including provision of sufficient layover capacity closed finally selected depot location and closed to Riga Central station
- **Finalisation of 1520 mm track layout in railway in the railway core area**
    - Further evaluate technical feasibility of proposed measures based on final decisions on future train service pattern
    - Decision about final track layout (target stage, implementation as part of Rail Baltica project, staging of track layout) bases on recommendations of this study and more detailed timetable stability analysis.

- Further decisions about financing of measures (which design- and implementation activities are to be funded by Rail Baltica project, which design- and implementation activities are to be funded by other national or European instruments)

- Further evaluate necessity, cost and benefits to replace or upgrade the existing interlocking systems in the railway core area to support the proposed track layout changes (e.g. double tracking, optimization of block sectioning, occupation of platform tracks by two successive trains in final stage) and to allow flexible operation during construction stages (single track work, occupation of platform tracks by two successive trains during construction stage 2). Any changes in the signalling system shall be also assessed in the light of keeping and restoring interoperability in signalling and train radio communication within the Baltic states and (as far as needed for cross-border traffic) within the whole 1520 mm railway system.

- **Decision-making related to future electrification system for 1520 mm infrastructure.** Target should be to avoid dual voltage in the heavily occupied sections, incl. Riga Central station, and also to support freight operation in Riga node including electrification to Krievu sala / Daugavgrīva. From current state of affairs 25 kV AC electrification shall be targeted due to easier implementation of Rail Baltica parallel to existing 1520 mm tracks and to provide a future proof solution. This will require equipping Skoda EMUs for dual voltage to support phased implementation.

- **1520 mm long-term infrastructure development outside the railway core-area**

  - The strategic goals and priorities for passenger service development outside the railway core area shall be defined based on results of this study. It is strongly recommended to support this activity by a more detailed intermodal traffic demand analysis for 1520 mm services (considering public rail and bus transport as well as private car).

  - The compatibility of proposed requirements and infrastructure measures with freight services is to be further elaborated by a more detailed timetable and capacity analysis.

  - The final decision on future speed upgrades is to be supported by more detailed benchmarking and safety assessment of level crossing solutions in order to determine the maximum target speed of passenger services (140 km/h in line with current Latvian rules or 160 km/h in line with Central European practice), including development of a roadmap of changing current national rules.

  - Based on these results a stepwise infrastructure upgrade strategy for the different corridors shall be developed and approved targeting implementation within next 10-15 years subject to required freight capacity and elaborated passenger service demand.

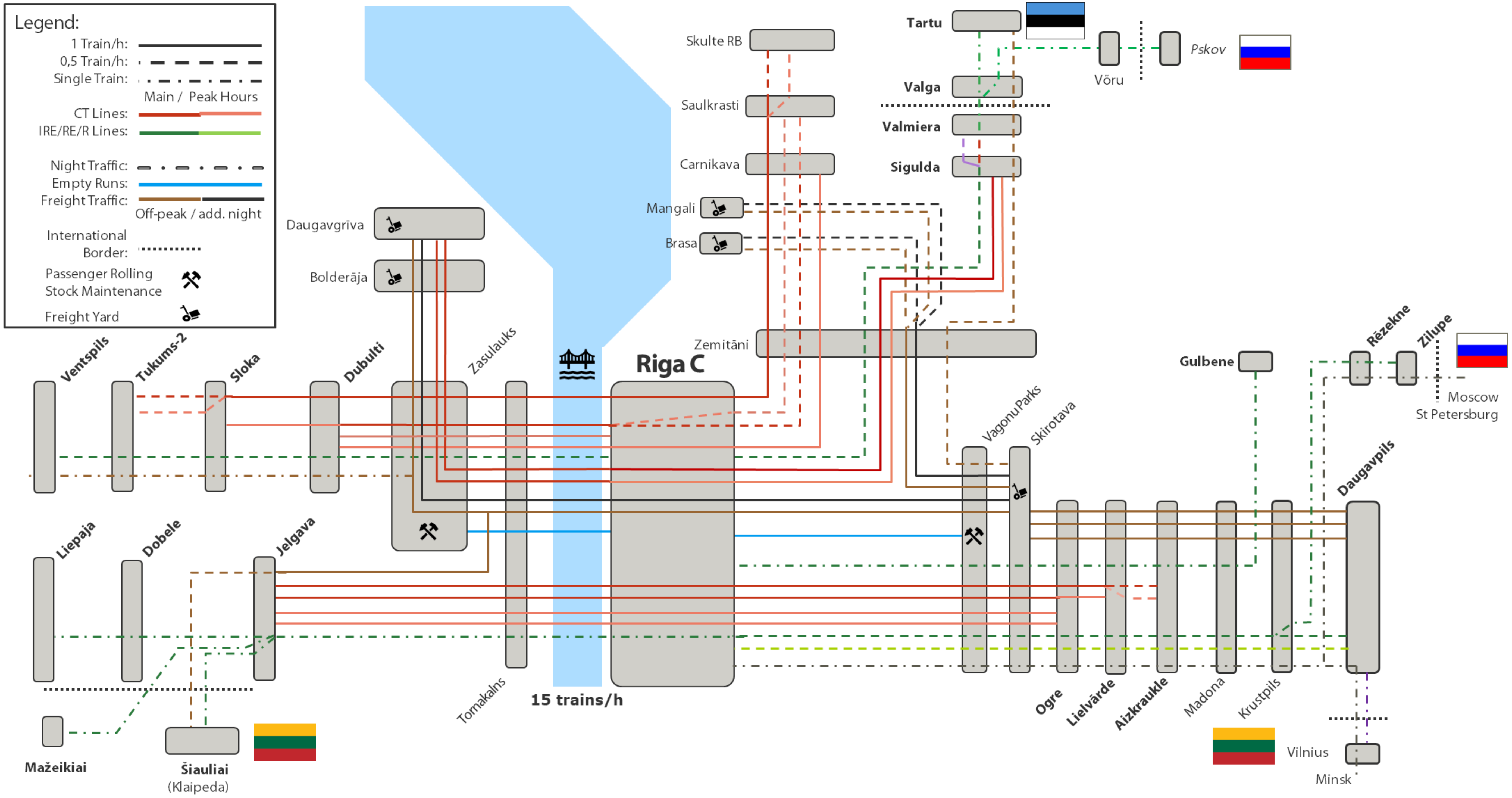
  - Overall, it is also advisable to develop a strategy for replacement of current signaling systems by ERTMS on the different corridors. This shall include a cost-benefit analysis and incorporate at least the activities in the neighboring countries Lithuania and Estonia to gain benefits quickly and to provide an interoperable solution.

- **Further implementation of the Rail Baltica project**
    - Where needed, the Rail Baltica alignment is to be adjusted in line with decided 1520 mm track layout changes in railway core area and with respect to final 1520 mm depot solution
    - The feasibility to cut travel times between Riga Central and Kaunas Central by 5-6 minutes shall be checked as part of ongoing CPTD process in order to allow meeting of north and southbound long-distance trains in Riga Central station to support the developed interchange concept (half-hour symmetry node in Riga Central station)
    - The requirements for provisions of regional services shall be regularly updated and further detailed as part of operational planning activities. The next update would be the incorporation of the results of the proposed Rail Baltica traffic demand study, for which procurement is started by RB Rail.
    - The model for national/cross-border regional traffic as well as related financing, procurement and operation is to be further detailed, to ensure that the finally proposed depot solution is meeting the future needs of the operators.
    - Last but not least a strategic decision about rolling stock to be used is required to finalise the detailed technical design of 1435 mm maintenance facilities.
- **Joint vision on development of 1520 mm service and infrastructure.** The ongoing discussions about fundamental service development goals for rail service and the lack of a common vision among the stakeholders perceived during the study indicate that it is necessary to develop a joint vision for
    - Development of rail passenger services in Riga suburban area, cross-country and cross-border with the target to get an integrated service model with benefits for whole of Latvia by providing faster, more convenient and more frequent connections between Riga and the regional centers. The focused targets should be to maximize the benefits of the existing rail infrastructure for the public and to ensure Latvian railways contribute to further sustainable developments within the EU Green Deal.
    - Development of rail freight services (ensuring capacity for current and future traffic, defining development goals with more focus on national targets, review needed infrastructure in the light of market changes, especially in Riga area).

This process shall be preferably led by the Ministry of Transport, but needs to involve all relevant stakeholders (ATD, LDz, PV and the private operators, Riga municipality, representatives from local communities). The infrastructure manager and transport authority (ATD) / railway operator (PV) shall develop a concise operational and technical strategy how to reach this vision.

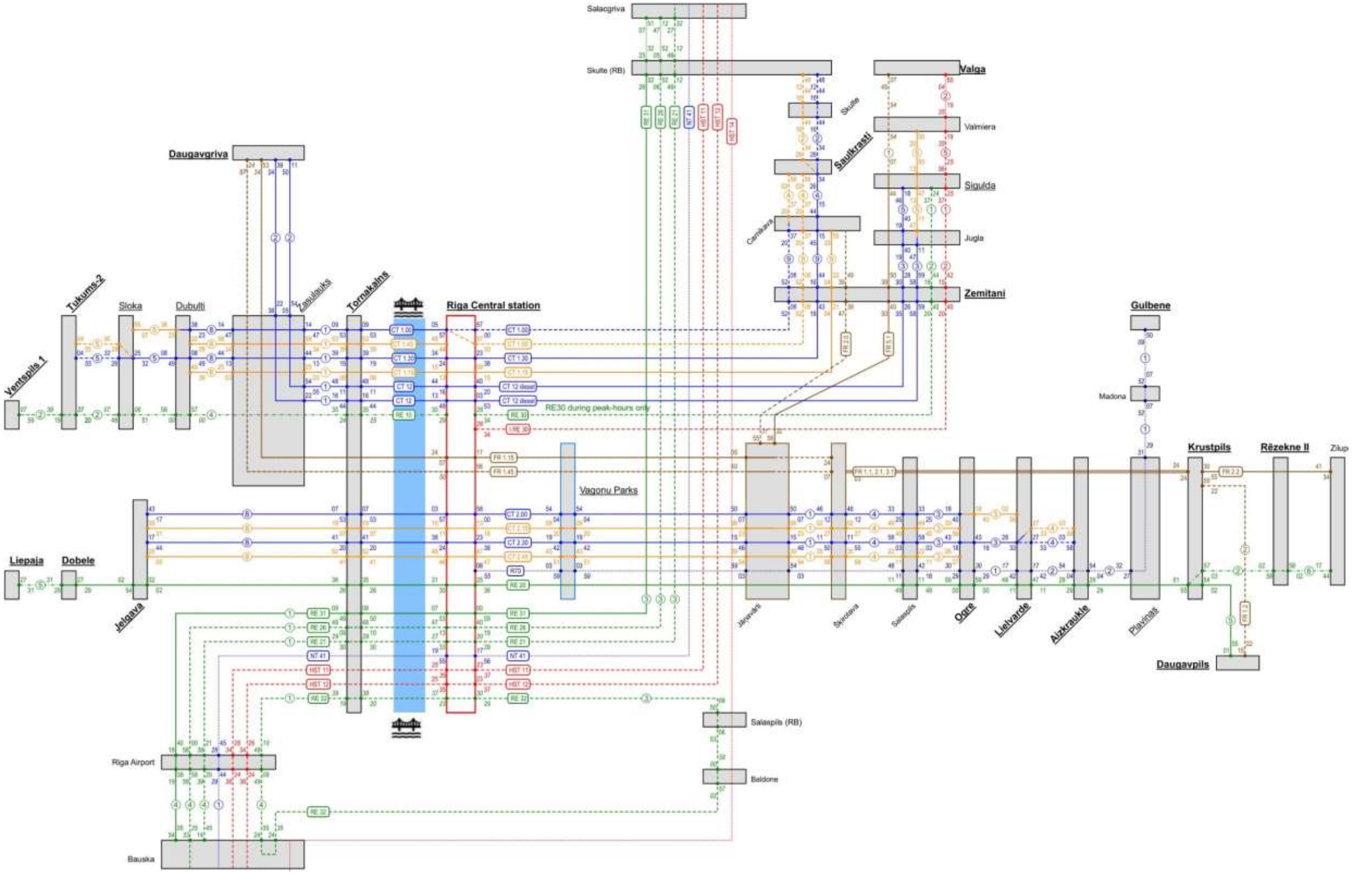
9. Annex

Annex 1: Consolidated quantity structure of 1520 mm passenger and freight services[74]

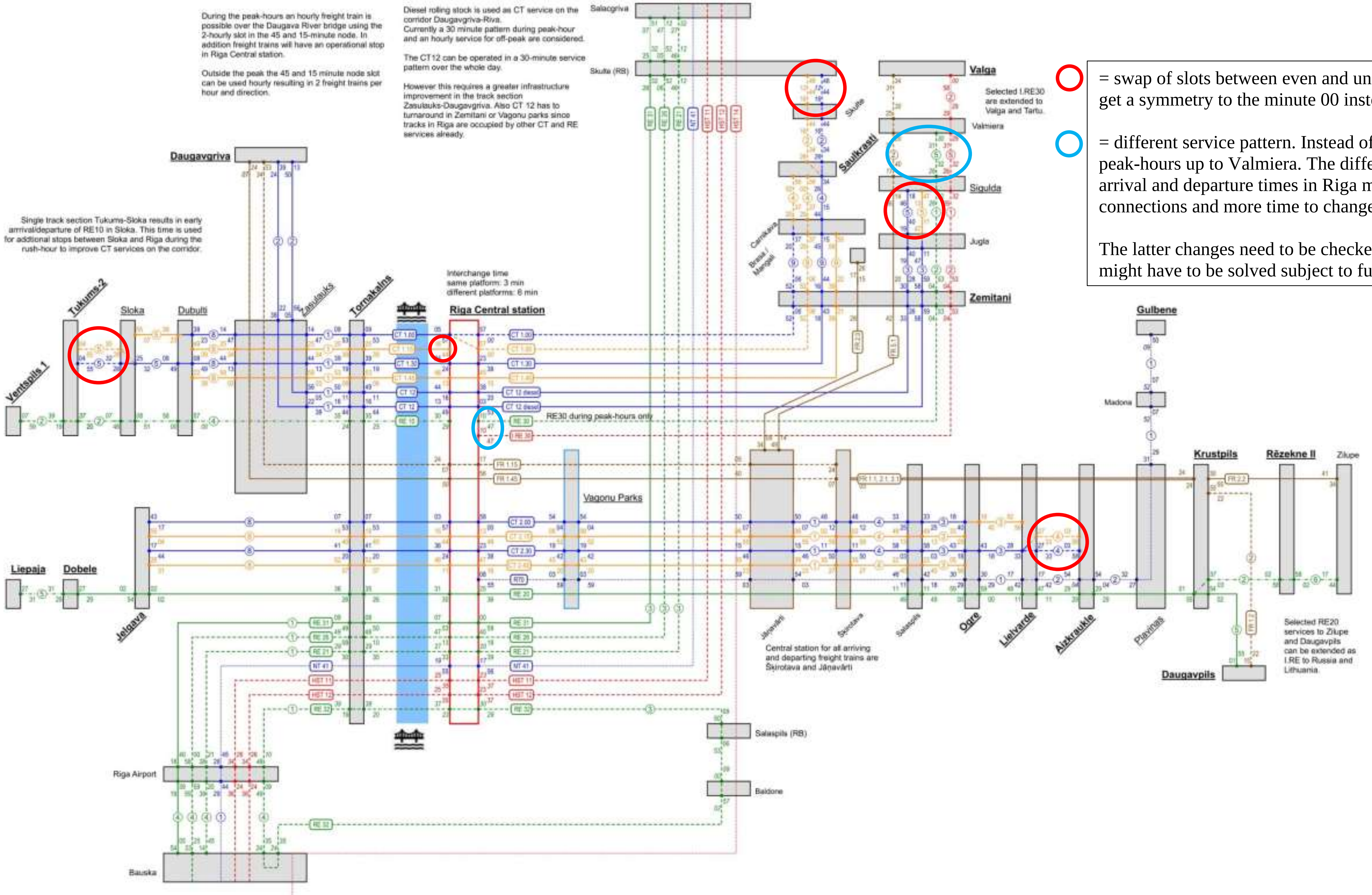


[74] Original requirements for quantity structure. Freight volume not shown in every graphical TT but possible as described above. On track section Riga-Sigulda hourly instead of 2-hourly freight path for systematical reasons implemented into the hourly passenger service pattern.

Annex 5: Line network graph – master timetable 2026/36 as used for operational analysis



Annex 6: Line network graph master timetable 2026/36 – potential optimisation of the timetable structure



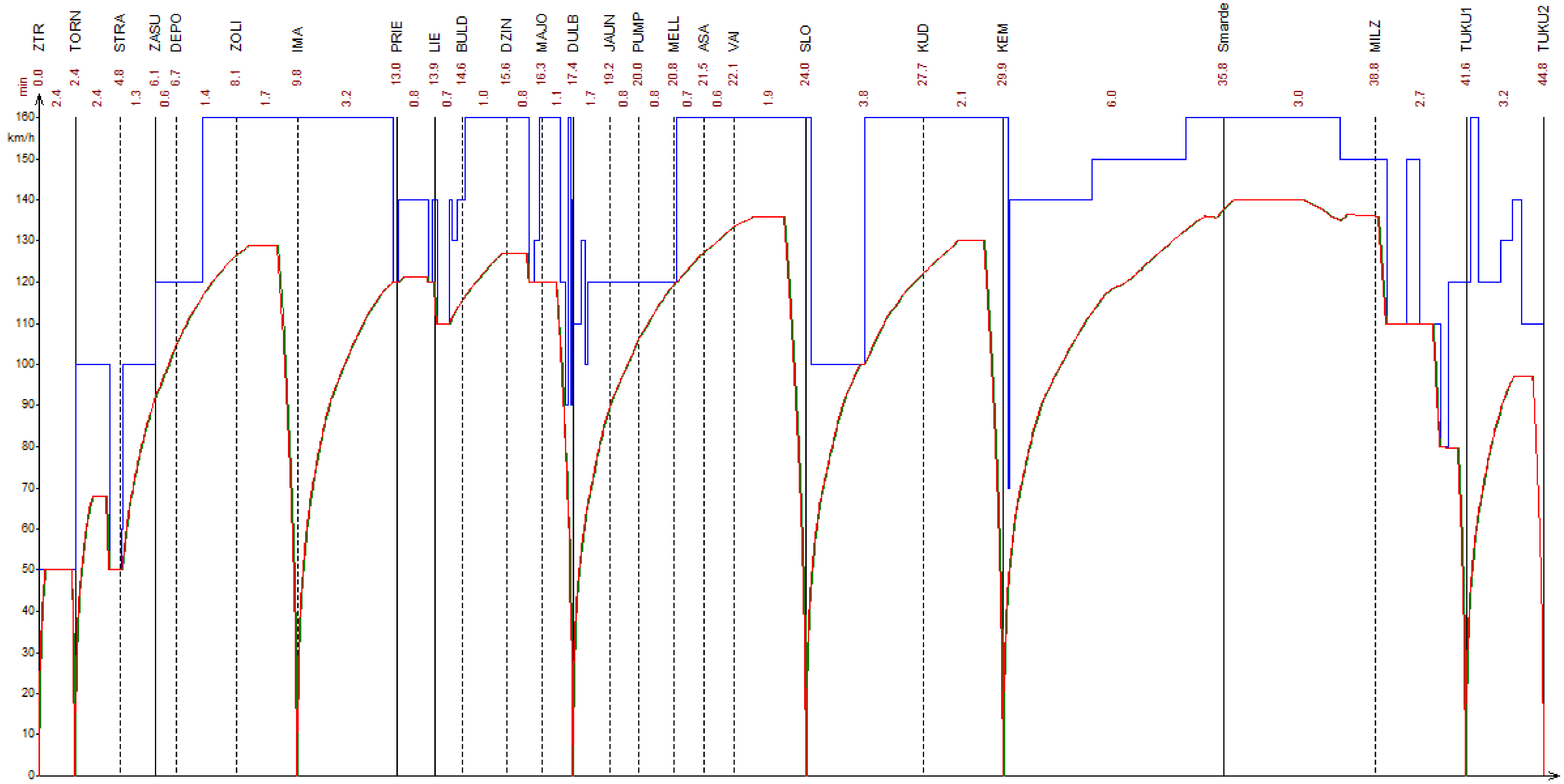
(red circle) = swap of slots between even and uneven hour in a 2-hourly service to get a symmetry to the minute 00 instead of a symmetry to the minute 30.

(blue circle) = different service pattern. Instead of CT 12 runs the RE 30 also during peak-hours up to Valmiera. The different pattern results in different arrival and departure times in Riga main station with additional connections and more time to change trains.

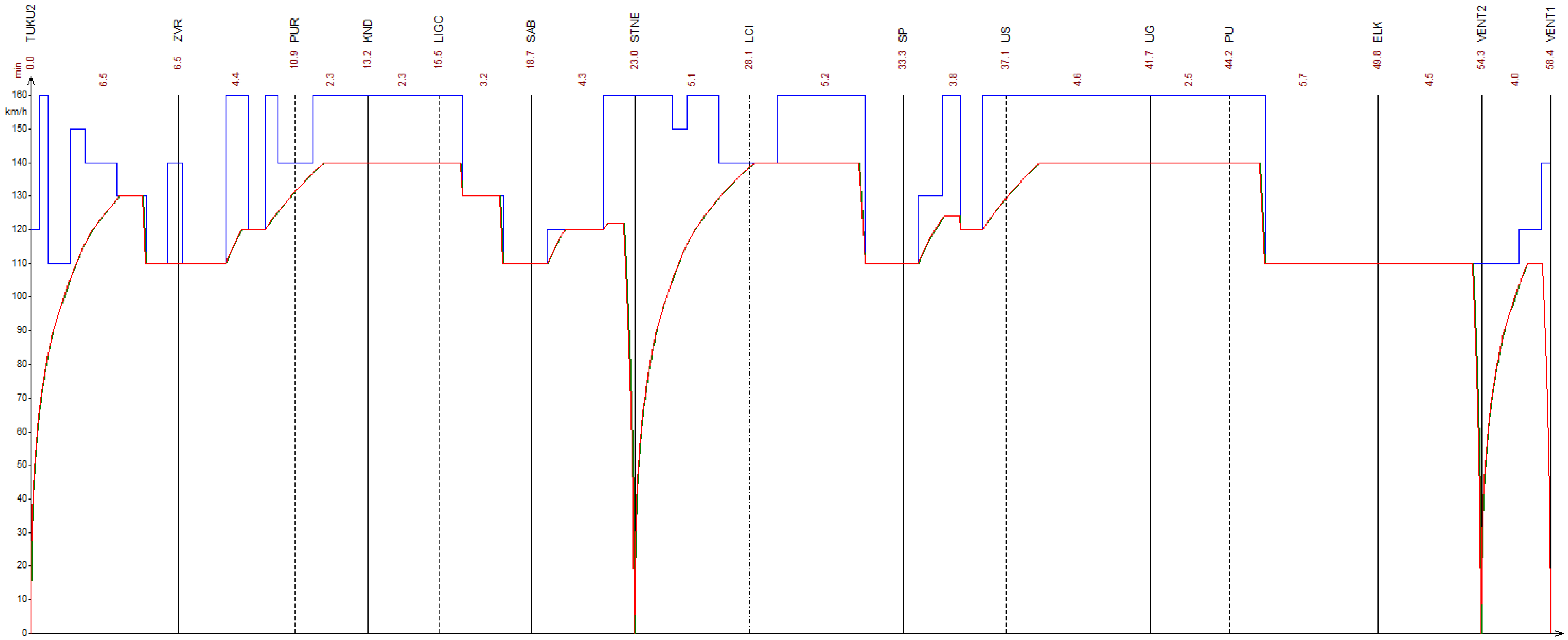
The latter changes need to be checked carefully. Remaining conflicts might have to be solved subject to further analysis beyond this study.

Annex 12.7: Assumed speed profiles

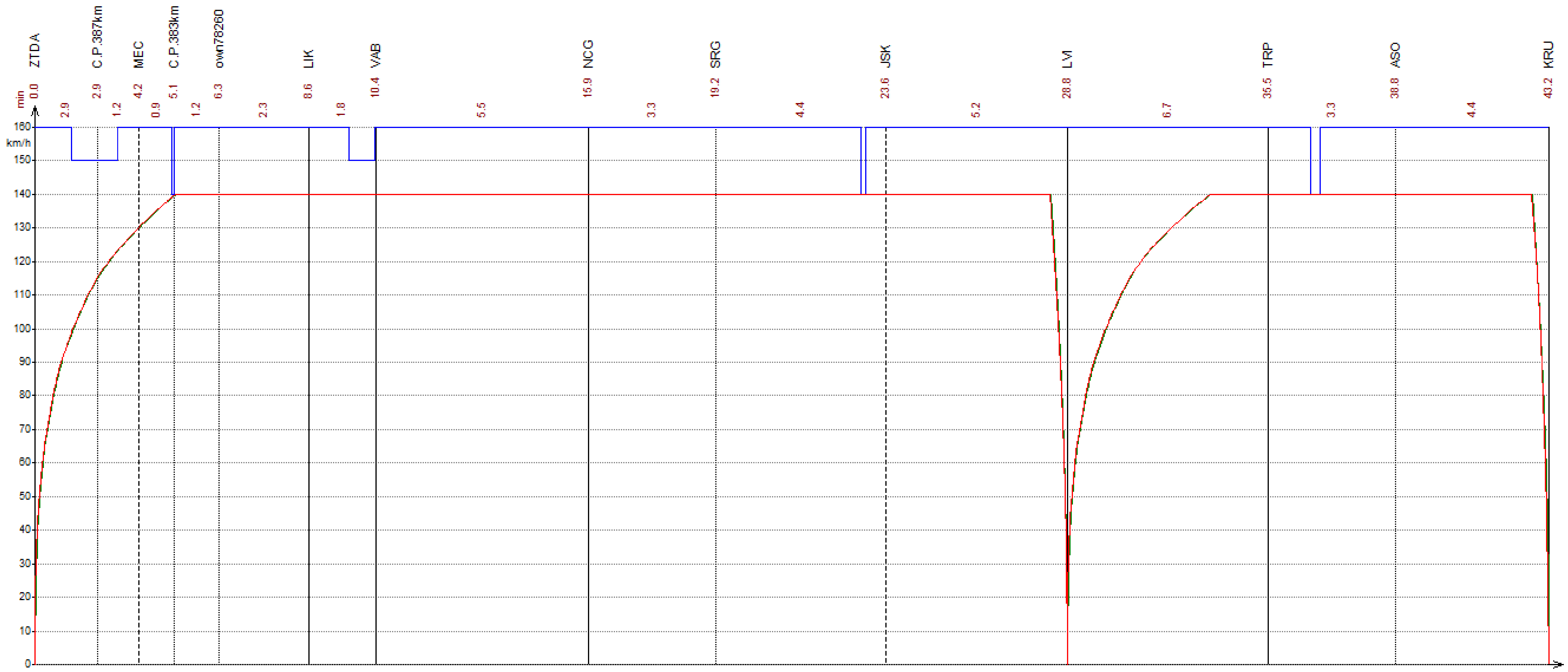
Riga – Tukums-2 140 km/h (DMU)



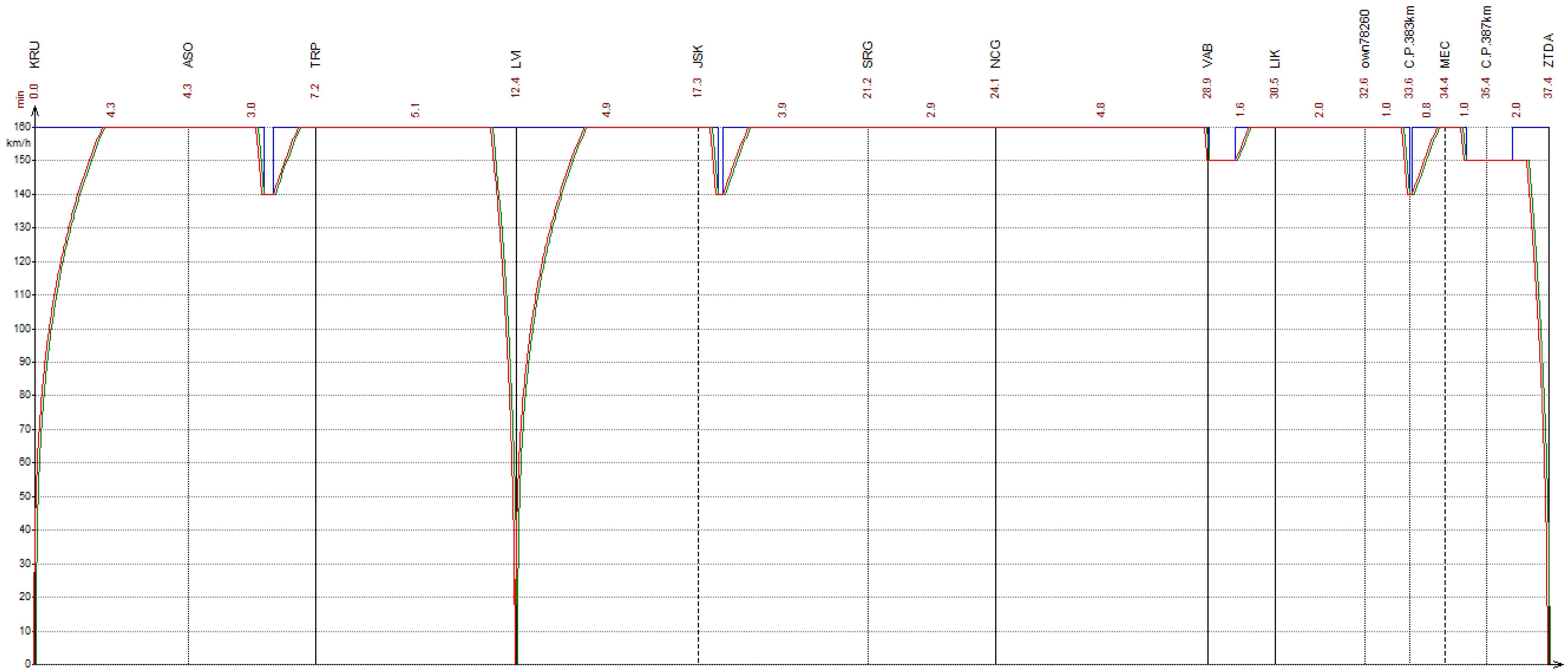
Tukums-2 – Ventspils 140 km/h (DMU)



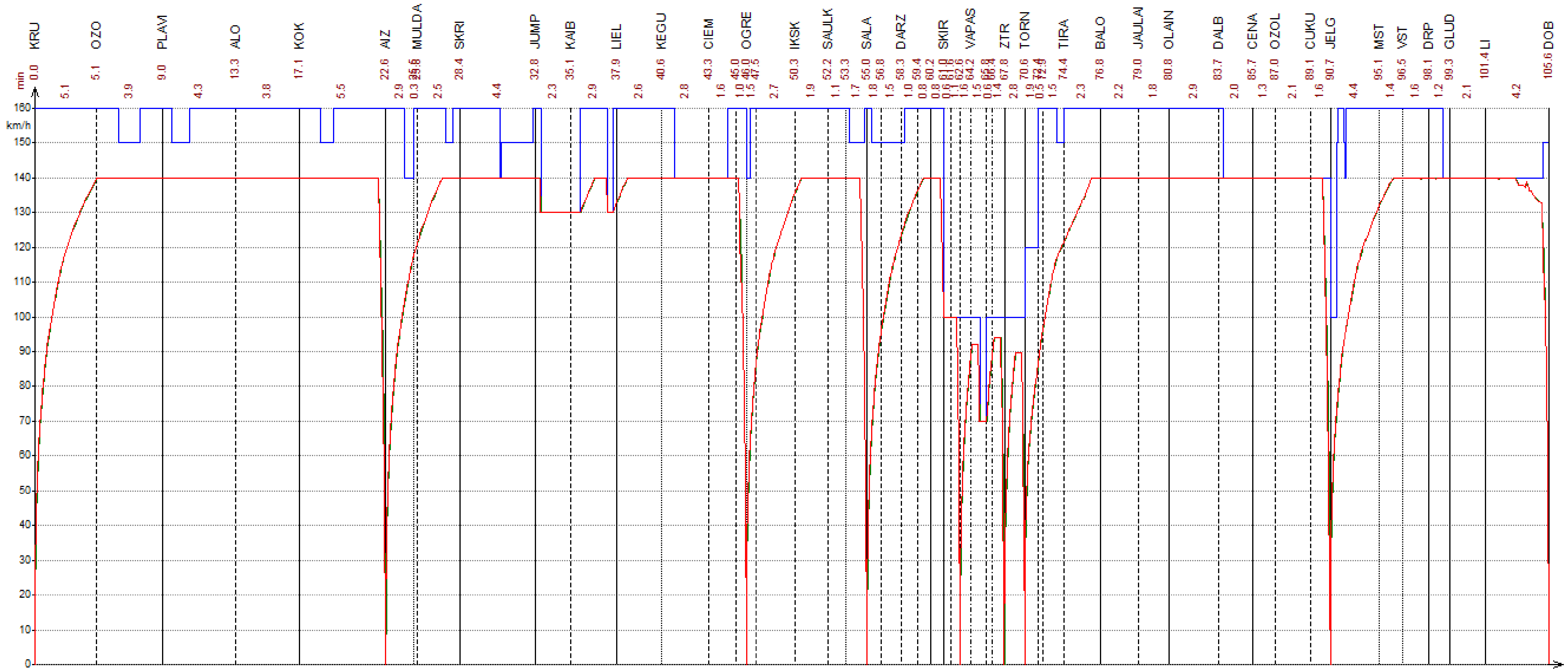
Daugavpils – Krustpils 140 km/h (DMU)



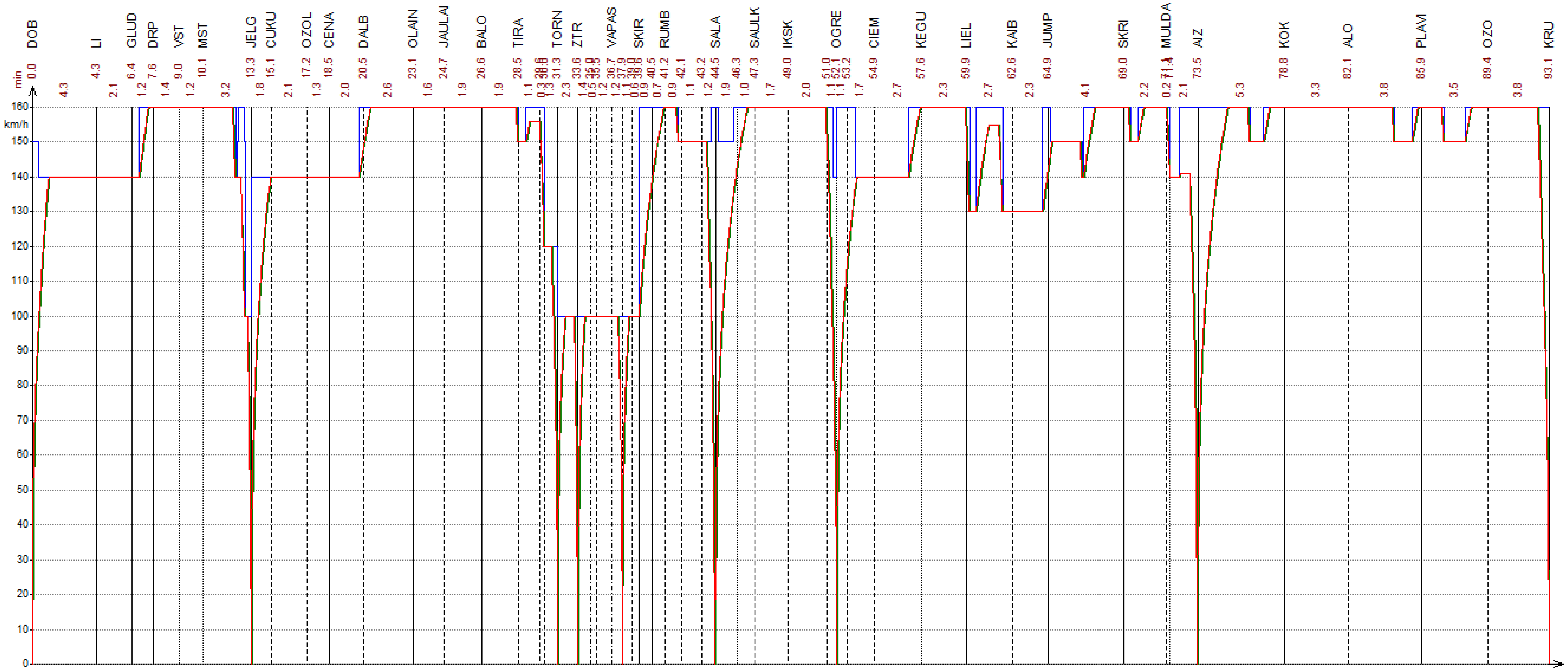
Daugavpils – Krustpils 160 km/h (EMU)



Krustpils - Dobele 140 km/h (DMU)

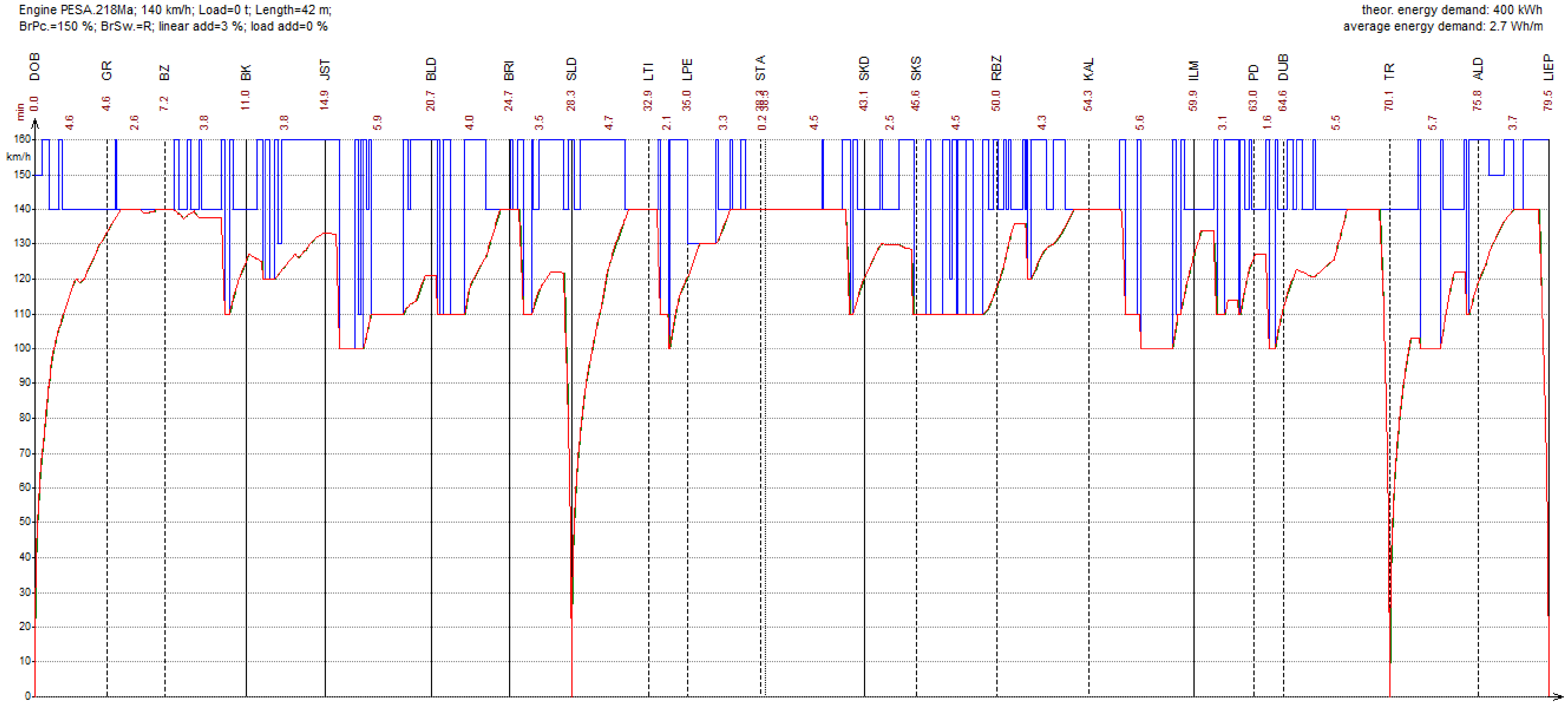


Dobele – Krustpils 160 km/h (EMU)

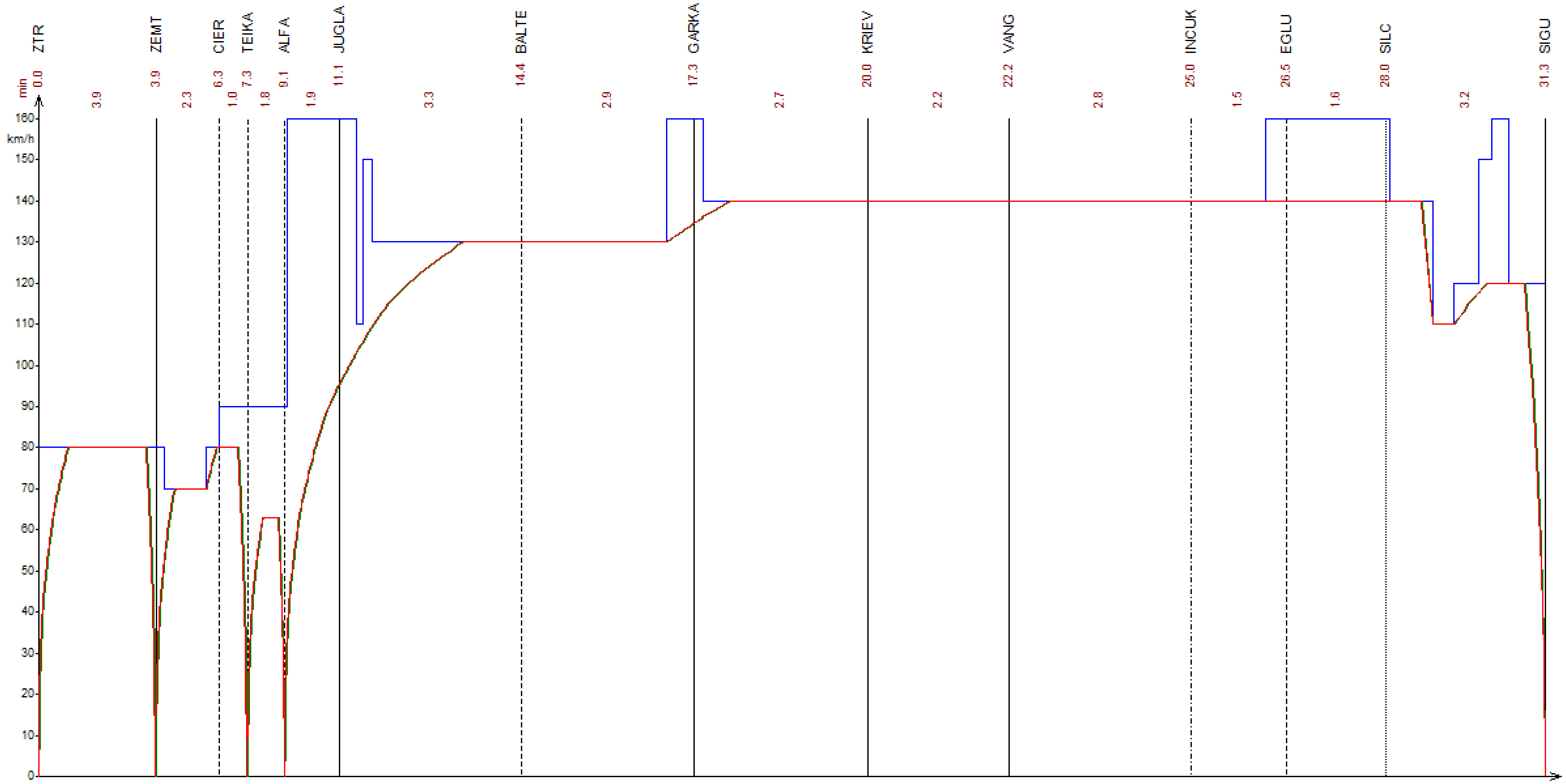


Remark: In section 8 this speed profile is only applied for indicated travel times Riga C – Krustpils.

Dobele – Liepaja 140 km/h (DMU)



Riga - Sigulda 140 km/h (DMU)



Sigulda – Valga 140 km/h (DMU)