MAPPING OF CROSS-BORDER ACCESSIBILITY IN THE CENTROPE AREA UNTIL 2050

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IPP **KORDIS**	Bratislavský kraj, Trnavský kraj, Nitriansky kraj, Jihomoravský kraj, Weinviertel, Wien, Wiener Umland/Nordteil, Wiener Umland/Südteil Nordburgenland, Győr-Moson-Sopron Megye	CZ-SK, SK-AT, HU-SK

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Note: The text did not pass the language proofreading

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1. INTRODUCTION

1.1. Assignment

1.1.1. CORCAP

Support for the development of ecological and efficient freight transport in Central Europe is the theme of an international initiative bringing together specialists in the field of transport and spatial planning from Germany, the Czech Republic, Hungary, and Slovakia. The interests of Czech and Slovak key actors (such as the Ministry of Transport and Construction of the Slovak Republic, Bratislava Self-Governing Region and others) is represented by KORDIS and the Institute of Spatial Planning (hereinafter referred to as IPP).

The main objective of the initiative is to strengthen the cooperation of stakeholders in the field of freight (and passenger too) transport and logistics along the Hamburg / Rostock – Dresden – Prague - Vienna / Bratislava - Budapest axis and to include the TEN-T corridor "Orient/East-Med" into the regional development strategies.

The Orient/East-Med (OEM) corridor on the territory of Slovakia passes through part of the territory of Trnava region (in the north-west part) and the territory of the Bratislava region in the north-south direction. From Bratislava, the OEM corridor continues further towards Petržalka to Hungary. On the Hungarian side of the territory, it continues to the town of Komárom, while this corridor also includes a port in the town of Komárno on the Slovak side (Nitra region).

Increasing the use of this corridor (especially in terms of transport of goods) would bring higher economic growth and increased employment in the whole Central European region, especially in areas along the main route, including the territory of South Moravia, Bratislava, Trnava and Nitra Regions. This initiative also builds on activities aimed at creating a 'New Silk Road'.

The CORCAP project includes several partners from Germany, the Czech Republic, Slovakia, and Hungary, and is being led by the Saxony Ministry of Interior (Sächsisches Staatsministerium des Innern). The CORCAP (Capitalisation of TEN-T Corridors for Regional Development and Logistics) project was approved by the members of the Monitoring Commission of the Interreg CENTRAL EUROPE - European Territorial Cooperation Programme in January 2019.

The main outputs are:

- **REGIONAL NEEDS AND CHALLENGES ANALYSIS FOR THE SOUTH-WEST SLOVAKIA** (IPP 2020) for efficient and environmentally friendly freight transport includes also identifying of the potential of the OEM Corridor for regional development. Emphasis was placed on the node functions of the Bratislava Region and the impact of territorial links to the Vienna agglomeration and on the territories of Trnava and Nitra region.
- **Pilot activity for the development of attractive multimodal logistics locations in the territory of South Moravia and Southwest Slovakia.** The solution was based on several analytical evaluations, from which it is worth to mention the GIS assessment of regional accessibility, in the territory of the CE CENTROPE region, according to various modes of transport and analysis of transport development scenarios up to 2050 and 2070. This is the subject of this study MAPPING OF CROSS-BORDER ACCESSIBILITY IN THE CENTROPE AREA UNTIL 2050. This study is followed by IDENTIFICATION OF SITES ATTRACTIVE IN TERMS OF MULTIMODAL LOGISTICS AND THE DEVELOPMENT OF PROFILES IN THE SOUTH MORAVIAN REGION AND SOUTHWEST SLOVAKIA REGION. Together, the two studies form the main output of the Pilot Activity.
- **OEM CORRIDOR CAPITALISATION PLAN FOR THE TERRITORY OF SOUTHWEST SLOVAKIA -** Corridor Capitalisation Plan is an innovative instrument with potential relevance for all TEN-T corridors. Currently, the existing practice of corridor development is mainly focused on

infrastructure standards and technical surroundings of the infrastructure system, following the principles of sectoral planning. The approach followed by the project goes beyond this practice, as it aims at the elaboration of consolidated strategies oriented to the interaction of regional development and transport infrastructure development, considering as well operational requirements of multimodal logistics locations and transport services.

1.1.2. IPP & KORDIS

Institute of Spatial Planning is a 'think tank' dealing with spatial planning, regional development, ecology and the environment, geographical information systems, sustainable transport and mobility. Within the CORCAP project, the IPP represents the interests of Slovakia and is responsible for the development of (i) Regional needs and challenges analysis for the Bratislava Region for efficient and environmentally friendly freight transport and identification of the OEM corridor potential for the regional development, (ii) Corridor Capitalisation Plan for the Southwest Slovakia and (iii) the Recommendations for the implementation of the Corridor Capitalisation Plan for the Southwest Slovakia.

KORDIS JMK is a public company founded by the South Moravian Region and the city of Brno. KORDIS is responsible for the integrated public transport system in the South Moravian Region and provides comprehensive activities in all areas of public transport, e. g. conceptual planning, operational control, control, and public relations. KORDIS is responsible for the management, development, and maintenance of regional and urban public transport, including local and regional buses and trains. KORDIS has many years of experience in the field of inter/multimodal transport, coordination of inter/multimodal public transport hubs, passenger information services, use of satellite navigation for Public Transport Control Centre.

The two institutions share an output in the so-called Pilot activity for the development of attractive multimodal logistics locations in the territory of the South Moravian Region (SMR) and Southwest Slovakia. The submitted document represents the first part of the Pilot activity.

1.1.3. Purpose of the task

At present, the potential of the rail network is underused, which is a pity. The EU has supported exploiting the potential of the railways in long-term, both in terms of passenger and freight transport. This is mainly related to the effort to improve the quality of the environment and the settlement environment. The project builds on the trend of further development of rail freight transport at the expense of mainly automotive transport, mainly long-distance truck transport. This makes it necessary to create an efficient system of a connection between railway terminal and logistics centre through the establishment of intermodal/multimodal hubs (IHUB).

The interest of the society or individual states, regions and municipalities is to modernize the rail transport system and to take advantage of its lower environmental burden on the territory, increasing transport speed, expanding capacity, and using the available lines and stations more efficiently. This is especially important when talking about an efficient transhipment of goods between rail and road transport.

The **aim of this study** MAPPING CROSS-BORDER ACCESSIBILITY IN THE CENTROPE REGION BY 2050 is to **model the development of the TEN-T network**, with an emphasis on the network of railway lines, by 2050 in the territory of CE CENTROPE region. This region includes border territories of Slovakia, the Czech Republic, Hungary, and Austria.

The main method used was network analysis, through which **the attractiveness index** was measured as an aggregate index of accessibility to selected transport entities (TEN-T international airport and TEN-T port, motorway or expressway, TEN-T or RFC railway and IHUB).

The results of the analysis form the basis for the development of IHUBs network in the territory of South Moravia and Southwest Slovakia, which is the subject of the second study of the Pilot Activity with the name IDENTIFICATION OF ATTRACTIVE MULTIMODAL LOGISTICS LOCATIONS AND ELABORATION OF PROFILES FOR DEVELOPMENT IN THE REGION OF SOUTH MORAVIA AND SW SLOVAKIA.

1.2. Target groups

- **Regional authorities** – South Moravian Region, Bratislava, Trnava and Nitra (Self-governing) Regions
- **National authorities** – Ministry of Transport of Czech Republic, Ministry of Transport and Construction of the Slovak Republic, Ministry of Investments, Regional Development, and Informatization of the Slovak Republic
- **City of Bratislava**
- **City of Brno**
- Relevant municipalities
- **Transport and logistics experts**:

→ Masaryk University Brno

→ SŽ – Správa železnic [management of nation-wide and regional railways]

→ AROS - Association of Railway Operators of Slovakia

→ ŽSR [Slovak national railway company]

→ Verejné prístavy [Public ports]

2. THEORETICAL BACKGROUND AND METHODOLOGY

2.1. Background

1. The current transport network of the CENTROPE region is composed of:
   a. main and arbitrary railway lines
   b. motorway and expressway network

   The transport system is gradually expanding, especially the motorway network. The modernization of the railway network lags behind the overall demands and expected transport requirements.
2. The projected traffic intentions will be in a substantial change in modal split limiting individual car transport (reducing the carbon footprint), which means:
   a. Strengthening all modes of public passenger transport, in particular rail passenger transport
   b. Limiting car traffic, especially in radial directions to the central parts of Brno and Bratislava
   c. The EU's intentions to reduce the carbon footprint will directly affect the transfer of freight transport from long-distance trucks to rail freight
3. The current transport of freight is expected to double by 2050/2070, while precise objectives in the development of intercontinental transport, particularly in the South-East Asia - Europe direction, are not known
4. It is necessary to prepare transport routes for long-distance freight transport throughout the region for the transport of freight in the amount of about 20-24 million tons/year in the main direction NW – SE. This will mean, considering the EU's intentions to limit car traffic, drawing attention to the railway arbitrary lines available today in order to ensure their increased throughput
5. The area of South Moravia and SW Slovakia are and will be increasingly important crossroads of long-distance transit (railway – highway – waterway) in all directions (NW-SE, N-S and E-W) with relatively balanced transport quantities of goods about 20 mil. tons/year in each main direction
6. The REGIONAL ANALYSIS OF CHALLENGES AND NEEDS FOR SOUTH-WEST SLOVAKIA document (CORCAP & IPP 2020) shows that the transit of the OEM corridor through the territory of the Slovak Republic should be assessed in the context of regions of the whole SW Slovakia, not just the Bratislava Region
7. It is neither an all-society intention nor a need for freight transport, especially long-distance transit freight transport, to pass through the built-up territory of the city of Bratislava

The life is complex, dynamic, and often unpredictable. We must always remind ourselves of this when processing studies and forecasts with a long-term perspective. This document is such a study. It is also important to bear in mind the fact that we are planning and forecasting in order to make a sensible decision today. It is clear to us that the forecast for the future is only true to a certain extent because we are working with many assumptions that will, with a high degree of probability, only partially be fulfilled in the real future. However, due to the nature of the task, it is not possible to proceed differently since the development of the railway network and intermodal terminals in relation to the structure of logistics centres adapt to the settlement structure. Rail freight transport is an important factor in ensuring sufficient quality of the settlement environment not only for today, but especially for the future. This is done so that the society and its management systems (decision makers) could implement appropriate measures to ensure the necessary quality of the settlement environment.

Until now, the development of the society has always been carried out in the territory and will continue to do so for the foreseeable future. The settlement is a manifestation of this. It is constantly evolving, and we can conclude this in accordance with the rules of dialectics. It develops in waves, with a continuous increase in human needs as opposed to the territory's possibilities. When development hits barriers, a qualitative change is sought to allow further development. And we can also say that any change negates the way it develops so far. This is also the case with the development of transport. The massive development of truck transport has hit a barrier to the potential of transport routes, or its tumultuous development in the territory, which is beginning to resemble cancerous exuberation. The answer is to find alternative solutions to ensure material and goods flows, without which the society cannot work. The simplest alternative is to modernize and expand the available railway network for freight transport purposes, more precisely, to shift part of freight to rail.

The industrial changes, related to increasing its efficiency pursue the objective of minimising production to warehouse and then transport the products to the final customer as soon as possible. In practice, this means building or rebuilding warehouse areas into logistics centres that ensure the speed and efficiency of the execution of goods flows from the manufacturer to the final customer. The effort to increase the share of the rail network in the transport of goods creates a necessity to build intermodal terminal facilities that will ensure efficient transhipment of containers to lorries, which then distribute the goods to logistics centres, where containers are "dismantled" and then transported by smaller cars to the final customer. Other types of transport are used for the transport of containers as well, namely shipping and air transport, but in the case of the Slovak Republic it is mainly rail transport. Its condition and possibilities of its development predetermine that, especially in the case of long-distance goods flows, it should take significant share in container transport.

2.2. Approach to the solution

As we have already stated, the life or part of reality that is the subject of our interest, which we want to purposefully drive towards ensuring a quality settlement environment – the system in question - is complex, extensive, dynamic, and intelligent. In order to be able to analyse it and predict its development, we need to simplify it into essential factors and develop its model. To do this, we use the existing level of knowledge in the field of urban transport as well as the available set of data on relevant factors of the territory forming an information system. In our case of geographical nature. In this context, it should be reminded that the level of knowledge and available data and statistics for solving the task is incomplete. This requires to an extensive use of the theoretical and practical experience of the team in the form of expert estimates, both in terms of the methods chosen and the available data.

At the same time, the processors are aware that due to the long-term outlook for the development of infrastructure to ensure sufficient freight transport capacities, it makes sense to consider the design of an interactive simulation model. Such a model would allow the design to be updated even after the completion of the project works. It can respond to ongoing changes resulting from the complexity and dynamics of reality.

Originally, the focus on only the Bratislava Self-governing Region was considered. However, mainly due to the results of the Regional Sustainable Mobility Plan of Bratislava Region (SGS 2019), the territorial scope was extended to the whole Southwest Slovakia, i.e., the area of Bratislava, Trnava and Nitra Regions. This way it is possible, especially in transit freight transport, to bypass the central positions of capital city of the Slovak Republic Bratislava. The potential for the development of rail transport in the central locations of Bratislava is, mainly due to the ongoing suburbanisation process, exhausted for the development of suburban passenger rail transport, so it is necessary to look for a new concept for freight transport.

The recent period shows that the development of informatisation creates new possibilities for reducing passenger transport as a result of working from home ("home office") for a number of workers, as well as by providing activities in the field of public services. But due to the unexplained nature of this issue, we have not been able to put this factor into a more specific form and we have not included it in development scenarios.

Another important factor is the border position of Bratislava and its tumultuous suburbanization development, which, although it is directed to the territory of the Slovak Republic, is also getting more and more strong into the territories of the neighbouring countries of Austria and Hungary. The proximity of Vienna, and its agglomeration, as well as the settlement structure of the county of Győr–Moson–Sopron are important factors. It can be assumed that the modernisation of railway network will also intensify the links of the Bratislava agglomeration to Budapest and Brno agglomerations (accessibility will be decreased to about 1 hour of travel time). It can be expected that by 2050, about 4 to 6 mil. inhabitants will be located in the radius of 1 hour accessibility (from Bratislava).

Regarding the territory of SW Slovakia, the population is around 2 mil. (Bratislava Region 670 thousands, Trnava Region - 565 thousands, and Nitra region – 675 thousands). Both natural and migration increase can be assumed in the future. Slovak national strategical planning document (Aurex 2012) foresees the formation of the settlement core areas of development not only around district and regional towns and city of Bratislava, but also by deepening of settlement cooperation and specialization mainly within the western part of the region of SW Slovakia. Slovakia faces an important task to purposefully shape the settlement system of Southwest Slovakia so that the adequate quality of the settlement environment is achieved on one hand, and to avoid uncontrolled urbanization, especially in the area of Bratislava on the other hand. This assumes a rational and efficient development mainly of transport infrastructure, where rail transport should play an important role in accordance with the principles of sustainable development.

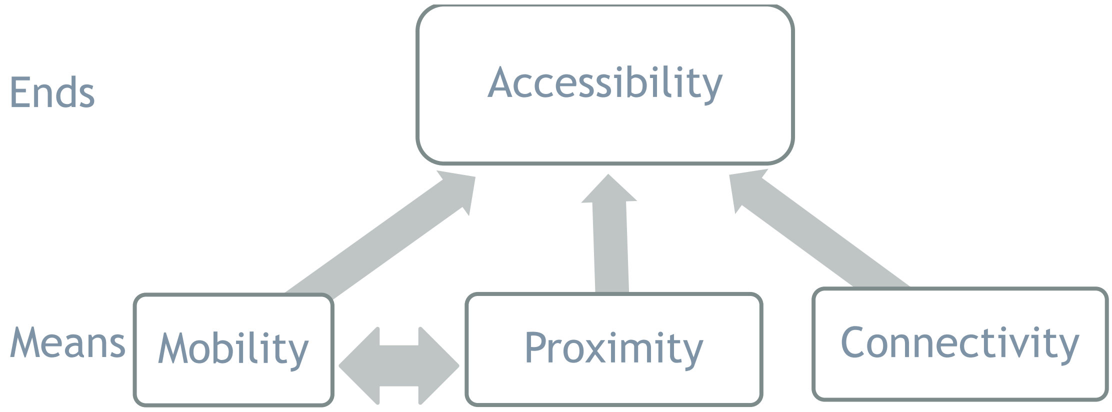
Given the location of SW in the Central European Region, this territory is a crossroads of at least three corridors of European importance, i.e., in addition to local and regional transport, cross-border and interregional transport will also be of great importance. Transit transport along Pan-European corridors, which has significant development potential, is and will increasingly be of particular importance. Speaking about freight transport and related infrastructure for securing the transport of goods and material flows, it is realistic to assume the interest of investors in building logistics centres and IHUBs not only of regional but also of national and Central European importance in the region of SW Slovakia. This must, of course, also be matched by the corresponding robustness of the railway infrastructure.

2.3. Accessibility evaluation

2.3.1. On accessibility evaluation

In general, “all locations have a level of accessibility, but some are more accessible than others. Thus, because of transportation, some locations are perceived as more valuable than others” (p. 11, Rodrigue, Comtois, Slac 2006). Firstly, the misinterpretations need to be clarified. There is a difference between **access** and **accessibility.** Accessibility is rather a relative concept that varies according to location within the transport network. There is also a difference between time (distance measured in time) and distance (measured in km). The same length of road segment may have different time distance in various cities, depending on the actual or long-term conditions (Rodrigue, Comtois, Slac 2006).

Fig. 1. Relationships between mobility, proximity, connectivity, and accessibility



Source: Levine et al. (2012)

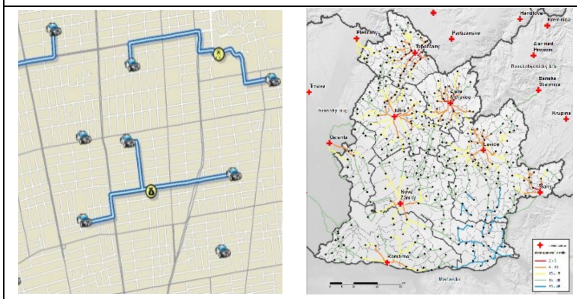
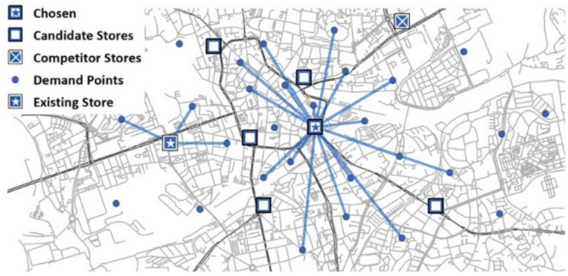
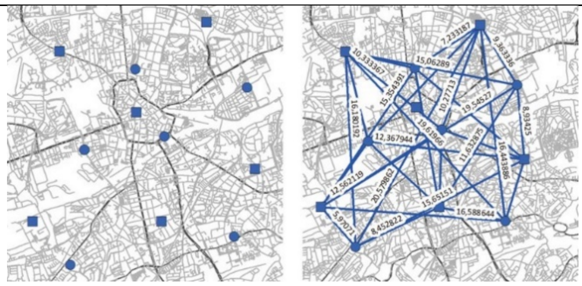
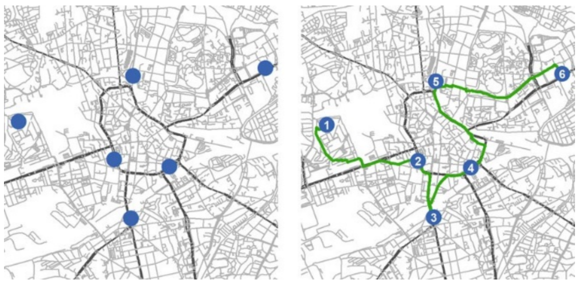
Mobility, connectivity, and proximity are means of accessibility. Mobility and proximity are closely related to each other, however in indirect proportion: the closer the origin and destinations are, the more probable that there is a slow transportation between them and vice versa (Levine et al. 2012).

From mathematical point of view, three types of accessibility indices are usually defined (ESPON 2013):

- travel cost - accumulated travel cost to a set of activities
- daily accessibility - accumulated activities in a given travel time
- potential - Accumulated activities weighted by a function of travel cost

Several authors of Slovak and Czech geography were dealing with accessibilities measurements. The accessibilities can be measured and depicted in several ways. Križan & Gurňák (2008) mentioned **cartographic** and **graphic** techniques. Based on their evaluations the most suitable cartographic technique is **isochrones.** Mostly used is the method of cartogram (choropleth). Less common are **cartodiagrams**, and **dot technique**. The use of concrete technique depends on the type of accessibility, its scale or hierarchical level of research and type of transport network.

Fig. 2. Network Analyst methods

	**Service Area** - Concentric zones show how accessibility varies with impedance. Once created, it is possible to identify how much land or how many people is within the neighbourhood or region.
	**Closest facility** enables to find 1 or more closest facility/s from multiple locations (here referred to as “incidents”), e.g., closest hospital to an accident, closest store to a customer's location etc.
	**Location-Allocation Analysis** helps find the best locations for facilities to serve a set of demand locations. It uses the Huff Model (Huff 1963).
	**Origin-Destination (OD cost Matrix)** enables to calculate the distances between multiple origins to multiple destinations. The lines are depicted straight due to performance reasons; however, they always have the attribute of the network cost (distance calculated using the network model), not straight-line distance.
	**Traveling Salesman Problem** - aim is to visit each of these locations in a certain order, that has to be the most efficient one regarding distance, required time or costs.

Source of the figures: Pászto, Jürgens, Tominc, Burian, (Eds.). (2020)

For the purpose of this study, the **Closest facility** method was selected, followed by method of cartogram with LAU2 as a basic territorial unit. The method thus defined was used in several projects - TRACC (ESPON

2013), territorial “generels” (transport plans) of Trnava and Nitra Region (AUREX 2015b & AUREX 2017a), Study for evaluation and monitoring of the Territorial Plan of the Nitra Region (AUREX 2015a & PPI 2018).

Tab 1. Different maximal speed limits in the Czech Republic, Slovakia, Austria, and Hungary in km/h

	CZ			SK			AT			HU		
	car	van	bus	car	van	bus	car	van	bus	car	van	bus
Motorways (D)	130	80	130	130	90	100	130	80	100	130	80	80
Expressways (R)	110	80	110	130	90	90	130	80	100	110	80	80
Motorways and Expressways in built-up areas (D+R)	80	80	80	90	90	90	130	80	100	130/110	80	80
Non-urban roads	90	80	90	90	90	90	100	70	80	90	70	70
Urban roads (in built-up areas)	50	50	50	50	50	50	50	50	50	50	50	50

Source: European Commission (2020) https://ec.europa.eu/transport

Tab 2. Different speed limits used for assessing accessibility in various projects in km/h

	Type of road	AUREX (2015b) & AUREX (2017a)	AUREX (2015a)	IPP (2018)	TRACC ESPON PROJECT (2013)	CORCAP - current study
road network	**Motorways (D)**	130*	110	90	115	**90**
	Expressways (R)	110*	100	90	105	**90**
	Motorways and Expressways in built-up areas (D+R)	80*	100	90	76	**76**
	First-class roads	90*	80	68 (58**)	67	**68**
	First-class roads in built-up areas	50*	80	68 (58**)	45	**45**
	Second-class roads	90*	70	50 (40**)	48	**50**
	Second-class roads in built-up areas	50*	70	50 (40**)	35	**35**
	Third-class roads	90*	55	48 (38**)	32	**48**
	Third-class roads in built-up areas	50	50	45 (35**)	25	**35**
	Local roads in built-up areas	50	50	45 (35**)	25	**35**
	(Car on a) Ferry	10	10	10	N/A	**10**

Note: * - maximum speed limit in Slovakia (as of 2017); Note2: ** - lower speeds were assigned to problematic road segments with inadequate condition of road-width

In TRACC ESPON project (ESPON 2013) also bus (35 km/h) as well as railway network was used for assessing the accessibility rates:

- Main line - double track 77 / 52 km/h (electrified/non-electrified)
- Main line - single track 57 / 52 km/h (electrified/non-electrified)
- Secondary line - single track 37 / 32 km/h (electrified/non-electrified)

2.3.2. The accessibility evaluation in the CE CENTROPE

- **AREA OF ANALYSES:**

> Southwest Slovakia and South Moravia

- **TYPE OF ASSESSMENT:**

> Accessibility assessment - in minutes - using the road network of motorways and expressways, 1st, 2nd and 3rd class roads, ferries and - in case of larger cities - the local communications in ESRI ArcGIS Network Analysis environment. Each type of road was assigned different average speed. See the Tab.

Tab 3. Speed limits used for assessing accessibility in current study (km/h)

Type of road	Average speed
Motorways (D)	**90**
Expressways (R)	**90**
Motorways and Expressways in built-up areas (D+R)	76
First-class roads	**68**
First-class roads in built-up areas	45
Second-class roads	**50**
Second-class roads in built-up areas	35
Third-class roads	**48**
Third-class roads in built-up areas	35
Local roads in built-up areas	35
(Car on a) Ferry	10

- **TEMPORAL CONDITIONS:**

> current state (2020)

> vision (2050)

- **ORIGINS AND DESTINATIONS OF ACCESSIBILITY ASSESSMENT:**

> Municipalities to:

  - **TEN-T international airports** – closest international airports as defined on TENtec Geoportal – Wien, Bratislava, Budapest and Ostrava
  - **TEN-T ports** – closest international airports as defined on TENtec Geoportal - Wien, Bratislava, Győr (Gyonyű), Komárno, Štúrovo and Budapest
  - **TEN-T & RFC railway lines** - railway stations (passenger or freight) lying on the Core and Comprehensive TEN-T corridors or Main and Diversionary RFC7 corridors
  - **Intermodal hubs/Multimodal interfaces** - closest existing intermodal terminal
  - **Highways and Expressways** - entry points to the motorways/expressways

The main source of road network was http://opentransportmap.info (© OpenStreetMap contributors). The database comprises the whole area of interest. The main advantage is that the nodes are topologically clear. It means that it is suitable for network analyses.

The current (2020) and planned **road development** (by 2030 and 2050) was gathered from various data sources.

- In the Czech Republic:
  - Geoportál Jihomoravský kraj (2020) [Geoportal of the South Moravian Region] with links to the spatial plans of the municipalities with extended competences that together cover all the area of the South Moravian Region (Blansko, Boskovice, Brno, Břeclav, Bučovice, Hodonín, Hustopeče, Ivančice, Kuřim, Kyjov, Mikulov, Moravský Krumlov, Pohořelice, Rosice, Slavkov, Šlapanice, Tišnov, Vyškov, Znojmo and Židlochovice)
  - Brno city GIS portal - gis.brno.cz
  - Geoportál silniční a dálniční sítě ČR (geoportal.rsd.cz/web) (ŘSD 2020) – Ředitelství silnic a dálnic [Roads and Highways Authority]
- In Slovakia:
  - Regional Spatial Plans of Bratislava (AUREX 2017b), Trnava (AUREX 2014) and Nitra Regions (AUREX 2015c)
  - Národná diaľničná spoločnosť (ndsas.sk) - national highway company
- In Austria:
  - ÖBB (oebb.at) – Austrian national railway company
  - ASFiNAG (2020) - Autobahnen- und Schnellstraßen-Finanzierungs-Aktiengesellschaft - Austrian publicly owned corporation which plans, finances, builds, maintains, and collects tolls for the Austrian motorways.
- In Hungary:
  - Conference on HSR Budapest – Warsaw - TRENECON (2020), Asbóth - Bersényi (2020)
  - TEIR.hu - Országos Területfejlesztési és Területrendezési Információs Rendszer [National Spatial Development and Spatial Planning Information System]
  - NIF.hu - NIF Nemzeti Infrastruktúra Fejlesztő Zrt [NIF National Infrastructure Development Ltd.]
  - KTI Budapest

Furthermore, the results for the accessibility assessment were incorporated into the Web Map Application to be found at IPP´s webpage https://ipp-oz.sk/corcap.

2.4. Evaluation of potential impacts of the conducted truck transport survey in the South Moravian Region

Coordinator of the Integrated System of the South Moravian Region (KORDIS JMK) carried out four surveys:

1) Analysis of rail freight transport in the Czech Republic
2) Quantitative survey of long-distance road freight transport in the South Moravian Region
3) Scenarios of transport development in the South Moravian Region until 2050
4) Qualitative survey of long-distance road freight transport in the South Moravian Region

Further, each survey will be briefly described. Subsequently, the methodology and results of the Qualitative Survey of Long-Distance Road Freight Transport in the South Moravian Region will also be explained.

1) Analysis of rail freight transport in the Czech Republic

The analysis describes the current state of rail freight transport in the Czech Republic (ČR). It lists the lines used and the intensity of their use for rail transport. Furthermore, information on railway transit in the Czech Republic can be obtained. Basic information about the rail freight transport market in the Czech Republic is presented by comparison between years 2005, 2007 and 2019. The volume of rail freight traffic is also described. It grows every year. The current state of rail freight transport has been described by an expert who has been dealing with freight rail transport for a long time.

2) Quantitative survey of long-distance road freight transport in the South Moravian Region

The aim of the survey was to map the intensity of road freight transport on the main roads in the South Moravian Region. The survey was carried out by Masaryk University in Brno. The subject was the analysis of traffic flows from the toll gates of the Road and Motorway Directorate of the Czech Republic. The data was from 2019. Based on the survey, it was possible to determine the transit of truck transport through the territory of the South Moravian Region. The intensity of truck traffic was analysed on the D1, D2, D52 and D46 motorways and on the 1/43, 1/50 first class roads.

3) Scenarios of transport development in the South Moravian Region until 2050

The aim was to formulate anticipated future trends in the development of freight and passenger transport in the South Moravian Region. The scenarios include the development of freight transport in the South Moravian Region until 2050. Part of the study is a brief discussion of key trends (such as pandemics, geographic location, global economy), their polemics and interpretations.

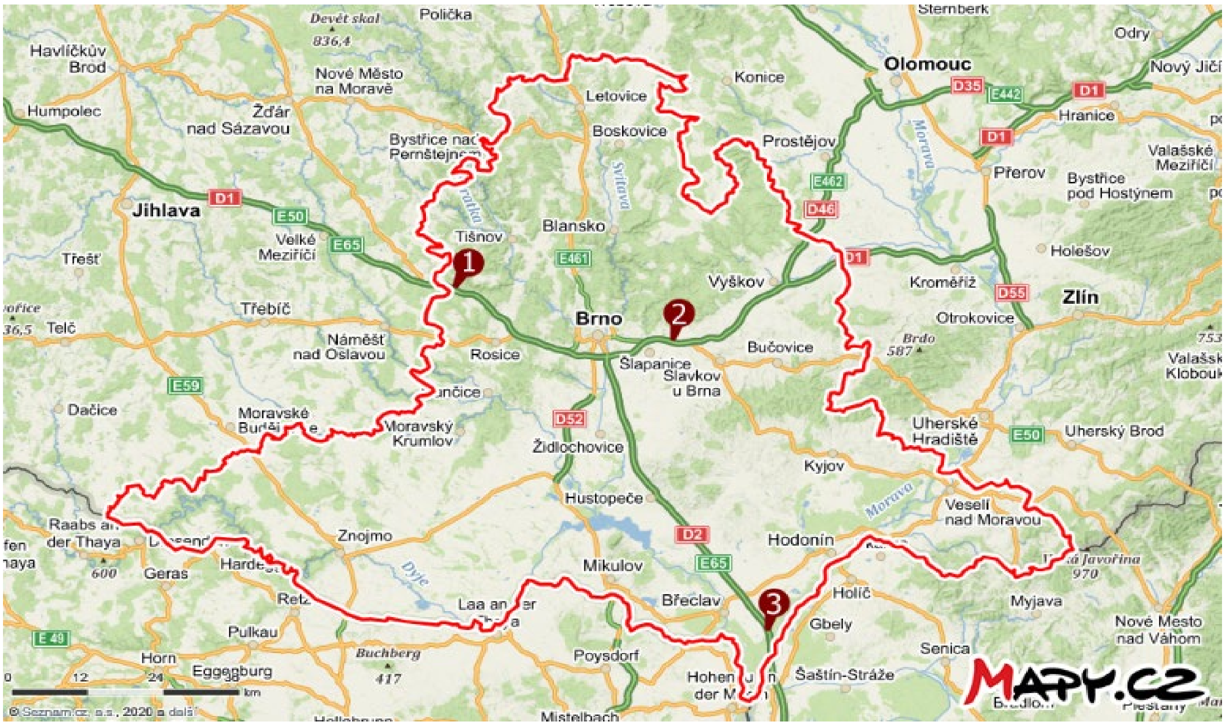
4) Qualitative survey of long-distance road freight transport in the South Moravian Region – methodology

Quantitative survey of long-distance road freight transport in the South Moravian Region was carried out by KORDIS JMK. This is a type of qualitative survey that was probably carried out for the first time in the Czech Republic. The aim was to find out information about the origin and destinations of trucks passing through the South Moravian Region, primarily along the axis of the TEN-T Orient/East-Med Corridor (D2 and D1 motorways) and to find out other necessary data on cargo, drivers, etc.

The survey was carried out between 22nd and 24th September and on 1st October 2020 and took place at three lay-byes along motorways near Brno (in both directions). According to the results of the pre-research, the three busiest lay-byes were selected:

1) Devět křížů – in the north-western part of the region near Velká Bíteš, next to D1 motorway
2) Rohlenka – roughly in the middle of the region, near Brno, on the D1 motorway
3) Lanžhot – in the southern part, near Břeclav, near the D2 motorway on the border with Slovakia

Fig. 3. Lay-byes where the survey was conducted



Source: mapy.cz

A total of 552 questionnaires were completed. Of these, 16 lacked the necessary information and therefore had to be excluded. The questionnaires were created in 12 language versions: Czech, English, Bulgarian, Croatian, Hungarian, Lithuanian, Polish, Romanian, Slovenian, Serbian, Turkish and Ukrainian.

Qualitative survey of long-distance road freight transport in the South Moravian Region – results

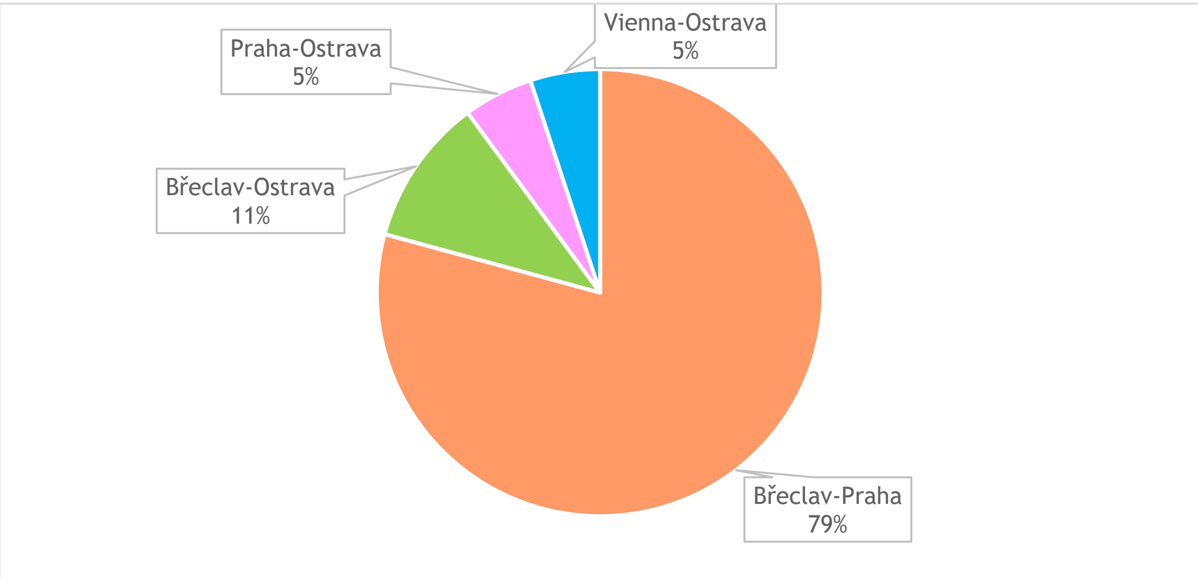
Truck routes

Data from valid questionnaires were processed and sorted according to truck routes. From the obtained data, the busiest route **Břeclav – Prague** was determined, which is most often used by freight drivers when crossing the territory of the region. Other busy routes according to the survey are:

- Břeclav – Ostrava
- Praha – Ostrava
- Vienna – Ostrava

The picture shows the share of trucks according to individual routes in the South Moravian Region.

Fig. 4. Share of trucks by route



Source: Truck transport survey in the South Moravian Region

Origin and destination countries

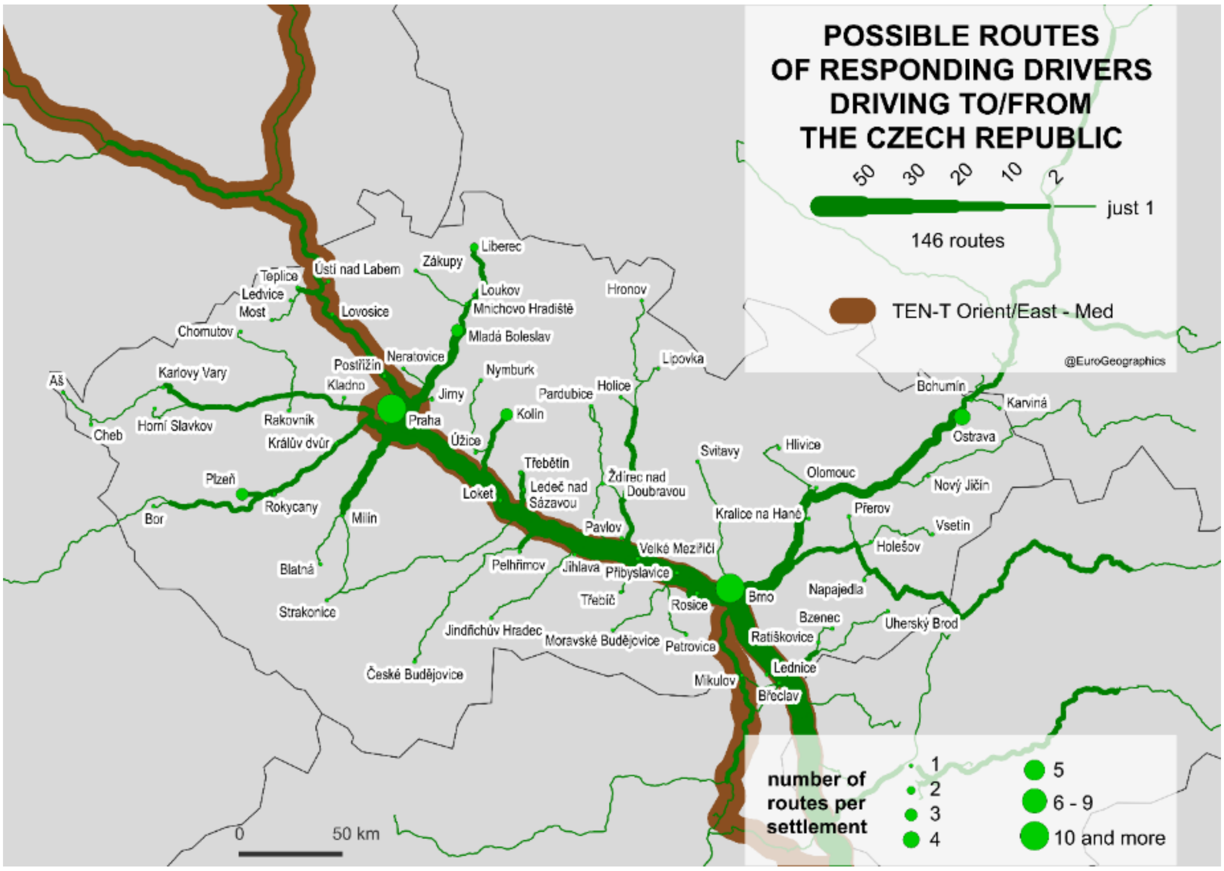
The largest number of respondents were drivers who headed from Hungary to Germany and vice versa, then from Romania or Slovakia to Germany and from Hungary to the Czech Republic. The values can be compared in the following Tab.

Tab 4. Number of trucks according to the origin and destination countries (sum for both directions)

Origin and destination country	Number of trucks
Hungary - Germany	59
Romania - Germany	37
Slovakia - Germany	37
Hungary - Czech Republic	36
Slovakia - Czech Republic	21
Serbia - Czech Republic	16

The picture bellow shows the direction of the road and the city where or from where the truck traffic most often goes.

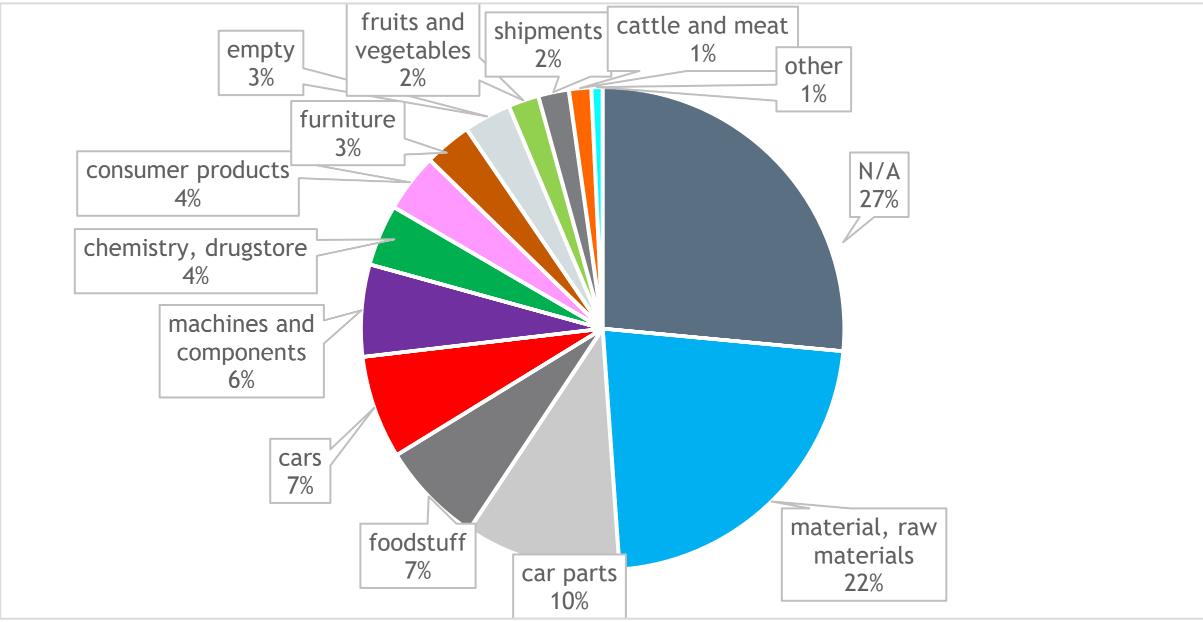
Fig. 5. Illustration of cities in the Czech Republic representing origins or destinations of truck transport



Source: Truck transport survey in the South Moravian Region

The type of cargo carried is shown in the figure bellow. Based on the data from the graph, it can be concluded that materials, raw materials, car parts, food and cars predominate.

Fig. 6. Share of individual cargo types

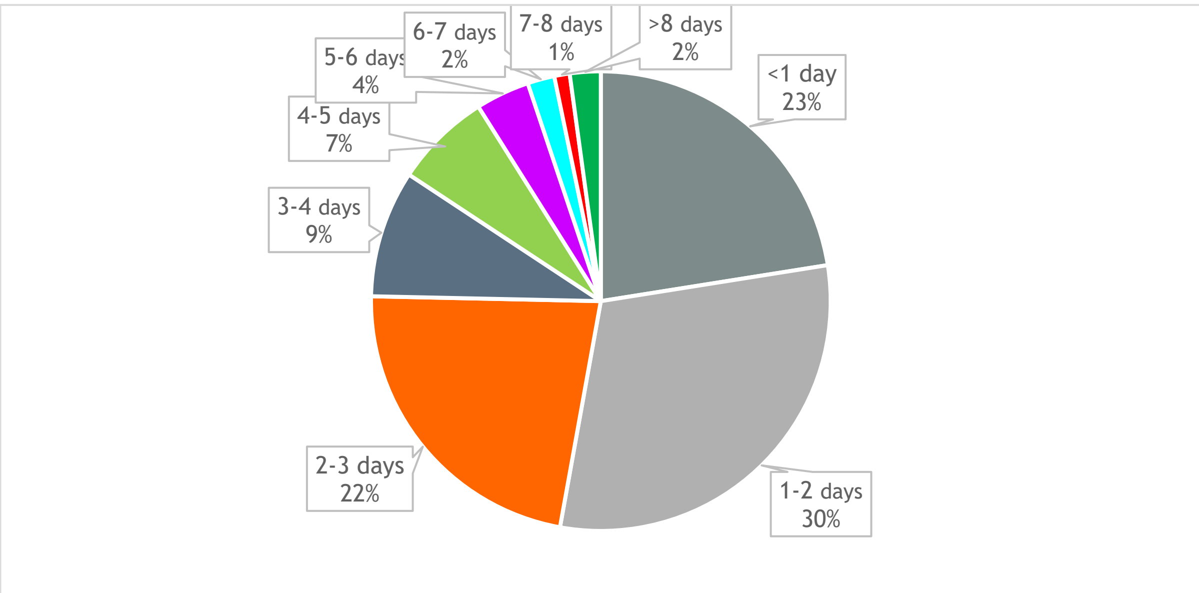


Source: Truck transport survey in the South Moravian Region

As for the return journey, the results of the questionnaire survey showed that 52% of drivers do not go back with an empty truck but loaded.

The following figure shows the time in days, that drivers spend on their journey. Based on the results of the questionnaire survey, it can be argued that 23% of respondents spend less than 1 day on the road, which represent to 83 drivers. 30% of respondents spend 1-2 days (112 drivers) and 22% spend 2-3 days (83 drivers) on the road. Other respondents (91 drivers) spend more than 4 days on the road.

Fig. 7. Time that drivers spend on their journey (days)



Source: Truck transport survey in the South Moravian Region

The survey has clearly confirmed the strong demand for the TEN-T corridor route from the Balkans to northern Germany and partly to Western Europe (Nuremberg and Stuttgart).

2.5. Analysis and modelling of freight transport performance in SW Slovakia

Methodology for the freight prognosis

Currently, it is very difficult to make any exact predictions of the future traffic of any kind.

For the needs of this document, separate forecasts of rail and road transport were processed. These were subsequently used in the design of the necessary measures to ensure smooth freight flows through the territory of this part of Slovakia in the scenarios of 2030, 2050 and in the very distant outlook (vision) of 2070.

Any predictions in these scenarios are extremely difficult to make due to two main reasons:

- Rapidly increasing general emphasis on the use of ecological technologies that have minimal impact on the state of the environment. The EU set a target of having transport systems with a 0% carbon footprint by 2050. This simply defined objective will result in a substantial change in the modal split from automotive (truck) transport in favour of rail freight transport. A similar process must follow in the passenger transport sector from the use of individual car transport to the various modes of public transport. There are currently no deeper analyses of how this set objective with a 0% carbon footprint will be achieved.
- The current pandemic situation with COVID-19 has resulted in a total decline in tourism (both internal and foreign), but also in the usage of all modes of public transport. There has been a noticeable shift to the reuse of individual car transport, with the consequence of a change in the modal split to the detriment of public transport, which has a serious negative impact on the environment (0%-carbon-footprint objective is at risk).

From the above, as well as due to the lack of more detailed data regarding the direction of freight transport, the forward-looking objectives were set by an expert estimate, considering the current trends.

The basic data for the calculation of future transport performances were provided from these crucial sources:

- database of the national freight carrier ZSSK–CARGO
- feasibility study of the Bratislava Railway Node (ŽSR 2019)
- public data on railway and road load carrying capacity or performance throughput available on the web pages of ŽSR (Slovak railway company) and SSC (Slovak road administration);
- regular surveys of the national traffic census carried out by the SSC (Slovak Road Administration) in the years 2005, 2010 a 2015.

Rail freight transport

For the purposes of this study, the load densities of rail freight transport in the European direction NW – SE (the OEM corridor direction), have been studied.

The national carrier ŽSSK–CARGO provided the data on transport performances for the previous period from 2010. In addition to the state-owned company ŽSSK–CARGO, other so-called third-party carriers operate on railway lines. These data were also considered in the analysis, which meant that material flows on all relevant lines of the SW Slovakia were assessed.

The result of the analysis of the real condition was estimating the railway lines permeability, without further examination of throughput of individual railway stations. The information was based on the documents of feasibility study of the Bratislava Railway Node (ŽSR 2019) and Regional Sustainable Mobility Plan of Bratislava Region (SGS 2019) and data from ŽSSK (national railway operator).

The procedure for processing the rail freight forecast was as follows:

- selection of relevant railway lines
- on the basis of CARGO data detection, the load on these lines in recent years in values such as number of trains, number of wagons, cost size in million tons, while values have been converted into quantities per year and per day
- throughput of individual lines (without assessing the throughput of individual stations) was obtained from the public sources (ŽSR)
- the individual line sections utilization has been recalculated on the basis of the above data for the 2020
- forecasting data for the forward-looking design year 2050 and 2070 were calculated by growth coefficients using statistical methods with the selection of the trend curve that has the best correlation

Tab 5. Rail freight growth coefficient – average of commodities

Year	2025	2030	2040	2050	2060	2070
Rail freight growth coefficient (commodities average)	1.17	1.26	1.32	1.36	1.40	1.47

> the key step was the calculation of the total traffic load on individual track sections separately for passenger and freight transport. For this purpose, quantities of freight loads were converted into number of trains. The proposed numbers of passenger trains were added to freight trains in the design years (Regional Sustainable Mobility Plan of Bratislava Region, SGS 2019)

> in the design years, individual track sections were assessed in terms of their permeability, with modifications and upgrades expected according to individual variants, which will have a positive impact on the gradual increase in the throughput of the line sections

> the assumption of higher tone performance of individual freight trains has been considered, particularly in long-distance transport from today's average 300-400 t/train to 900-1100 t/train

> development of transport technologies, especially in ensuring the speed and safety of transport is expected

> for the target years (2030, 2050 and 2070) the number of trains needed per day was calculated by means of trend increase in cargo and then compared with the expected line throughput in the relevant section and year

> compared to the required throughput (resulting from the expected amount of freight and passenger transport) and the expected throughput of individual line sections, the necessary measures to increase their throughput were localised, as shown in the relevant graphs

> calculations of the throughput of individual track sections were performed for several possible variants (scenarios) of the solution:

- **Variant 0**
  - There will be no new investment construction in the future, except the necessary operational maintenance to ensure safe and smooth transport as in the current conditions
  - Includes those investment actions that are already under construction, or their implementation is already agreed
- **Tangential Variant**
  - There will be an investment reinforced bypass, tangential railway line through Senica, which bypasses the Bratislava Railway Node
  - Railway lines around Bratislava Railway Node
  - Will be used primarily by rail passenger transport
- Subvariant Tangential + broad-gauge line
  - Broad-gauge line Košice – Nové Zámky – Bratislava – Parndorf (AT) – Wien (AT)
  - Other railway lines in operation according to the Tangential variant
- **Radial Variant**
  - Investment reinforced radial-led railway lines in the direction to/from the Bratislava Railway Node
  - Construction of the railway tunnel through the Little Carpathians
- Subvariant Radial + broad-gauge line
  - Broad-gauge line Haniska – Nové Zámky – Bratislava – Parndorf (AT) – Wien (AT)
  - Other railway lines in operation according to the Radial variant

- Based on the calculated throughput of the individual railway sections assessed in each variant and stage of the solution, the limit sections where it will be necessary to investmently strengthen the railway infrastructure have been localized.
- According to these investment actions, it will be possible to draw up construction plans in such a way as to achieve the required quantitative parameters in rail freight transport to ensure the transport of expected quantities through the territory of the Southwest Slovakia.

Road transport

Predominantly transit road freight transport assumes the use of capacity and fast roads, which are already in operation in the area under construction or in preparation. These are mainly communications:

- Motorways – D1, D2, D4
- Expressways – R1 a R7
- I. class roads – sections of roads No. I/2, I/63

The procedure for processing the road freight transport forecast was as follows:

- Selection of relevant roads.
- From the database of road nationwide traffic surveys, data on the load on individual road sections were analysed.
- The shares of freight transport and especially the share of trucks were analysed in the data sets.

- The share of transit truck road transport was determined by analytical assessment of truck traffic on the entrance profiles to the solved area.
- The expected future development of road transport until 2040 was calculated using growth coefficients resulting from a comparison of a series of national traffic censuses from 2005 to 2015.
- The forecast data for the design years 2050 and 2070 were calculated by the method of growth coefficients using statistical methods with the selection of the trend curve that has the best correlation.
- The development of road transport is assumed to culminate around 2030.
- EU measures to reduce the carbon footprint envisage limiting road transport, especially transit trucking, which means significantly reducing the potential share of long-distance freight transport in Central Europe.
- Roads that are in operation, under construction and in approved preparation will also have sufficient capacity for long-distance transit road transport. Any insufficient transport capacity will be addressed by shifting to rail freight.
- The needs for new road routes due to the provision of prospective road freight transport were not defined.

Common prognosis of transport performance

The expected transport policy, affected by the EU initiatives and measures, in the outlook will support mainly rail freight transport and it will therefore be possible to foresee a shift freight transport from road to rail.

Tab 6. Expected change in the modal split (road vs. rail)

	Share of road/rail freight transport (%)		
	2010	2030	2050
Road transport (t/d)	74.6%	68.0%	46.6%
Rail transport (t/d)	25.4%	32.0%	53.4%

By 2050, in Variant 1, which expects the investment in the development of railway infrastructure, the transfer will be more significant and will be less related to Bratislava and its surroundings.

Rail freight transport prognosis until 2050

Since 1989, following a change in the social order in the countries of Central and Eastern Europe, a fundamental change in the modal split has been started in freight transport in favour of freight (truck) car transport. Road freight transport has proven to be better suited to the requirements of the economy, in particular due to its immediate availability and ability to adapt to the requirements for the transport of various types of goods to a wide variety of destinations.

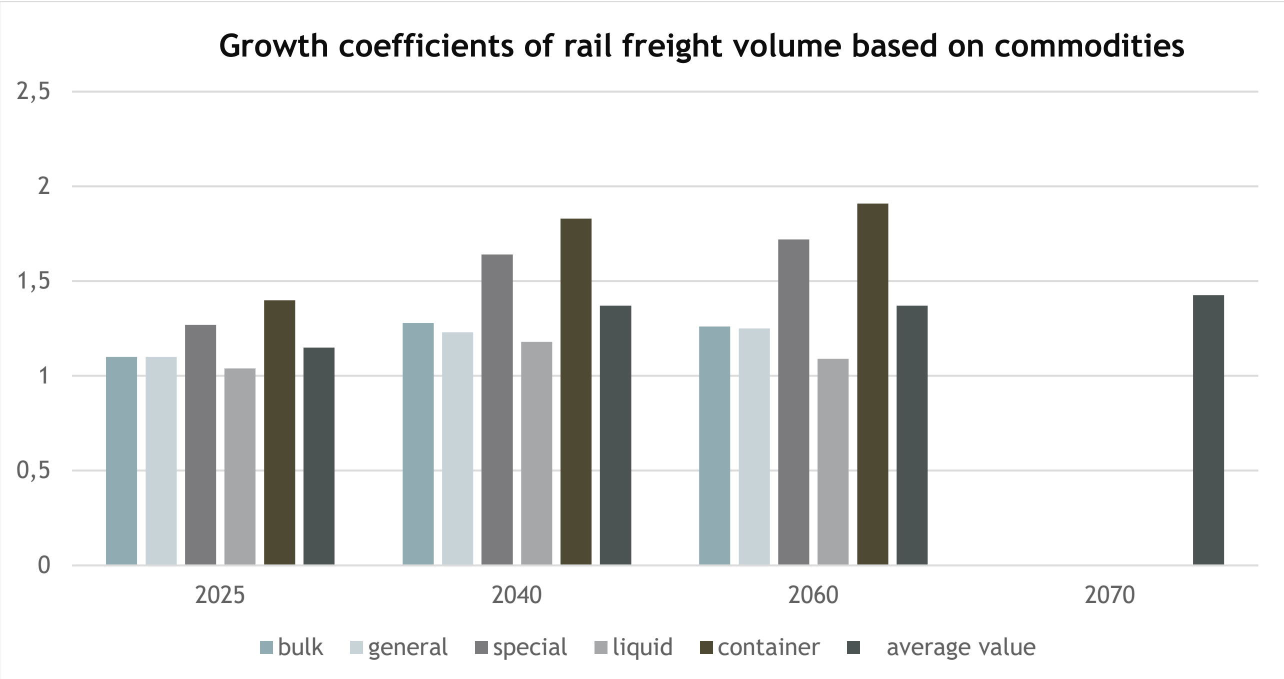
The road freight transport ability to adapt quickly to market requirements has resulted in a massive shift in freight transport from rail to road. At the same time, the railway ceased to fulfil its long-standing and stable function as a carrier of goods (especially bulk), which, together with its great inertia in the development of railway lines and equipment, has the effect of the decline of rail freight transport, although the railway consistently keeps advantages mainly in the price of long-distance transport of goods and in the transport of mass substrates.

Based on the current developments in rail freight transport and the composition of goods, expert forecasts on future possible developments have been calculated. These estimates were transformed into growth factors, which were subsequently used for the calculations of future freight volumes in 2030, 2050 and 2070.

Tab 7. Forecast of the development of rail freight transport in the direction of NW - SE in SW Slovakia

Kúty - Štúrovo, both directions	2 010		2 015		2020 (2019)		2 030		2 040		2 050	
	wagons/ year	trains/ year	wagons/ year	trains/ year	wagons/ year	trains/ year	wagons/ year	trains/ year	wagons/ year	trains/ year	wagons/ year	trains/ year
cargo	17,961	599	25,925	864	78,494	2,616		2,747		2,410		2,410
cargo - third carriers	19,970	666	32,624	1,087	112,946	3,765		4,367		4,680		4,920
cargo in total	37,931	1,264	58,549	1,952	191,440	6,381		7,115		7,090		7,330
non-loaded trains		702		1,084		3,545		4,743		5,064		5,236
freight trains total in train/year		1,967		3,036		9,927		11,858		12,154		12,566
growth coefficient in 2020						1		1.34		1.37		1.42
freight trains total in train/day (24 h)								42		43		45

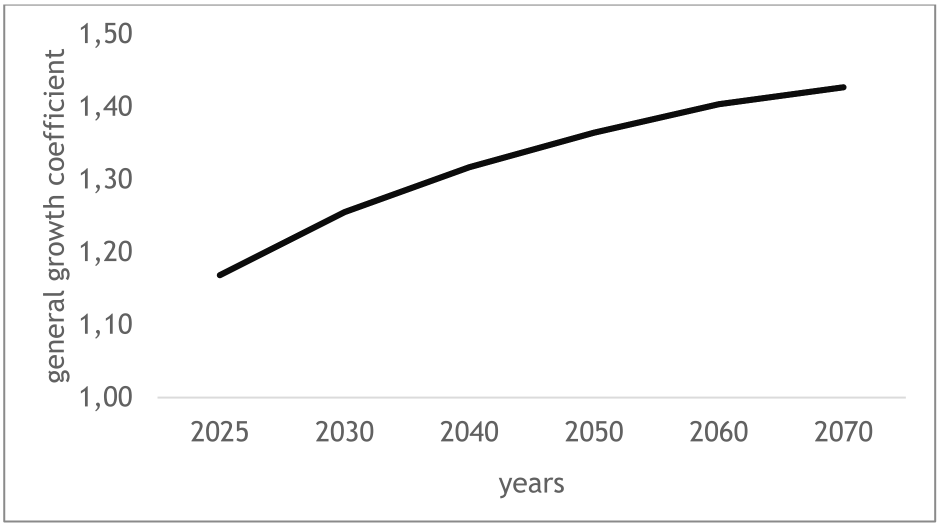
Fig. 8. Estimation of different types of goods in rail freight transport growth development



This graph shows a significant increase in container transport and a decrease in transport of liquid materials.

From the above dependencies, it was possible to compile a general growth coefficient for the long-term increase in rail freight transport without specifying the cargo type. This general growth coefficient reflected each type of goods.

Fig. 9. Expected curve of rail freight growth



The growth coefficient for the long-term estimate of the general growth of rail freight transport by 2050 and 2070 is compiled for the situation when road freight transport will not be intentionally limited.

The EU's intention to limit greenhouse gas production with a view to achieving 0% CO_2 emissions by 2050 will have very serious consequences for the development of road freight transport, especially long-distance transit truck transport. As a result, this will mean a gradual increase in the requirements for rail freight transport, mainly the long-distance one. This group of intentions also includes a project of broad-gauge railway in the east-west direction, which will create an alternative route for freight transport from Southeast Asian countries, especially to the central part of Europe.

Assessment of the state of available railway lines throughput

Weak, low-permeable places in the railway network were defined when verifying the permeabilities of individual lines in SW Slovakia. In this context, it should be noted a long-term neglect of the development of railway transport in the transport system (rail and tramway public transport). Public attention has been mainly focused on the development of the motorway network.

The assessing of the permeability of individual lines was based on the data issued by ŽSR (Slovak railway company) for GVD 2020/21 (ŽSR 2020) as well as the freight train traffic diagram (ZSSK CARGO). Train traffic diagrams (timetables) of passenger services of all kinds (Os – passenger train, REX – regional express, R – express train and IC – InterCity, https://www.zsr.sk/pre-cestujucich/cestovny-poriadok-2020-2021) were also considered. For the outlook years 2050 and 2070, a gradual improvement of transport technology, in particular its IT parts, was envisaged. This should have an impact on increasing the throughput and safety of individual tracks and station sections of railway lines.

In a more detailed analysis of the direction of individual rail freight flows through the territory of SW Slovakia, it was found that the strongest goods flows are present in the main direction NW-SE of Europe on the OEM corridor route, which represents over 23 million tons/year of total estimated cargo in 2050.

The total direction of cargo transport with minimal development of railway lines is marked as **Variant 0**, where only those development projects that are already in the preparation and project work stage or have started are expected to be implemented.

If the improvements in the operational parameters of railway lines and infrastructure will be realized, it is reasonable to expect the increase in the weight of the goods transported up to 26 million tonnes/year.

Variant 1 assumes increasing the throughput in the NW-SE direction mainly by capacity growing of tangential tracks No. 128 (116) + 128 (133) + 120 (130) + 120 (135), i.e., Kúty – Senica – Trnava – Galanta – Nové Zámky – Komárno / Štúrovo – SK/HU, which will allow rail freight transport to bypass congested lines leading through

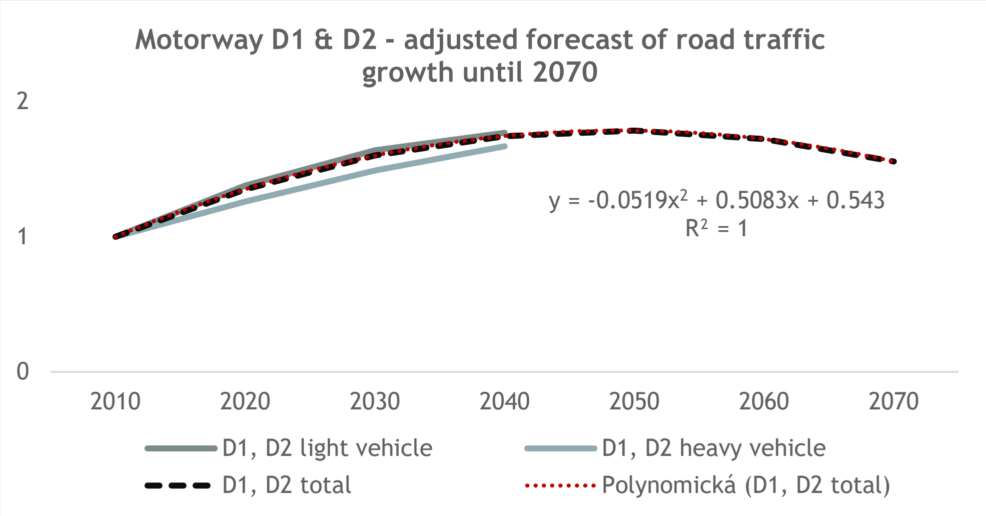
Bratislava (main station). At the same time a suitable alternative rail route will be created through the territory of the SW Slovakia.

Road freight development forecast

The basis for the calculation of expected road freight transport in the long term of 2050 – 2070 was the examined development series of intensities on basic motorways leading through the SW Slovakia. The EU's objectives in creating a sustainable environment are a factor that will also have an impact on the future development of road freight. At the same time, the main objective is to achieve 0% of carbon emissions, which will practically mean a significant reduction in road transport as it is operated today.

The above assumptions have been reflected in the development charts of the expected intensity of automotive transport on highways D1 and D2 – see figure Growth coefficients for heavy road freight transport.

Fig. 10. Growth coefficients for heavy road freight transport



Tab 8. The volume of transiting road freight transport forecast (mil.t / year / two-way)

road	section	year 2030		year 2050		year 2070	
		Variant 0	Variant 1	Variant 0	Variant TAN	Variant 0	Variant TAN-RAD
D2	Kúty -Malacky	7,913	6,726	8,820	6,726	7,687	6,726
D2	Malacky - BA	12,328	7,397	13,740	7,397	11,975	7,397
D1	Senec - Trnava	13,079	13,079	14,577	14,577	12,705	12,705
D1	Trnava - Piešťany	10,966	10,966	12,222	12,222	10,652	10,652
51	Senica - Jablonica	758	1,441	851	851	780	780
63	Bratislava - Dunajská Streda	3,553	3,553	3,987	3,553	3,653	3,553
2	Malacky - Kúty	1,731	1,731	1,942	1,942	1,780	1,780
D4	(A) - D1- D2 - R7 - (H), tunel Karpaty	0	5,004	0	5,49	0	6,299
R7	Bratislava - Dunajská Streda	0	7,465	0	7,465	7,559	7,559
R1	Trnava - Nitra	6,577	6,577	7,330	7,331	6,389	6,389

Note: TAN – tangential, TAN-RAD tangential-radial

Tab 9. Total weight routing via SR in mil.t./year - non-investment status (Variant 0), year 2050

Transport mode	from / to		
	CZ	AT	HU
Rail freight transport	11,404,800	8,791,200	10,216,800
Road freight transport	10,762,319	19,410,000	12,945,000
Total	22,167,119	28,201,200	23,161,800

Tab 10. Total weight routing via SR in mil.t./year - investment status (Variant TAN al. RAD), year 2050

Transport mode	from / to		
	CZ	AT	HU
Rail freight transport	11,700,000	11,102,400	13,816,800
Road freight transport	10,610,667	25,514,000	12,942,000

Note: TAN - tangential, RAD - radial

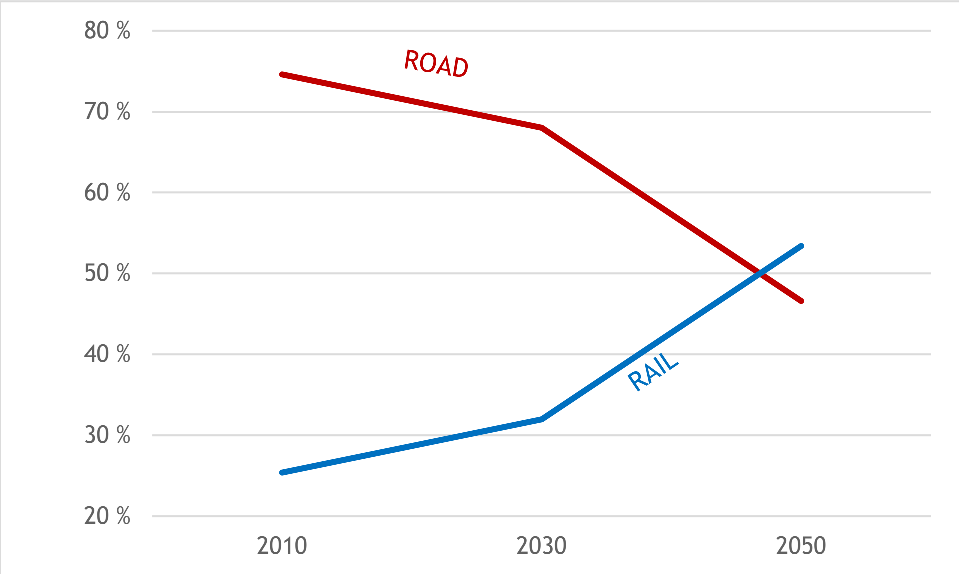
In evaluating the currently known circumstances, it will be possible to foresee a gradual change in the modal split in transit freight transport through the SW Slovakia in favour of rail freight transport, as shown in the following table:

Tab 11. Change in modal split of road and rail freight transport

	2010		2030		2050	
Transport mode	weight (t)	Share of road/rail freight transport (%)	weight (t)	Share of road/rail freight transport (%)	weight (t)	Share of road/rail freight transport (%)
Road transport	106,938 t	74.6%	122,421 t	68.0%	98,200 t	46.6%
Rail transport	36,485 t	25.4%	57,610 t	32.0%	112,530 t	53.4%
Total	143,423 t	100.0%	180, 031 t	100.0%	210,730 t	100.0%

Note: Freight transport volumes are in the direction SE - NW (tonnes/day/two-way)

Fig. 11. Change in the modal split of road and rail freight transport until 2050



This is mainly the transit of road freight transport between Poland and southern Europe. Road freight transport mainly uses the route of the D1 motorway (AT/SK – Bratislava – Trnava - Žilina – SK/PL) and the R1 expressway (Trnava – Nitra – Central Slovakia).

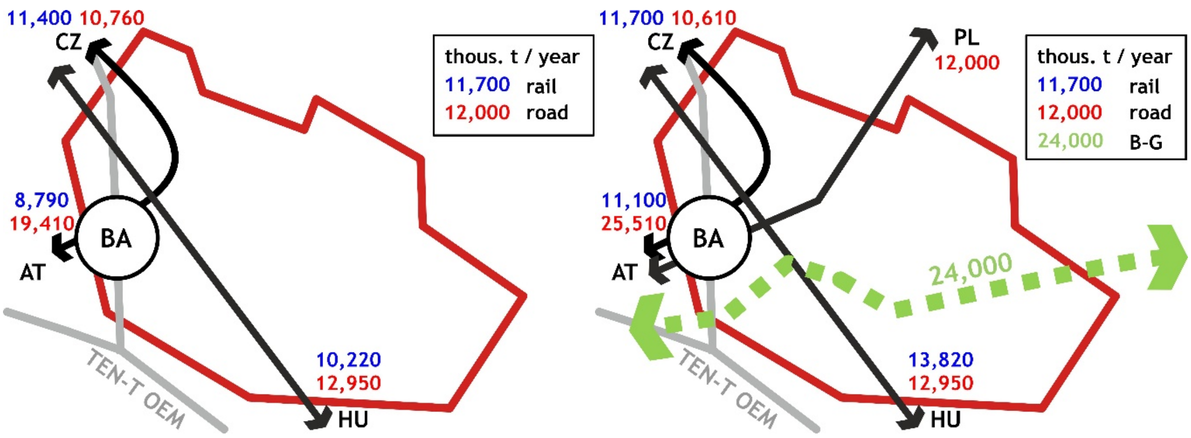
In this transit direction in the 2050 scenario, it is expected that it will be transported up to 21 mil. tonnes of goods using both main freight modes of transport (railway and road). This quantity is fully comparable to the previously preferred transit direction of NE-SE of Europe.

In the case of the operation of a broad-gauge line, the east-west direction of transit freight transport will be decisive.

The intention to strengthen the throughput of the line 128 (116 a 135) Kúty – Senica – Trnava – Sereď is fully justified by the current impassability of the Bratislava Railway Node and due to the fact, that most of its capacity is intended to be used for the purpose of passenger (regional) transport of Bratislava Region. The substantial strengthening of tangential rail link will make it possible to create sufficient reserves in rail operation, mainly for long-distance rail freight transport on a Pan-European scale.

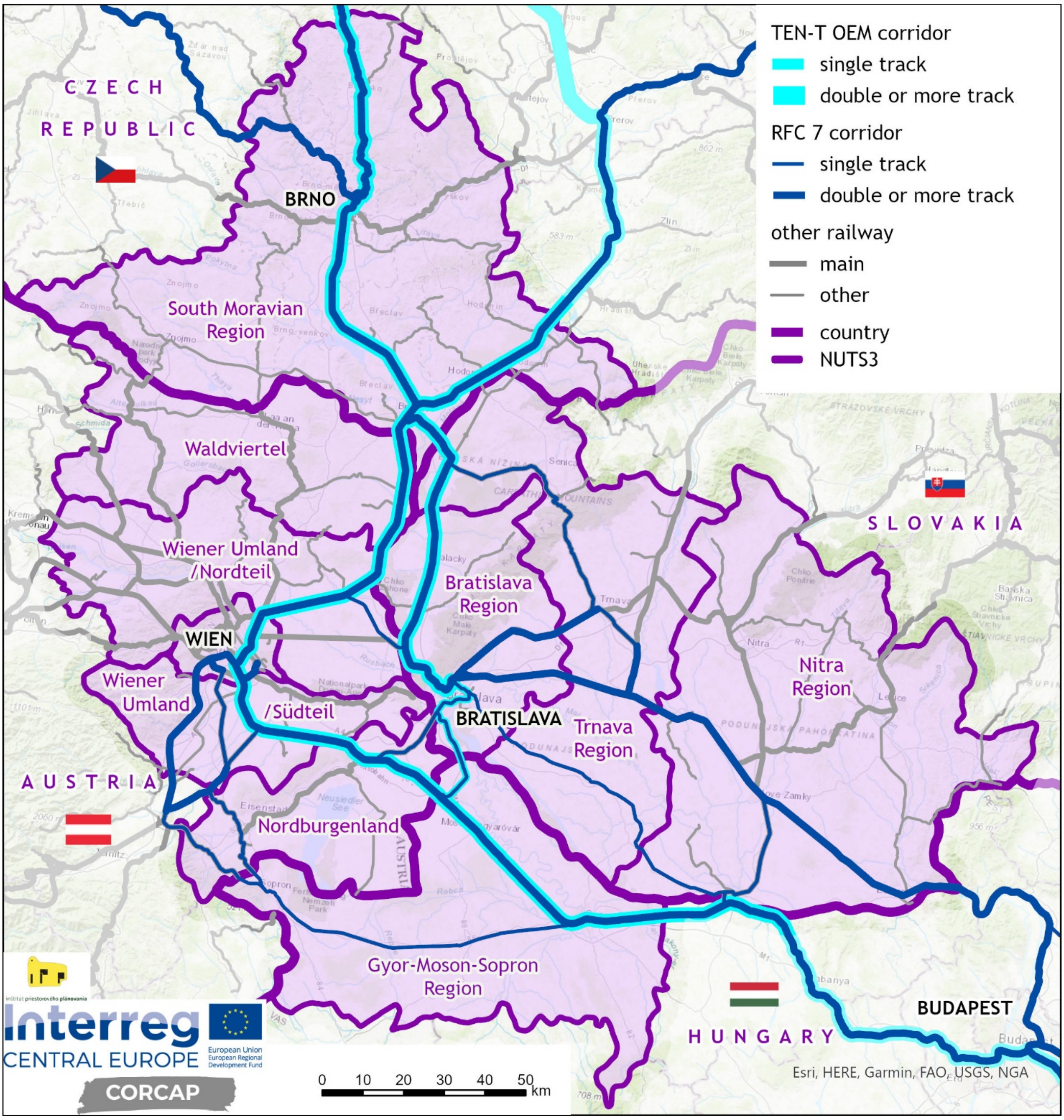
In order to determine the expected transport load, it was necessary to base it on the total rail and road freight volumes. The common values are shown in the following graphs separately for Variant 0 and Variant 1 as described above.

Fig. 12. Estimated weight by rail and road freight transport in 2050 – Status 0 & Status 1 (with investment)



3. TEN-T AND RFC-7 OEM TRANSPORT NETWORKS DEVELOPMENT MODELLING

Map 1. Area of interest



Source: TENtec (2020)

3.1. Transport network in the CENTROPE region

The REGIONAL ANALYSIS OF CHALLENGES AND NEEDS FOR SOUTH-WEST SLOVAKIA (CORCAP & IPP 2020) document showed that the transit of the OEM corridor through the territory of Slovakia should be addressed in the context of regions of the whole South-West Slovakia, not only of the Bratislava Region. Therefore, the assessment of not only the TEN-T OEM corridor but also the RFC 7 OEM corridor is advisable. That is the reason why a much wider region has been chosen as the area of interest of this study - the CENTROPE region; in particular only the parts of CENTROPE through which the international corridors TEN-T OEM or RFC 7 OEM pass. In addition to Czech and Slovak NUTS3 regions (South Moravia; Bratislava, Trnava and Nitra regions) only the eastern NUTS3s of the Federal Republic of Niederösterreich and the northern part of the Federal Republic of Burgenland were involved: Waldviertel, Wiener Umland/Nordteil, Wiener Umland/Südteil and Nordburgenland. From Hungary only Győr-Moson-Sopron County was involved. Such extent of CENTROPE region is referred here as **CE** (Central-East) **CENTROPE**.

Railway network

CENTROPE region is ranked among the areas with above-average to the highest density (EUROSTAT 2021) in terms of rail network density (rail km per 1,000 km^2). More detailed information on rail transport of the South Moravian Region and South-West Slovakia is provided in the following chapters.

On the territory of the **South Moravian Region**, the axial are the tracks of category E (nationwide, included in the European railway system). Running in the north-south direction is the line 002 (Česká Třebová – Brno – Břeclav – CZ/SK direction Kúty / CZ/AT direction Wien). Running in the east-west direction are the lines 250 and 300 (Havlíčkův Brod – Brno and Brno – Přerov). These tracks are complemented by line 330 (Přerov – Břeclav), that follows the flow of the Morava River near the Slovak border. Lines 002 and 330 are part of the TEN-T corridors **OEM** and **Baltic-Adriatic** respectively. In addition, lines 002, 250 and 330 are part of RFC corridors 5 and 7 **(Baltic-Adriatic** and **OEM).** These tracks are complemented by the ones that belong to category C (other railways nationwide): 240 and 340 (Jihlava – Brno – Uherské Hradiště), 241 and 248 (Okříšky – Znojmo – Šatov – CZ/AT). Of the proposed investments, the **high-speed line** - divided into 2-3 sections - is of great importance, as discussed in more detail in Chapter 3.5.1.

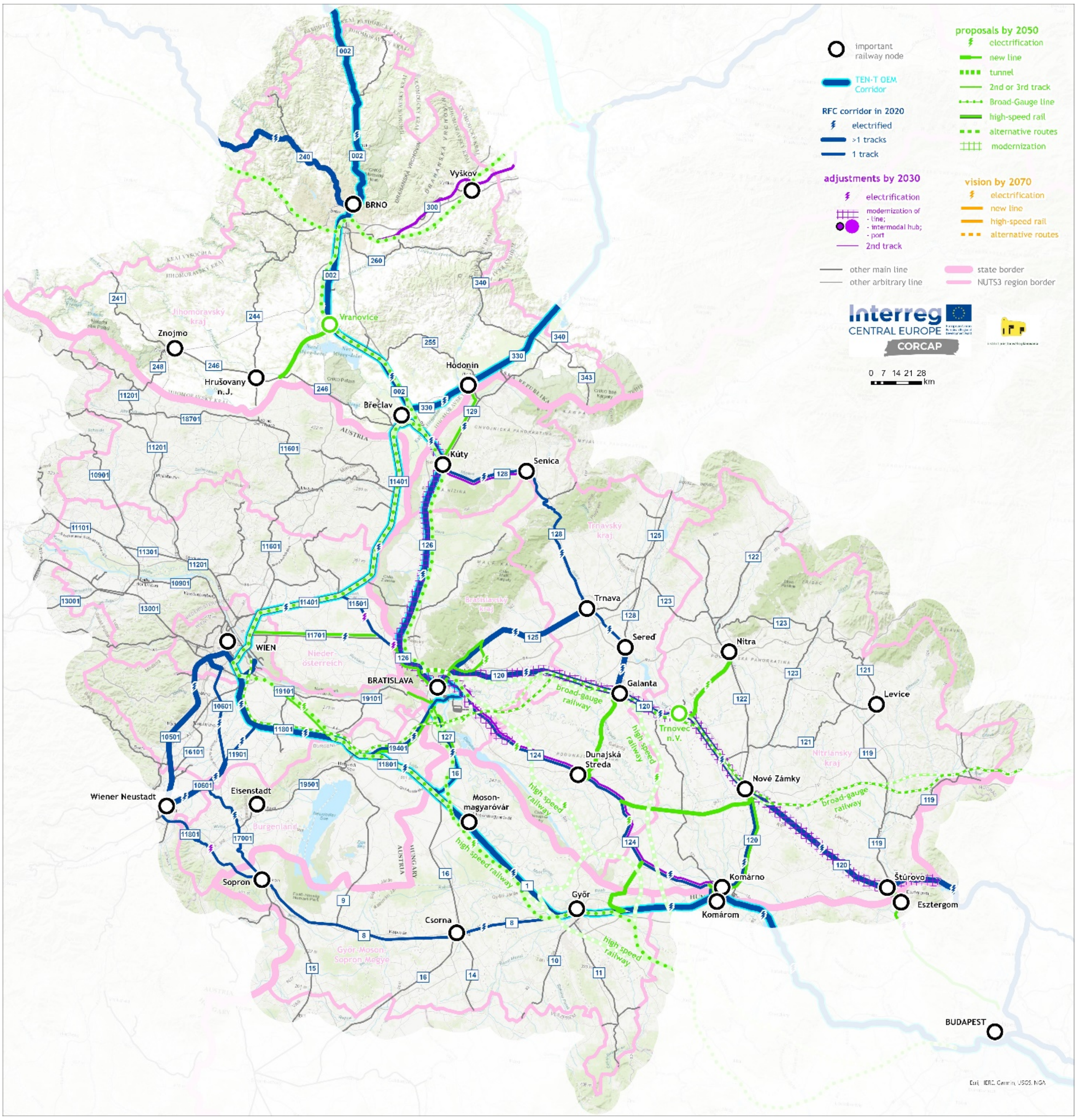
In **SW Slovakia** the backbone of railway network is formed Category 1 tracks, which are also part of the TEN-T core and comprehensive network. Tracks 126 (110, SK/CZ – Kúty – Bratislava) and 120 (130 and 135, Bratislava – Galanta – Nové Zámky – Štúrovo / Komárno – SK/HU) are part of TEN-T **OEM,** track 125 (120, Bratislava – Trnava – Leopoldov – Púchov) is part of the **Baltic Adriatic** corridor and track 121 (150, Palárikovo – Levice – Hronská Dúbrava) is part of the comprehensive network. From the point of view of this project, the tracks of the lower Category 2 are also important: 128 (116 & 133: Kúty – Trnava – Sereď) and 124 (131, Bratislava – Komárno) which were designed for inclusion in the comprehensive network. With the exception of track 121 (150), all listed tracks are part of RFC corridors Nr. 5, 7 and 11 (**Baltic-Adriatic, OEM** and **Amber**). Chapter 3.4 discusses the tracks of SW Slovakia in more detail. From the existing proposed investments, the **high-speed line** (SK/HU – Bratislava – SK/CZ) and the **broad-gauge line** (Haniska – Nové Zámky – SK/AT) as well as the Trnovec nad Váhom – Nitra line are of great importance. Other proposed lines are of a local character with a purpose for regular passenger transport in the Bratislava agglomeration with the extent to the neighbouring Trnava region.

The territory of the **Austrian part** of CE CENTROPE is characterized by the radial structure of the lines coming out of the Vienna agglomeration. The axis of the north-eastern part consists of the track 11401 (Nordbahn: Wien – AT/SK direction Břeclav in the Czech Republic), which in its second half aligns the Slovak border. The axis of the eastern part of the region consists of tracks 11801 and 19401 (Ostbahn Wien – AT/HU direction Hegyeshalom and Győr / Kittsee – AT/EN direction Bratislava in Slovakia). The axis of the southern part consists of track 10501 (Südbahn Wien – Bruck a. d. Mur – Graz – AT/SI). The axes of the western part of the region consist of tracks 10901 (north of the Danube - Franz-Josefs-Bahn Wien – Gmünd – AT/CZ) and

13001 (south of the Danube – Westbahn Wien - Linz). The Westbahn and Ostbahn are part of the TEN-T corridor **Rhine - Danube,** Nordbahn and the western part of the Ostbahn are part of the **OEM** and **Baltic Adriatic**. The OEM then continues in its south-eastern branch towards Hungary (HU). The **Baltic Adriatic** corridor is characterized by several branches in the area of "twin-city" Vienna and Bratislava – from Bratislava to Vienna northly – 11501 or 11701 southly (Ostbahn). From south it is connected to Vienna by lines 10601 (Pottendorfer Linie) and 11901. The RFC corridor lines use all of the above-mentioned lines as TEN-T corridors, as well as others heading from the Vienna agglomeration to Sopron (HU) - 5, 7 and 9 (**Baltic-Adriatic**, **OEM** and **Rhine - Danube**). Of the proposed investments, a **broad-gauge** line (AT/SK – Parndorf - Wien) with potential multimodal terminals in Parndorf and Vienna is of great importance.

In the territory of the **Győr-Moson-Sopron County,** the axis is formed by track Nr. 1 leading from the northwest of the Austrian border to the east (Győr and Komárom). Together with the short section of track Nr. 16 (Hegyeshalom – Rajka – HU/SK), it is part of the TEN-T **OEM** and **Rhine -Danube** corridor. The proposed investment of the **high-speed line** (Budapest - Győr – SK/HU) is of great importance. Another important is line Nr. 8 (Győr - Sopron - HU / AT), which, together with the line Nr. 1 and section of the line Nr. 16, is part of the RFC 7 **OEM** corridor. In addition, line Nr. 8 is part of the RFC 11 **Amber** corridor, together with the entire length of north-south line Nr. 16 (HU / SK - Rajka - Csorna - Szombathely) and line Nr. 15 in the west part of the region (Sopron - Szombathely).

Map 2. Railway network in the CE CENTROPE region



Sources: CZ - Geoportál Jihomoravský kraj (2020), gis.brno.cz; SK - AUREX (2014), AUREX (2015c), AUREX (2017b); AT - ÖBB (2021); AT & SK - BG (2018); HU - TRENECON (2020), Asbóth - Bersényi (2020); © OpenStreetMap contributors

Road network (motorways/expressways and I. class roads)

The CENTROPE region ranks among areas with above-average density in terms of motorway network density (km of motorways/expressways per 1 000 km^2). Values above 50 (the best) are characteristic of the area between Bratislava and Vienna (EUROSTAT 2021).

Most sections of the existing **motorways of the South Moravian** Region - D1 (Prague – Brno – Ostrava – CZ/PL), D2 (Brno – Břeclav – CZ/SK) and D52 (Brno – Mikulov – CZ/AT) - replicate the TEN-T OEM corridor in its course. The exception is section of D1 (Brno – Přerov – CZ/PL), which is part of the TEN-T Baltic Adriatic corridor. The road network designs include the completion of the D52 as well as the construction of two new motorways D43 Brno – Svitavy – junction with D35, which will complement the skeleton in the north-south direction and D55 (Břeclav – Hodonín – Olomouc) along the Slovak border. The latter will be included in the TEN-T comprehensive network once completed.

The only motorway/expressway in the **region of Southwest Slovakia,** which is part of the TEN-T OEM corridor is D2 (SK/CZ - Malacky – Bratislava – SK/HU). It is located in the western peripheral/border part of the region in the north-south direction. In addition to this direction, the motorways come radially from Bratislava to the northeast - D1 (Bratislava – Trnava – Žilina – Košice – SK/UA), east (in the perspective) - R1 (Trnava – Nitra – Banská Bystrica – Košice) and southeast - (Bratislava – Holice – in the perspective also Dunajská Streda - Nové Zámky – Šahy). Southwest and northwest (in the perspective) towards Austria is covered by D4 (circle around Bratislava). D1 is part of the TEN-T Baltic Adriatic corridor. The existing sections of R1 (from Trnava to the east) are part of the TEN-T comprehensive network. After the construction of the R7 in full length, three motorways/expressways in the almost parallel east-west direction (R1, R7 and M1) will be available for motorists between the sections 1. Mosonmagyaróvár - Győr – Komárom (HU), 2. Bratislava – Dunajská Streda - Nové Zámky and 3. Trnava – Nitra – Zlaté Moravce (SK).

The Austrian part is covered by the densest network of motorways/expressways in whole CE CENTROPE region. The structure of the network in this part of the territory is rather radial, from Vienna it comes out in several directions: northwest – A22 (Donauufer Autobahn) with a continuation to the north - S3 (Weinviertler Schnellstraße: Stockerau – Hollabrunn – Guntersdorf) and west – S5 (Stockerauer S.: Stockerau – Krems); west – A1 (West A.: Wien - St. Pölten - Linz – AT/DE) and A21 (Wiener Außenring A.); south – A2 (Süd A.: Wien – Wiener Neustadt – Graz – AT/IT) and A3 (Südost A.: Guntramsdorf – Eisenstadt); southeast – A4 (Ost A.: Wien – Schwechat – Nickelsdorf – AT/HU) together with A6 (Nordost A.: Bruckneudorf – Kittsee - AT/EN); north – A5 (Nord A.: Wien - Wolkersdorf – Poysdorf – in at/CZ view). In the perspective there may be an interesting connection between Vienna and Bratislava by the northern road – S8 with connection to the Slovak D4.

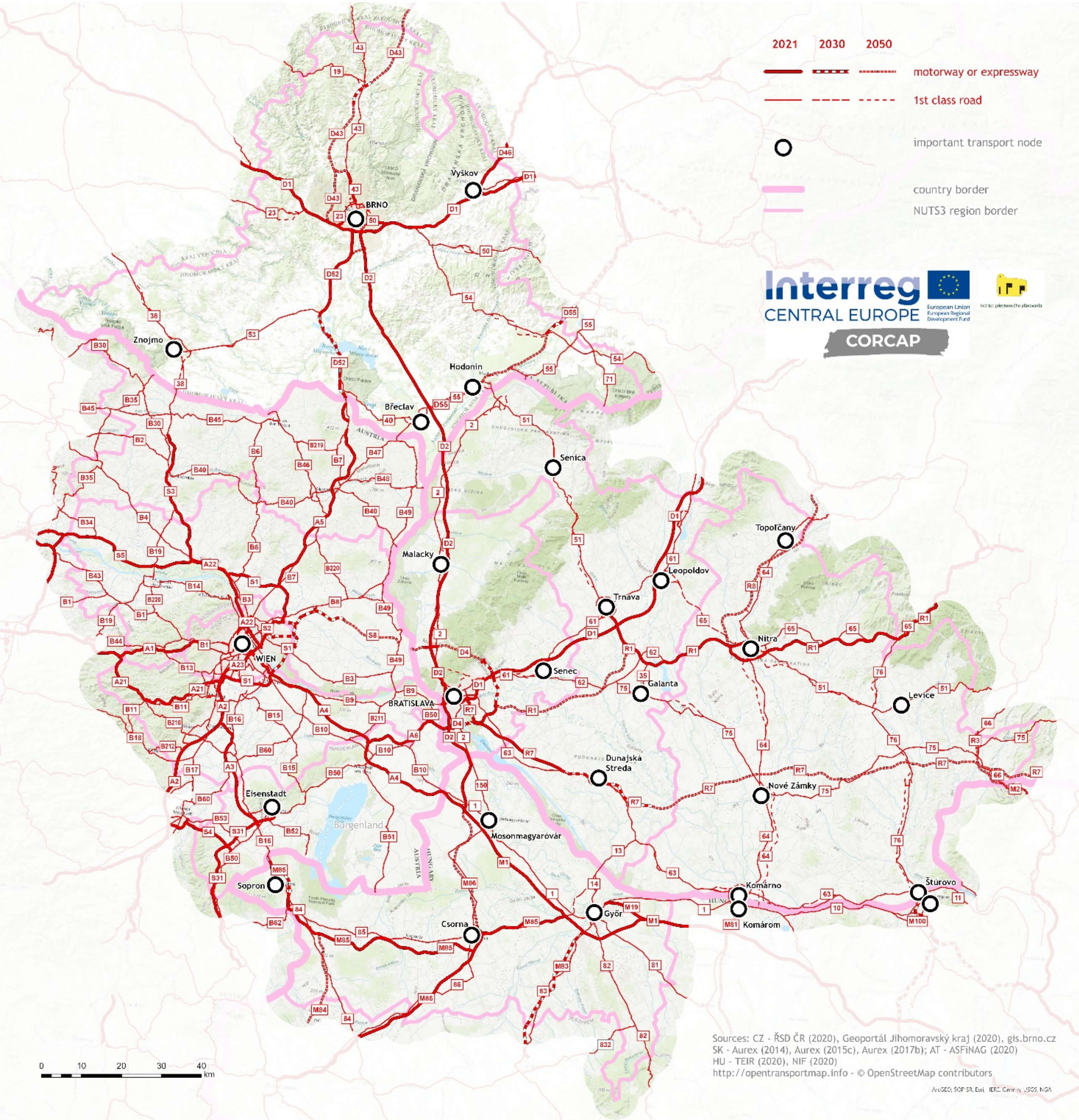
The second densest network is in the **County of Győr-Moson-Sopron**, which will be further enhanced in the future. The main communication is M1 motorway (AT/HU – Győr – Budapest) located in the north-eastern part of the region - part of the TEN-T OEM. In the north it is connected to the M15 to Bratislava (Slovakia). The axis in the east-west direction is the motorway M85 connecting Győr and Sopron (and the AT/HU border in the outlook). In addition to the existing M15, the north-south axis is also formed by the motorway M86 (Csorna – Szombathely, in the outlook with a connection to the M1/M15). The network will be complemented by M84 (Sopron – Szombathely) and M83 (Győr – Pápa).

First class roads have an additional function to motorways in all four parts of the CENTROPE region, although in many places these are important axis communications. A greater expansion of their network can only be seen in the region of SW Slovakia, with the road Nr. 65 (Nitra – Leopoldov). Other proposals are devoted exclusively to bypasses of towns and villages (especially in the Nitra and South Moravian Regions). The network of 1st class roads construction on Austrian territory appears to be complete. On Hungarian territory there are still reserves in the continuation of roads from Austria in the north-south direction around Neusiedl Lake (B51 and B52).

The following maps present the development of the **railway and road network in the CE CENTROPE region** by 2030, 2050 and 2070. The next map shows the current road network together with proposals by development projects with expected completion by 2030 and 2050. In the Czech Republic, development intentions are mainly taken from the spatial planning documents of municipalities with extended competence (Blansko, Boskovice, Brno, Břeclav, Bučovice, Hodonín, Hustopeče, Ivančice, Kuřim, Kyjov, Mikulov, Moravský Krumlov, Pohořelice, Rosice, Slavkov, Šlapanice, Tišnov, Vyškov, Znojmo and Židlochovice). In Slovakia, the data source is regional planning documents of Bratislava Region (AUREX

2017b), Trnava Region (AUREX 2014) and Nitra Region (AUREX 2015c). In Austria, the development is taken from information provided by ASFiNAG (2020 - Autobahnen- und Schnellstraßen-Finanzierungs-Aktiengesellschaft), an Austrian state-owned company that plans, finances, builds, maintains, and collects tolls for Austrian motorways.

Map 3. Road network in the CE CENTROPE region



Sources: CZ - ŘSD ČR (2020), Geoportál Jihomoravský kraj (2020), gis.brno.cz; SK - AUREX (2014), AUREX (2015c), AUREX (2017b); AT - ASFiNAG (2020), HU - TEIR (2020), NIF (2020); http://opentransportmap.info - © OpenStreetMap contributors

3.2. Regional accessibility development according to different transport modes by 2050 in the CE CENTROPE region

The theoretical background of the accessibility assessment is part of the Chapter 2. The accessibility of municipalities from/to the following transport entities was analysed.

- **TEN-T International airports**

The municipalities of the CE CENTROPE territory are lying in the catchment area of 4 international TEN-T airports: Wien - Schwechat, Bratislava - M. R. Štefánik, Budapest - Ferencz Liszt and Ostrava - Mošnov. Only the first two airports are located directly in the area. After the completion of expected development plans of road infrastructure by 2050, no significant changes are expected. Improved accessibility is expected for the municipalities of the SE part of the Nitra Region (SK).

- **TEN-T Ports**

The municipalities of the CE CENTROPE territory are lying in the catchment area of 6 TEN-T ports: Vienna, Bratislava, Győr, Komárno, Štúrovo and Budapest. Except the last one mentioned, all ports are located directly in the area. After the completion of expected development plans of road infrastructure by 2050, no significant changes in this indicator are expected. The municipalities of the northern part of the South Moravian (CZ) and Nitra Regions (SK) are expected to have better accessibilities.

- **Main railways** (part of the TEN-T OEM & RFC-OEM corridors - train stations lying on this route)

After the completion of expected development plans of road infrastructure by 2050, slight changes in this indicator are expected in the eastern and western margins of the area. Improved accessibility will be recorded in the northern part of the Nitra Region (SK), the western part of the South Moravian Region (CZ) and the western part of Waldviertel (AT).

- **Inter/Multimodal terminals (IHUBs)**

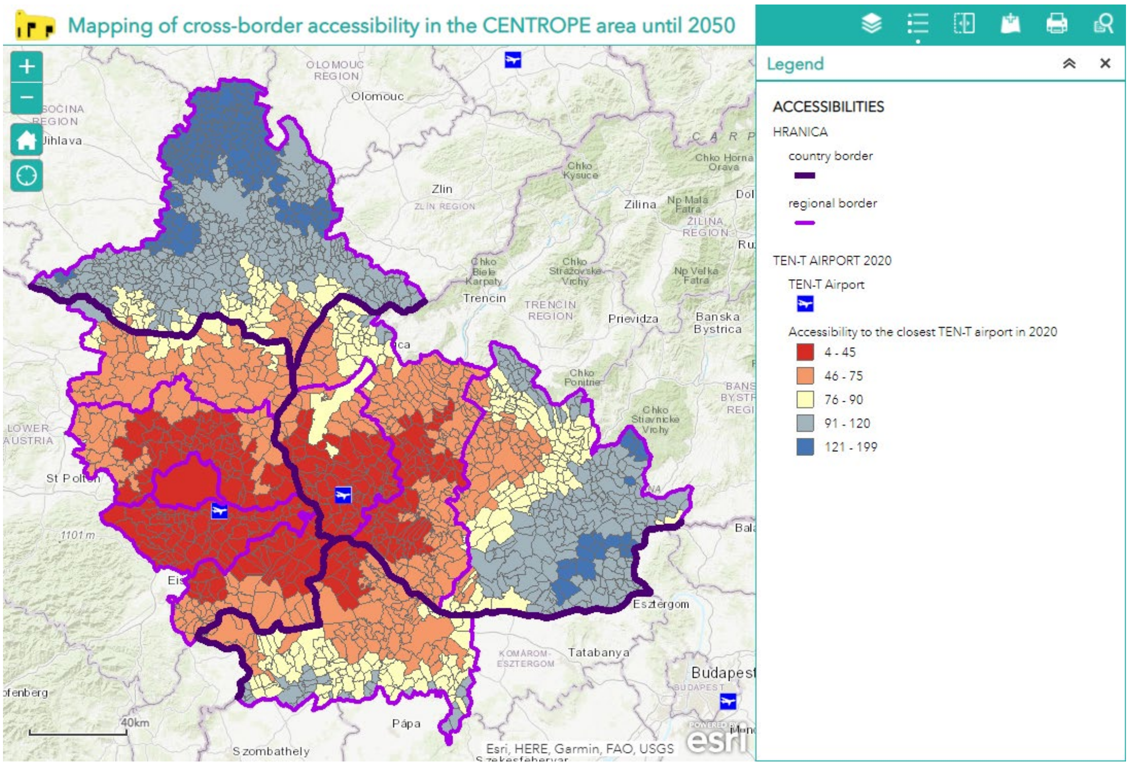
The municipalities of the CE CENTROPE territory are lying in the catchment area of 18 IHUBs (of which 10 are located directly in the area. After the completion of expected development plans of road infrastructure by 2050, municipalities of the northern part of the South Moravian Region (CZ) and Nitra Region (SK) will record improved accessibility.

- **Motorways and expressways** (entrances/exits to the motorways/expressways)

The CE CENTROPE area is characterized by a relatively dense network of motorways and expressways. The marginal municipalities of the South Moravian Region (CZ) and the Nitra Region (SK) were characterized by worse accessibility (over 45 minutes). In 2050, a significant change can be expected in the northern and NE parts of both of these regions. However, the municipalities in the eastern part of the Wien-Umland/Nordteil region (AT) as well as selected municipalities in the Bratislava (SK) and Trnava regions (SK) and also one municipality in the Győr-Moson-Sopron region will also see an improvement. The southwestern edge of the South Moravian Region (CZ) will remain the only area with accessibility worse than 45 minutes.

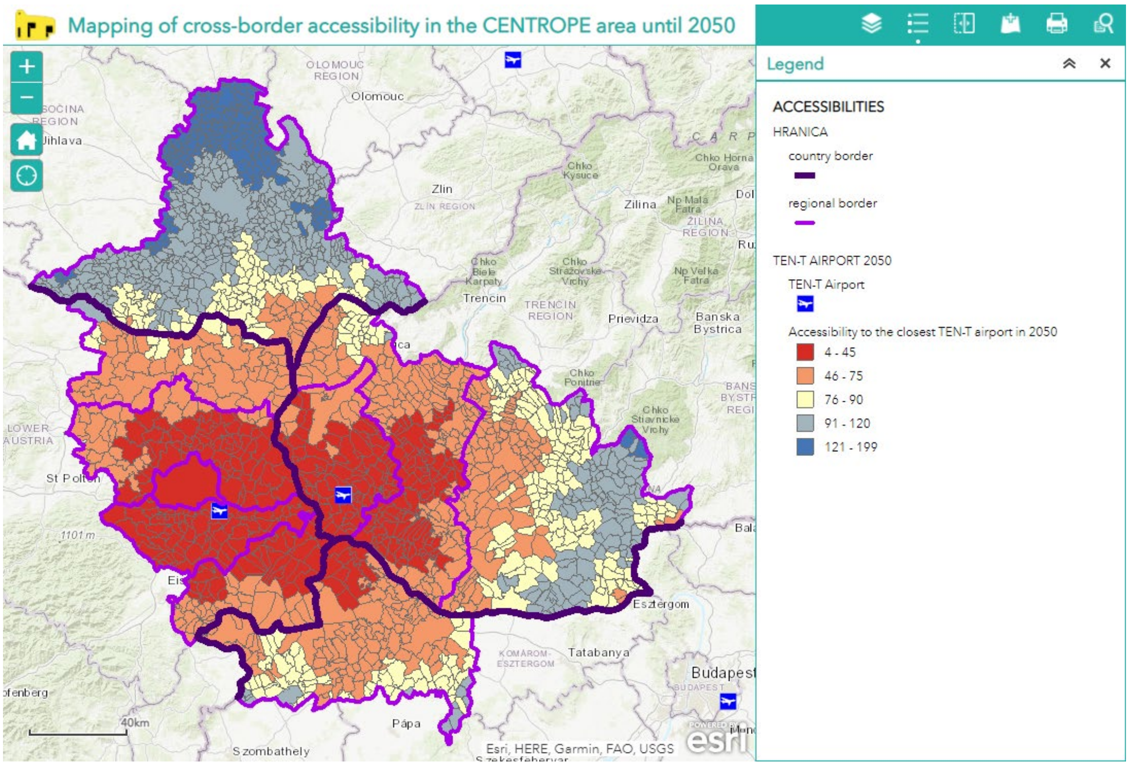
Similar changes as in the case of motorways can be interpreted in the analysis of the total position potential, which was created by the sum of the above-mentioned accessibilities. Graphic representation of the above-mentioned indicators is shown on the maps on the following pages.

Map 4. Accessibility to the closest TEN-T International Airport in 2020 (in min)



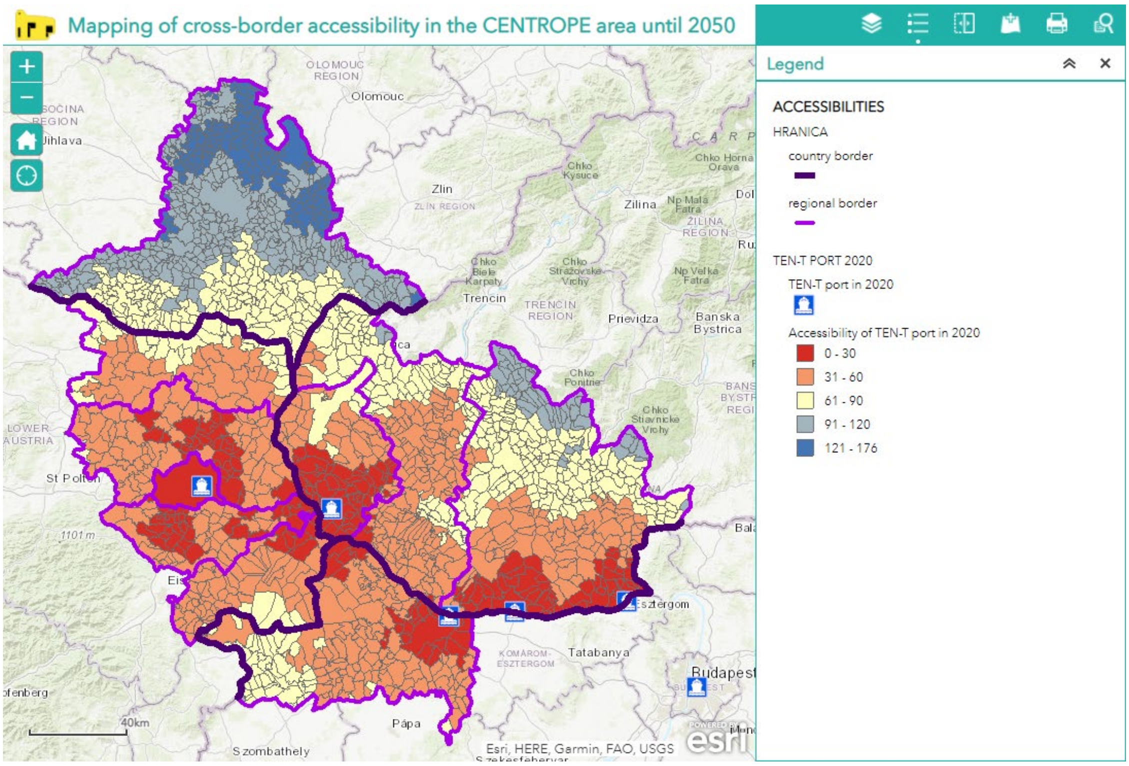
Source: https://ippoz.maps.arcgis.com/apps/webappviewer/index.html?id=c48527451f444a3b9885bef3ca3013ea

Map 5. Accessibility to the closest TEN-T International Airport in 2050 (in min)



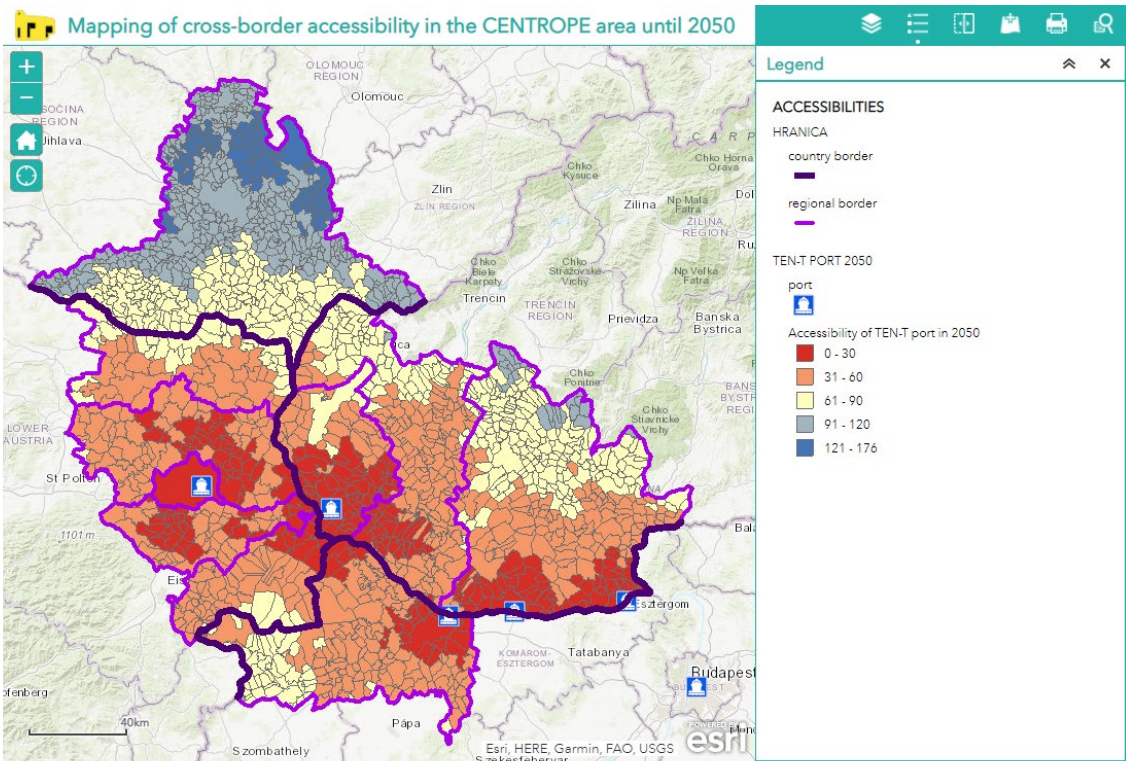
Source: https://ippoz.maps.arcgis.com/apps/webappviewer/index.html?id=c48527451f444a3b9885bef3ca3013ea

Map 6. Accessibility to the closest TEN-T International Port in 2020 (in min)



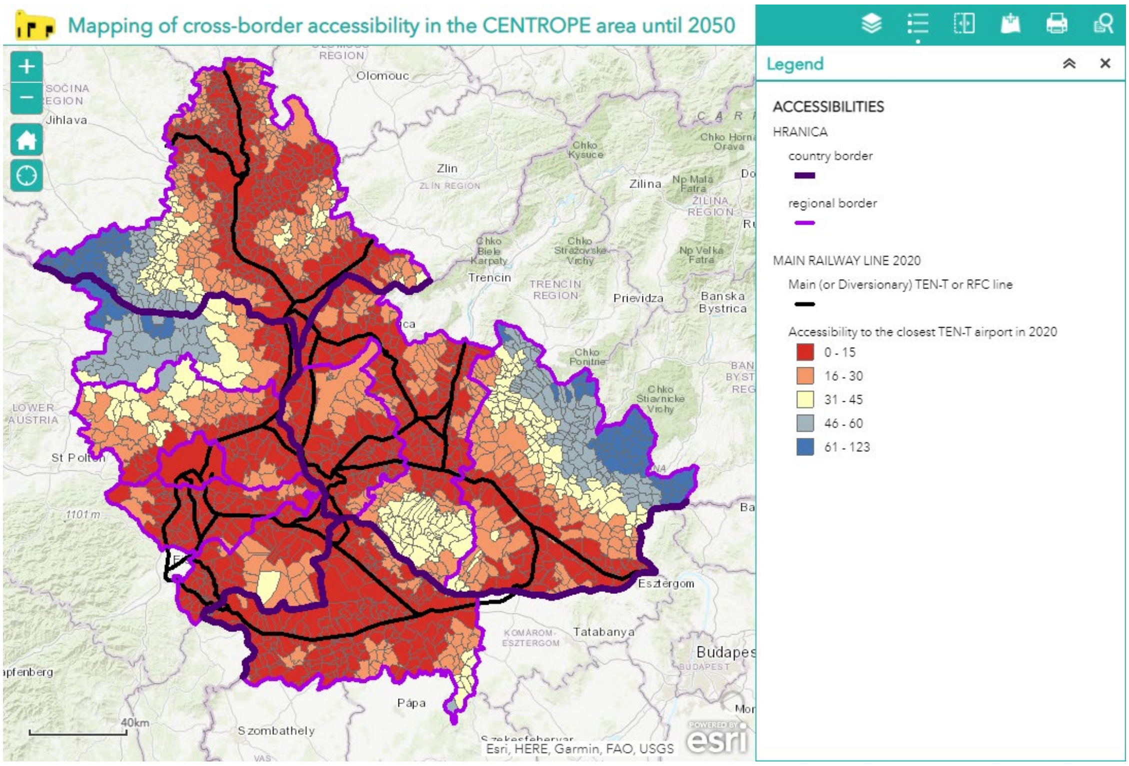
Source: https://ippoz.maps.arcgis.com/apps/webappviewer/index.html?id=c48527451f444a3b9885bef3ca3013ea

Map 7. Accessibility to the closest TEN-T International Port in 2050 (in min)



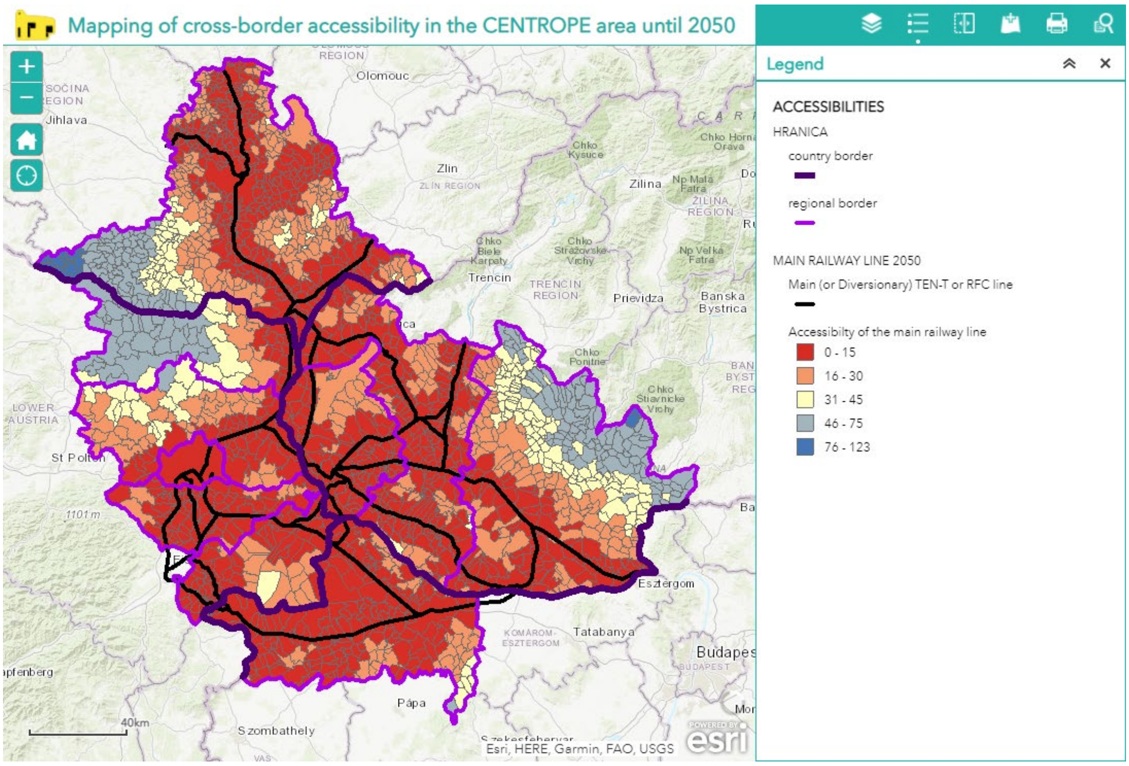
Source: https://ippoz.maps.arcgis.com/apps/webappviewer/index.html?id=c48527451f444a3b9885bef3ca3013ea

Map 8. Accessibility to the main railway TEN-T OEM or RFC-OEM corridor line in 2020 (in min)



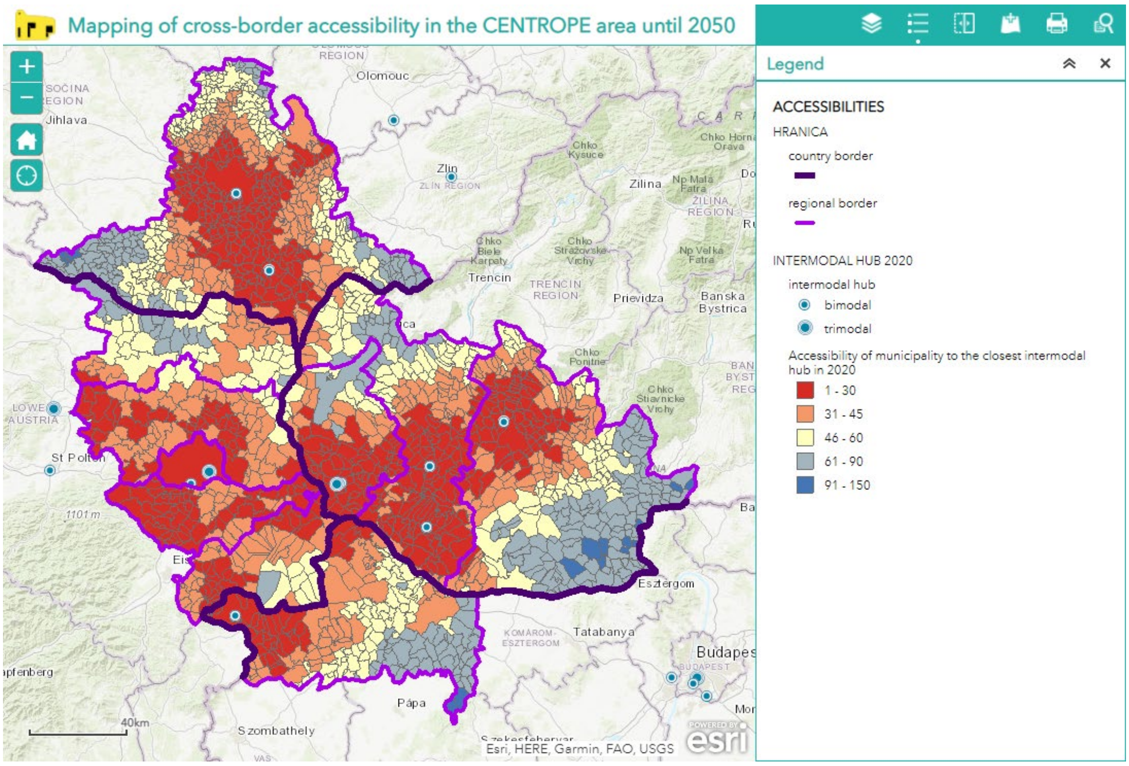
Source: https://ippoz.maps.arcgis.com/apps/webappviewer/index.html?id=c48527451f444a3b9885bef3ca3013ea

Map 9. Accessibility to the main railway TEN-T OEM or RFC-OEM corridor line in 2050 (in min)



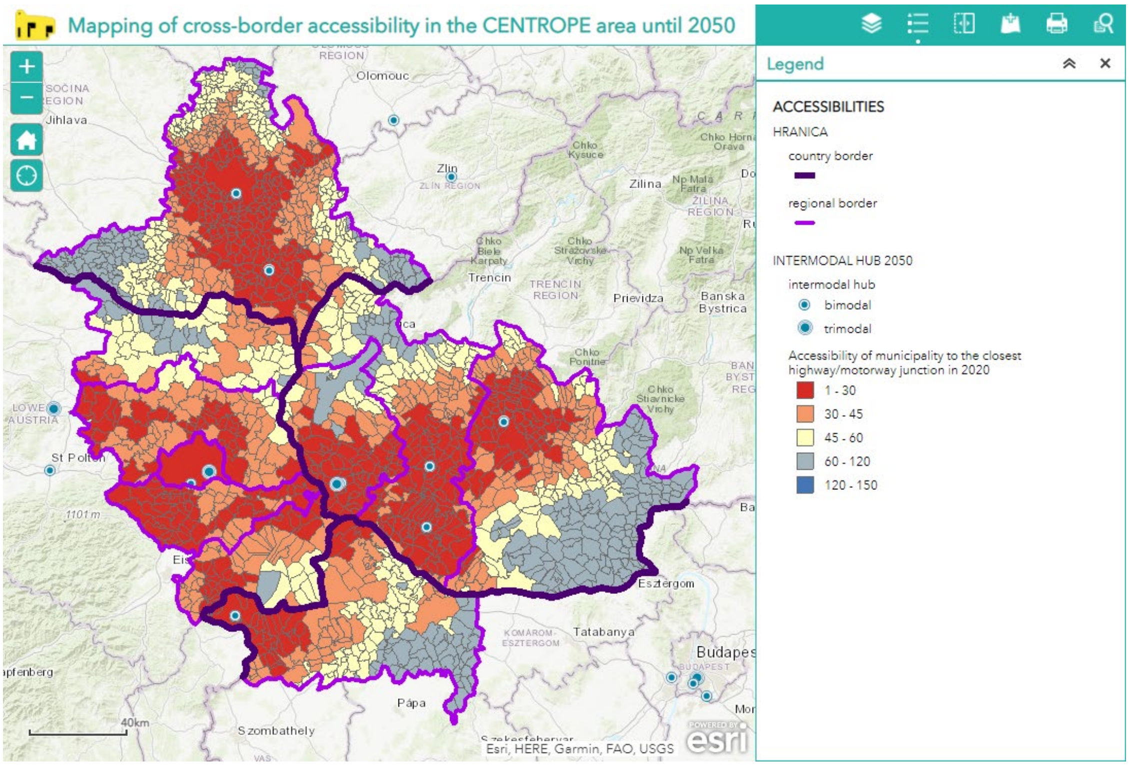
Source: https://ippoz.maps.arcgis.com/apps/webappviewer/index.html?id=c48527451f444a3b9885bef3ca3013ea

Map 10. Accessibility to the closest IHUB in 2020 (in min)



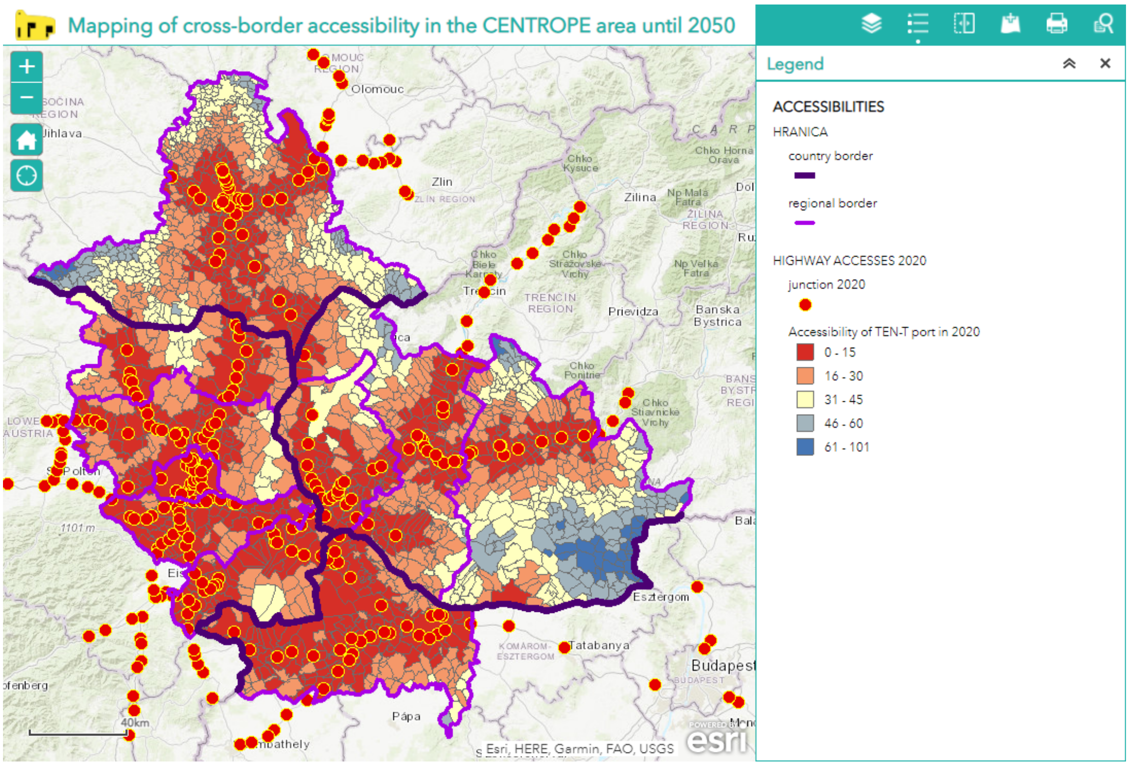
Source: https://ippoz.maps.arcgis.com/apps/webappviewer/index.html?id=c48527451f444a3b9885bef3ca3013ea

Map 11. Accessibility to the closest IHUB in 2050 (in min)



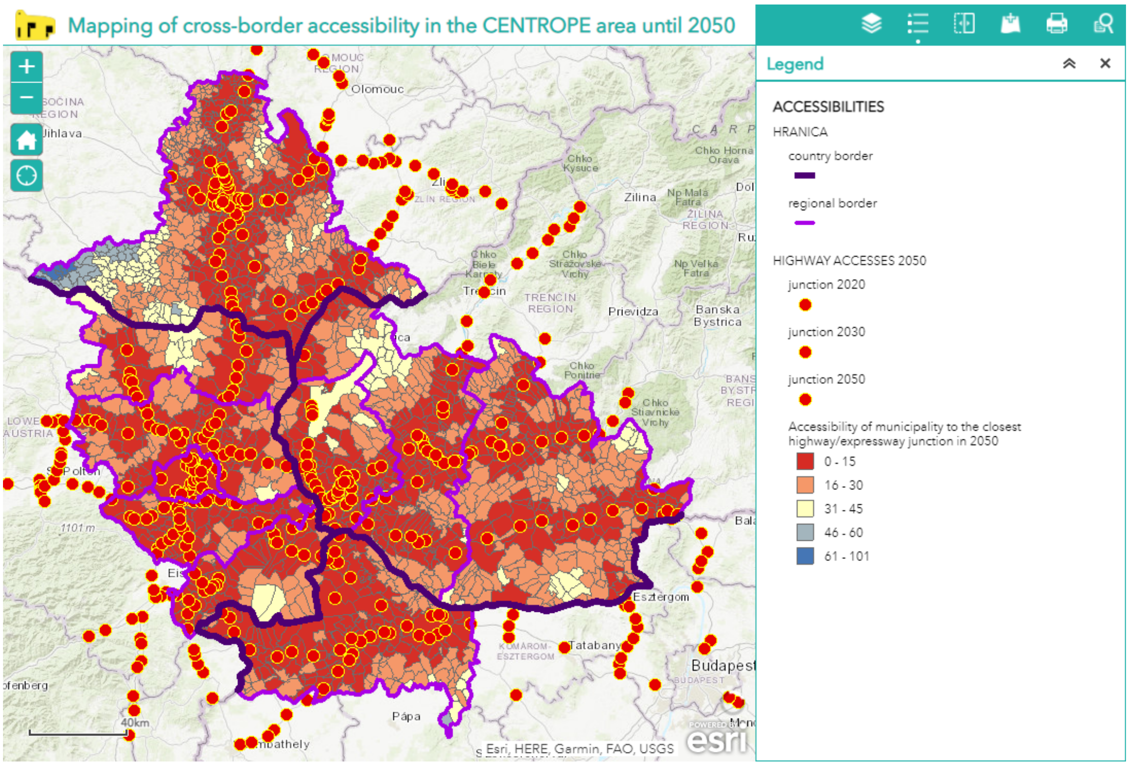
Source: https://ippoz.maps.arcgis.com/apps/webappviewer/index.html?id=c48527451f444a3b9885bef3ca3013ea

Map 12. Accessibility to the closest motorway (expressway) entrance in 2020 (in min)



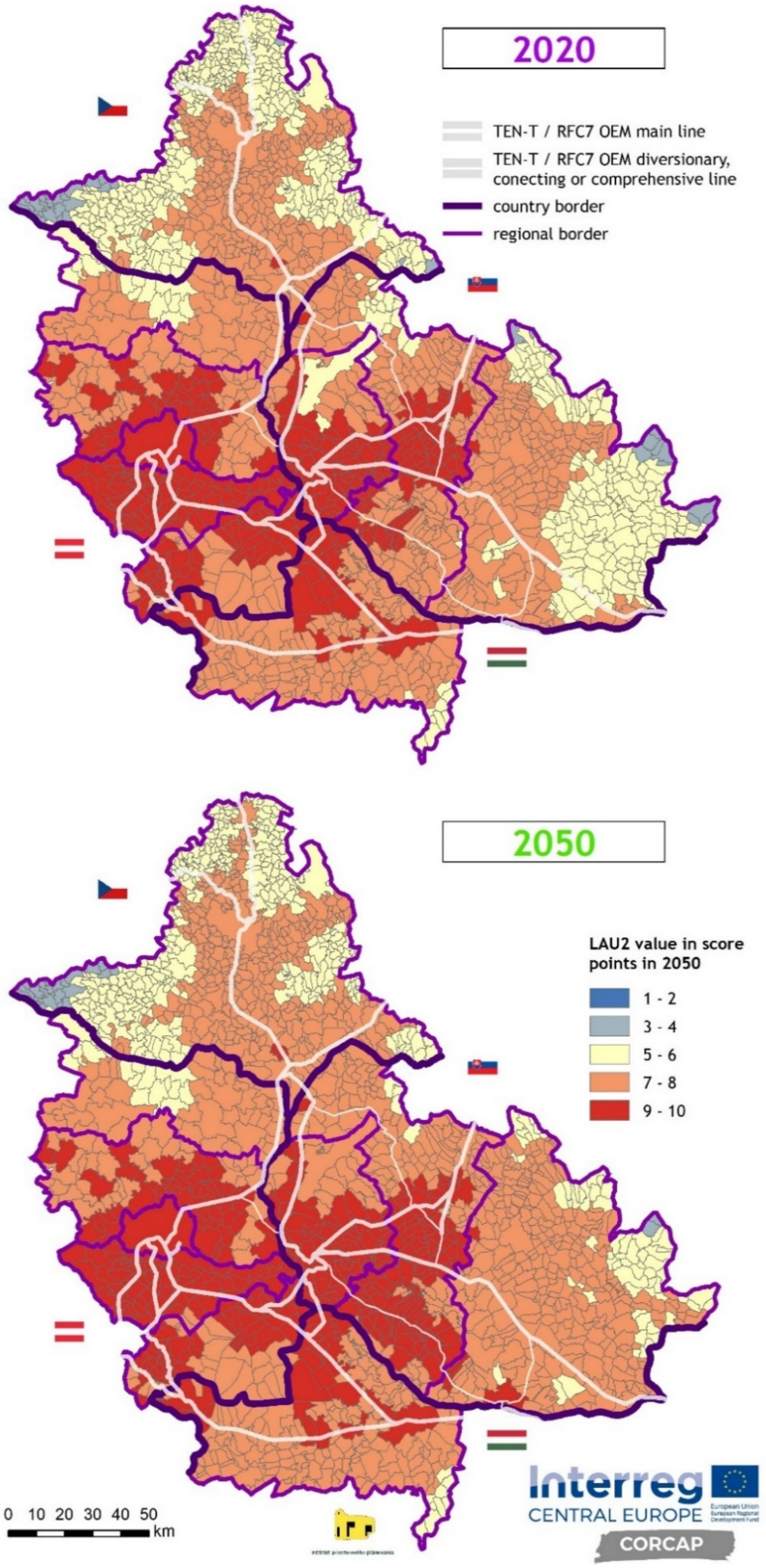
Source: https://ippoz.maps.arcgis.com/apps/webappviewer/index.html?id=c48527451f444a3b9885bef3ca3013ea

Map 13. Accessibility to the closest motorway (expressway) entrance in 2050 (in min)



Source: https://ippoz.maps.arcgis.com/apps/webappviewer/index.html?id=c48527451f444a3b9885bef3ca3013ea

Map 14. Total positional potential of CE CENTROPE municipalities in 2020 and 2050



Source: https://ippoz.maps.arcgis.com/apps/webappviewer/index.html?id=c48527451f444a3b9885bef3ca3013ea

3.3. Transport Network of the South Moravian Region (KORDIS)

The transport network of the South Moravian Region is an integral part of the transport network of the entire Czech Republic. For a better view of the transport network in the South Moravian Region, a summary of the transport infrastructure system in the Czech Republic will be given below. Table provides summary information on the infrastructure of the railway and road transport networks in the Czech Republic. Data are from 2018.

The following Tables show selected characteristics of the transport system of the South Moravian Region (SMR) in comparison with the whole Czech Republic. The length of roads and the length of tracks have almost the same share in the whole territory of the Czech Republic, namely about 8%. While comparing the share of the SMR in the area of the Czech Republic (approximately 10% and per capita approximately 11%), this shows that the transport system is not as saturated as it probably should be. The number of cars, lorries and truck tractors is quite similar to the other characteristics mentioned above.

Tab 12. Railway and road transport infrastructure throughout the Czech Republic in 2018

indicator	value
Total operating length of lines	9,572 km
Total length of roads and motorways	55,477 km
Length of motorways in operation	1,215.7 km
Length of 1st class roads	5,817.9 km
Total number of locomotives	1,999 pcs
Total number of electric and diesel motor vehicles	1,089 pcs
Wagons owned by commercial railway operators	32,231 pcs
Total number of passenger cars	5,747,913 pcs
Total number of trucks and road trailers	710,622 pcs

Source: Sydos, 2020

A big difference can be seen in the length of 1st class roads in the SMR, where the share is 7.69 % in the entire length of 1st class roads in the Czech Republic. However, motorways have a higher share, so it is possible to conclude that the lack of 1st class roads is due to the number of motorways. However, the motorway system in the South Moravian Region has not yet been completed and motorways are still being built.

Tab 13. Selected characteristics of the transport system of the South Moravian Region in comparison with the Czech Republic

indicator	value (year)	value in %
Total operating length of lines	785.4 km (2018)	8,21 %
Total length of roads and motorways	4,284.4 km (2018)	7,69 %
Length of motorways	160.3 km (2018)	12,81 %
Length of 1st class roads	422.1 km (2018)	7,26 %
Total number of passenger cars	594,778 pcs (2018)	10,35 %
Total number of trucks and road trailers	81,146 pcs (2018)	11,42 %

Source: Sydos, 2020

Road transport

The road transport network in the South Moravian Region includes the D1 road, which is currently an important road not only in the region, but also in the entire territory of the Czech Republic. The D1 connects the capital city of Prague with Brno, where it continues towards Ostrava and Poland. Part of the D1 road belongs to the 4th Pan-European corridor that connects Germany (Dresden) and Turkey (Istanbul). Part of the D1 also belongs to the TEN-T Orient/East-Med corridor.

In the north-south direction, the road connection is not well developed, because in presence several motorway connections are missing, especially in the area north of Brno where only road of national importance I/43 is situated. South of Brno, there is the D2 motorway to Bratislava (Slovakia) and the D3 motorway to Vienna (Austria), but this motorway is not fully built in South Moravia. There is not much traffic on these two motorways, traffic congestion is not as common as on the D1. The only problematic part may be the proximity of Brno, where the intersections of all the previously mentioned motorways are located. The D2 motorway is also part of the TEN-T Orient/East-Med corridor.

The following European international roads are located in the South Moravian Region:

> E50: CZ/DE - Rozvadov - Pilsen - Prague (highway D1) - Brno (1st class road I/50) - Uherske Hradiste - Stary Hrozenkov – CZ/SK

> E59: Jihlava - Znojmo (D1 motorway and 1st class road I/38; E50 and E65 overlap on the D1 motorway) - Hatě - CZ/AT

> E65: CZ/PL - Harrachov - Turnov - Prague (D1 motorway) - Brno - Břeclav (D1 motorway, 1st class road E50 and highway D2 overlap) - CZ/SK

> E461: Svitavy (1st class road I/43) - Brno (2nd class road II/640, 1st class road I/42, 1st class road I/23, highway D1) - Mikulov (1st class road I/54 and 1st road) 1st class road/52) - CZ/AT

> E462: Brno (D1 MÚK 1st class road I/52, Vyškov 1st class road I/46) - Olomouc - Český Těšín - CZ/PL

There are also 4 motorways in the South Moravian Region, but only 2 are completed:

> D1: Prague - Brno - Ostrava - CZ/PL

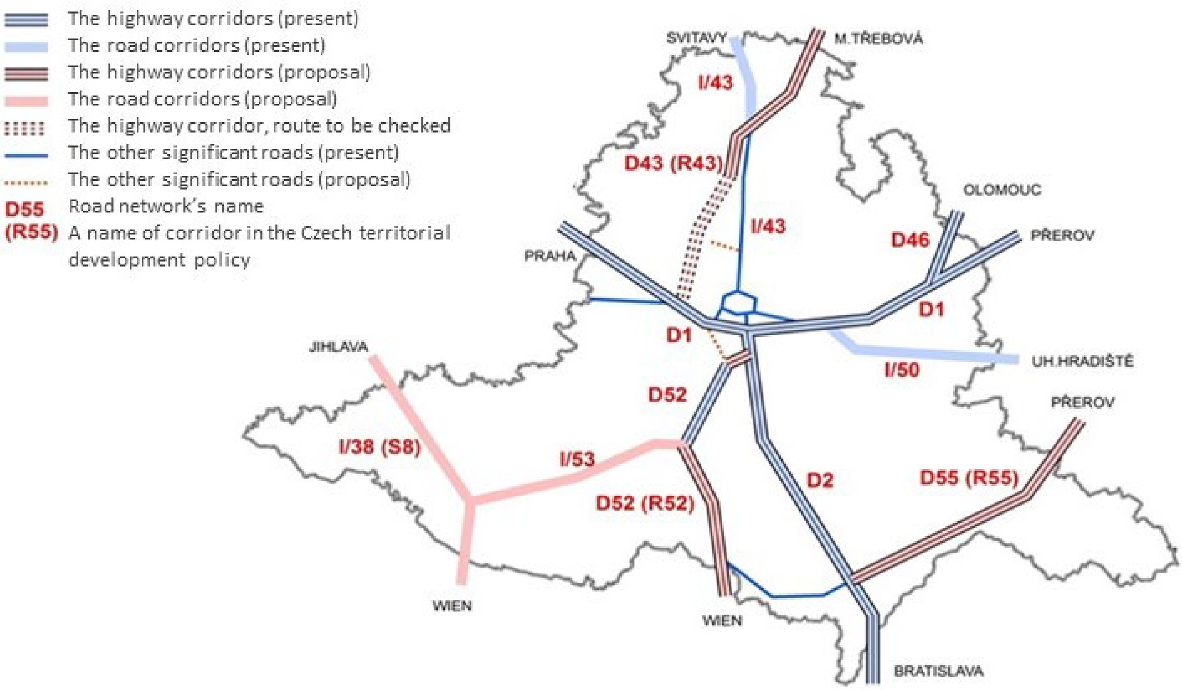
> D2: Brno - Břeclav - CZ/SK

> D43: Brno - Svitavy - connection to D35 near Moravská Třebová

> D52: Brno - Mikulov - CZ/AT

The SMR has fourteen 1st class roads: I/38, I/55, I/71, I/19, I/23, I/43, I/47, I/50, I/51, I/52, I/54, I/70, I/40, I/53. The 2nd class roads make up 33 % share of all roads in the region with a total length of 1,476 km. The next lower level of roads are 3rd class roads with a total length of 2,494 km, which is a 54% share of all roads in the region. The density of the road system is 62.5 km per 100 km^2 and 39.3 km per 10,000 inhabitants. The highest density per 1 km^2 has the district of Brno-city (76.1 km) and the lowest density the district of Hodonín (50.1 km). The density per 10,000 inhabitants is completely different, the lowest density is in the district of Brno-město (4.7 km) and the highest in the district of Znojmo (87.4 km).

Fig. 13. Road transport network in South Moravian Region



Source: https://www.krjihomoravsky.cz/Default.aspx?ID=344176&TypeID=2

Rail transport

Important railway hub of the SMR railway transport network lies in Břeclav, which is located at the intersection of transit corridor I and II:

- Transit Corridor I: CZ/DE - Děčín st.hr. - Prague-Holešovice - Pardubice - Brno - Břeclav – CZ/SK
- Transit Corridor II: CZ/PL - Petrovice u Karviné st.hr. - Ostrava - Přerov - Břeclav st.hr. - CZ/AT

The connection between Germany and Slovakia is possible through Transit Corridor I, which passes through the South Moravian Region and Brno. Unfortunately, nowadays this corridor faces two problems: the congested capacity of the tracks and in some parts the speed of the rail transport is low. Therefore, it is necessary to modernize Corridor I in the SMR in order enabling the fastest connection between cities.

A north-south train connection is possible via Transit Corridor II that connects Poland and Austria and also passes through the South Moravian Region. Compared to the Transit Corridor I, the second one is built almost in its entire length. The only possible obstacles could be a section of the corridor with train stations in Ostrava and Přerov.

The following routes are located in the South Moravian Region:

- 240 Brno – Jihlava – Havlíčkův Brod
- 241 Znojmo – Okříšky
- 246 Znojmo – Břeclav
- 248 Znojmo – Šatov – CZ/AT
- 250 Havlíčkův Brod – Brno – CZ/SK
- 260 Brno – Česká Třebová
- 300 Brno – Přerov
- 330 Břeclav – Přerov
- 332 Hodonín – Holíč nad Moravou (SK)
- 340 Brno – Uherské Hradiště
- 342 Bzenec – Moravský Písek
- 343 Hodonín – Veselí nad Moravou
- 344 Veselí nad Moravou – Vrbovce (SK)

Water transport

There are no waterways or public ports in the SMR. We can only mention Baťa's Canal, which was built as a tool for transporting coal from South Moravia to Otrokovice in the 1930s. Today, however, it is only a tourist attraction. Other types of transport connected with water are mainly tourist attractions too. We can mention the Kníničky Dam, The Vranov Dam, the river Dyje in Břeclav, ponds in the Lednice-Valtice Area and the river Punkva in the Moravian Karst.

Air Transport

There is one public international airport Brno - Tuřany in the SMR. Currently it offers several scheduled flights to Berlin, London, and Milan. Charter and cargo flights are also on offer. Furthermore, the SMR has 5 public airports, which have the status of aeroclubs and have a predominantly grass runway. Such airports are located in Břeclav, Brno-Medlánky, Vyškov, Znojmo and Kyjov. The Air Rescue Service in the SMR has several HEMS (Helicopter Emergency Medical Service) ground heliports for its medical purposes in Boskovice, Břeclav and Blansko and the HEMS roof heliport in Brno-Children's Hospital, Brno-IBC (shopping arcade), University Hospital Brno and in Kyjov.

3.4. Transport Network in the Southwest Slovakia

The basic course in the development of transport scenarios is defined in the document "Strategic Plan for Transport System Development of the Slovak Republic" (MDaV SR 2016), which comprehensively assesses the possibilities of development across all needs arising from the requirements for planning, development and operation of all transport modes.

One of the global strategic objectives is:

- GSO3: Increasing the competitiveness of transport modes in passenger and freight transport (road transport counterparts) by setting the corresponding operational, organizational and infrastructure parameters leading to an effective integrated multimodal transport system supporting the economic and social needs of the Slovak Republic. Improving the quality of transport planning in the Slovak Republic by defining the optimal target value of the modal split in the conditions of the Slovak Republic and setting steps and tools for achieving it.

That implies the legitimate attention required by freight transport and especially by the railway.

The state of the transport system of the SW Slovakia, which is immediately adjacent to CZ, AT, and HU, is essential for the already required and in the future even more required connection of the north-western and south-eastern part of Europe.

For the purpose of evaluating current and future possibilities for cargo in the area of the SW Slovakia, it is necessary to check the needs for long-distance - transit and origin-destination local transport.

For these purposes, rail freight transport was already used in the past (especially until the 1990s). Its network had been built already during the World War I. There is a significant **bottleneck** in the rail transport network with limited capacity lying in the city of Bratislava.

In the last 30 years, there has been a massive development of road freight transport, especially over long distances. Long-distance truck transport has been involved in all components of economic life. This has led to a great social pressure on the development of road infrastructure, mainly in building of new sections of motorways.

The transport network suitable for freight transport in this region consists of sections of:

- Railways (in particular tracks 126 [110], 125 [120], 120 [130], 124 [131], and 128 [133] and tracks in Bratislava)
- Motorways D1, D2, D4 and expressways R1 and R7
- 1st class roads - I/2, I/51, I/61, I/63, I/64, and I/75

Motorway and road network

For the purposes of studying the possibilities of directions of traffic flows, throughputs of motorways, expressways and 1st class roads in SW Slovakia were also considered.

The following sections are in operation:

- Motorway D1: Bratislava (junction with D2) – Bratislava (junction with R7) - Ivanka pri Dunaji (junction with D4) - Trnava (junction with R1) – Žilina (outside the area of interest)
- Motorway D2: border SK/HU – Bratislava (junction with D1) – Stupava (junction with D4) – Kúty – border SK/CZ
- Motorway D4: border SK/AT - Stupava (junction with D1) – Ivanka pri Dunaji (junction with D1) – Rovinka (junction with R7) – Jarovce (junction with D2) – border SK/AT

- Expressway R1: Trnava (junction with D1) – Nitra – Banská Bystrica (outside the area of interest)
- Expressway R7: Bratislava (junction with D1) – Rovinka (junction with D4) – Holice (later Dunajská Streda - Nové Zámky/direction Šahy)
- First class roads: I/2, I/51, I/63

Rail transport

Basic knowledge of the configuration of the railway network was presented in the Regional Analysis of Challenges and Needs for the South-West Slovakia (IPP 2020). For the needs of railway freight transport, it is possible to use all the tracks in the territory of SW Slovakia, that are as follows (major and arbitrary railway tracks).

The main railway tracks (Firstly the track number in the official timetable is given, then the number in the public timetable is given in brackets):

- 1st category – major tracks of great importance:

> Track Nr. 126 (110) Bratislava main station – Kúty – state border SK/CZ, double-track corridor electrified line with a maximum line speed of 140km/h. The track is part of the OEM corridor, implementation of modernization at a speed of 160-200km/h

> Track Nr. 126 (110) branch Devínska Nová Ves – state border SK/AT, non-electrified single-track with a line speed of 80km/h, preparation for electrification, possible double-track

> Track Nr. 120 (130) Bratislava main station – Galanta – Palárikovo – Nové Zámky - Štúrovo – state border SK/HU, electrified corridor double-track with a maximum line speed of 140km/h, preparation for modernization at a speed of 160-200km/h

> Track Nr. 121 (150), Palárikovo – Šurany - Kozárovce - Zvolen, electrified single track. The highest line speed is 80-100km/h

> Track Nr. 125 (120) Bratislava main station – Trnava – Leopoldov – Žilina (outside area of interest), electrified corridor double-track upgraded to a maximum line speed of 160km/h on the whole section. The track is part of the Baltic Adriatic corridor

> Track Nr. 127 (132) Bratislava-Rača/Bratislava-Vajnory – Bratislava-Petržalka – Rusovce – Rajka (HU), electrified single track. The highest line speed is 60-80km/h, the line is part of the TEN-T OEM corridor

> Track Nr. 127 (137) Bratislava-Petržalka – state border SK/AT, electrified single track. The highest line speed is 60-80km/h

> Track Nr. 128 (133) Galanta – Sereď – Leopoldov, electrified double track. The highest line speed is 100km/h

- 2nd category – major tracks of minor importance:

> Track Nr. 122 (140) Nové Zámky – Šurany - Nitra – Lužianky – Topoľčany - Prievidza (outside area of interest), electrified single track. The highest line speed is 80-100km/h

> Track Nr. 123 (141) Leopoldov – Zbehy – Lužianky, non-electrified single track. The maximum line speed is 100km/h

> Track Nr. 124 (131) Bratislava main station – Dunajská Streda – Komárno, non-electrified single track. The maximum line speed is 80km/h

> Track Nr. 128 (116) Kúty – Senica – Trnava, electrified single track. The highest line speed is 70-80km/h

> Track Nr. 128 (133) Trnava – Sereď, electrified single track. The highest line speed is 80km / h

Arbitrary routes

- 3rd.category – arbitrary tracks:

> Track Nr. 119 (152) Štúrovo – Čata - Levice, electrified single track. The maximum line speed is 80-90km/h

> Track Nr. 119 (153) Čata – Šahy – Zvolen, electrified single track. The maximum line speed is 70km/h

> Track Nr. 123 (141) Lužianky - Zlaté Moravce - Kozárovce, non-electrified single track. The maximum line speed is 60-70km/h

> Track Nr. 123 (141) Topoľčianky - Zlaté Moravce – Úľany nad Žitavou, non-electrified single track. The maximum line speed is 60-80km/h

> Track Nr. 129 (114) Kúty – Holíč n. Moravou – Skalica in Slovakia, non-electrified single track. The maximum line speed is 50km/h

- 4th category – arbitrary tracks with simplified traffic management:

> Track Nr. 123 (142) Zbehy - Radošina, non-electrified single track, simplified rail transport management. The maximum line speed is 60km/h, currently out of order

> Track Nr. 124 (134) Šaľa – Neded, electrified single track, simplified rail transport management. The maximum line speed is 60km / h, currently out of order

> Track Nr. 124 (136) Kolárovo - Komárno, electrified single track simplified rail transport management. The maximum line speed is 40km/h, currently out of order

> Track Nr. 126 (112) Zohor - Plavecký Mikuláš, non-electrified single track, used mainly for freight transport, passenger transport to the extent intended primarily for recreation. The connection to Jablonica has not been implemented. The maximum line speed is 70km/h

> Track Nr. 126 (113) Zohor - Záhorská Ves, non-electrified single track. The maximum line speed is 60km/h, currently out of order

> Track Nr. 128 (117) Jablonica - Brezová pod Bradlom, non-electrified single track. The maximum line speed is 50km/h, currently out of order

> Track Nr. 129 Piešťany - Vrbové, non-electrified single track. The maximum line speed is 20km/h, currently out of order

The railway network of the Bratislava Region was modernized only on the railway corridor Bratislava - Rača – Púchov – (Žilina). There a complete modernization was carried out with the replacement of the railway substructure as well as the superstructure. The speed was increased to 160 km/h, off-level crossings were built, and traffic safety was increased. Increased demands on rail transport in this crucial section of the railway track in the direction to Bratislava show its insufficient capacity. The remaining tracks suffer to a large extent from obsolescence and lack of maintenance. In recent years there have not been any modernization nor development of the railway infrastructure. At present, the modernization of track Nr. 126 (110) Bratislava – Kúty in the section Devínska Nová Ves – Kúty is being implemented.

The Regional Spatial Plan of the Bratislava Self-governing Region (AUREX 2017b) has a territorial reserve devoted to Bratislava - Vajnory – Čierna Voda – Pezinok – Modra – Smolenice tracks; Devínska Nová Ves - Devínske Jazero – Stupava – Lozorno; Plavecký Mikuláš – Jablonica; Bratislava-Filiálka – Petržalka, branch Ružinov – Bratislava Airport – Vajnory; which all should serve mainly for passenger suburban rail transport.

Recently, the V4 transport ministers of Slovakia, Hungary, the Czech Republic, and Poland declared their intention to connect the capitals of these countries with a high-speed rail line, while signing a declaration on cooperation in the development of the high-speed rail network in Central Europe. The high-speed network should connect cities of Warsaw, Prague, Bratislava, Vienna, and Budapest within a few years (SL 2020, Asbóth – Bersényi 2020, TRENECON 2020). It would bring passengers a substantial reduction in transport time between the four countries and a real alternative to road and air transport.

Special interest should be given to the **broad-gauge railway proposal** from Ukraine to Austria through southern and southwestern parts of Slovakia: Haniska – Nové Zámky – Bratislava – Parndorf (AT) – Wien (AT). This project has the ambition to be an alternative and faster transport route from South-East Asia to Europe (IPP 2020). Further information was the subject of the CORCAP Regional Study (IPP 2020).

Regional Sustainability Mobility Plan of Bratislava Region (SGS 2019) presented these views only as a possibility that these massive infrastructure projects, which will be implemented only in the distant future and at the design stage of this project, will not affect the shape or scope of the necessary measures to ensure sustainable transport performance in the territory of Bratislava Region, in particular of the public passenger rail transport.

3.5. Development Scenarios in the South Moravian Region (KORDIS)

3.5.1. Rail transport

High-speed lines in the Czech Republic

The Czech railway encounters on daily basis problems connected to capacity, length, and speed. The section of the Česká Třebová – Praha track due to lack of capacity no longer allows the addition of another connections. The section Brno – Česká Třebová is difficult to pass due to slow speed. Track through Vysočina Region has a problem with high length. The planned construction of the high-speed line will speed up connections not only between Brno, Prague, and Dresden, but also with the capitals of neighbouring states.

At the moment, the construction of high-speed lines is in the phase of studies or spatial proceedings. Two routes were considered – along the D1 motorway or through Pardubice. A shorter variant along the D1 motorway was chosen.

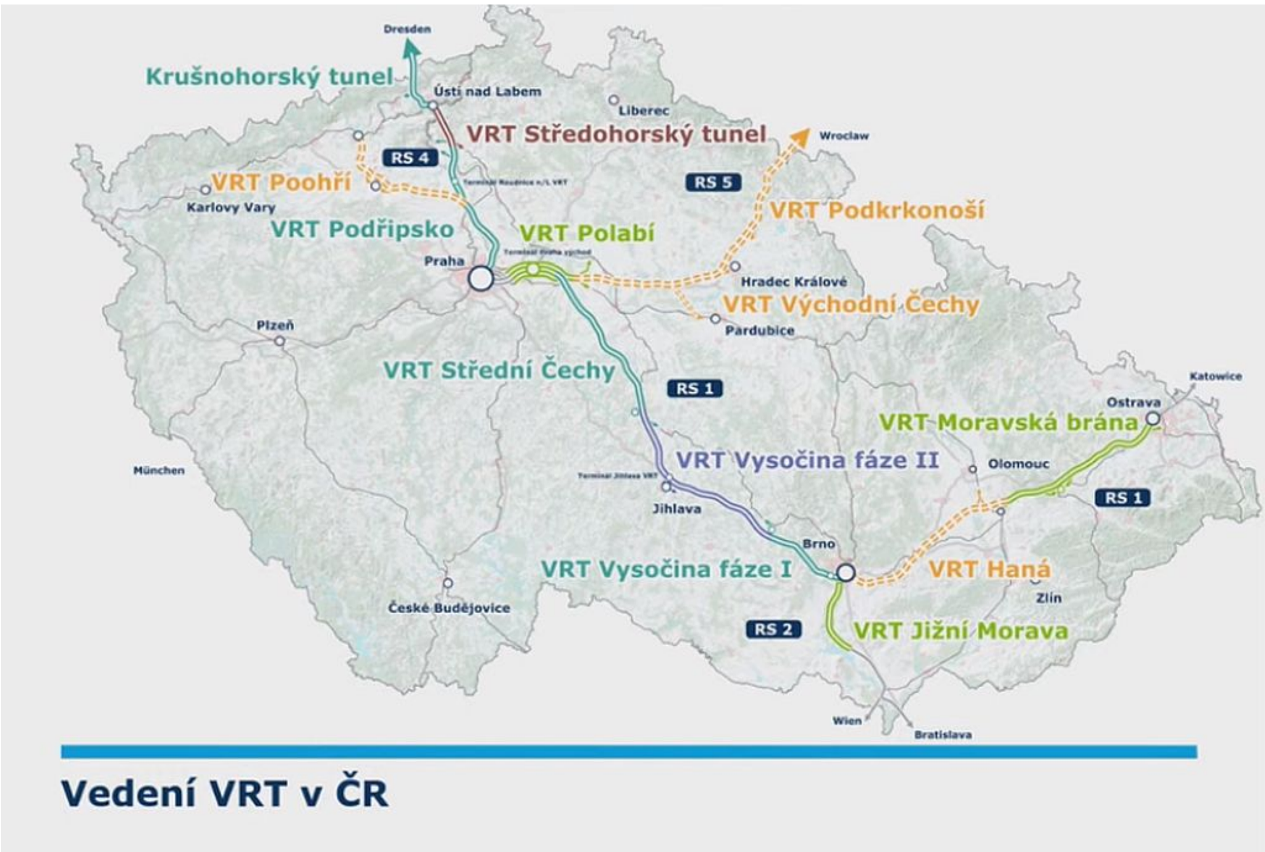
The high-speed line will allow residents of the Czech Republic and tourists to use fast connections between cities and countries. It also produces a minimum emission value. Travel time will be shortened several times. For example, the journey from Brno to Prague currently takes 2 hours and 35 minutes, after the construction of the high-speed line the journey will take 55 minutes.

The first prepared section of the high-speed line in the Czech Republic is in Polabí, where traffic will be ensured between the station Praha-Běchovice and Poříčany. The key milestones, according to the information portal of Správa železnic (Railway Administration - (www.spravazeleznic.cz), are described below:

- Completion of the EIA (Environmental Impact Assessment) process for the first section of the high-speed line (2022)
- Commencement of spatial proceedings for the first sections of the high-speed line (2022)
- Provision of land for the construction of high-speed line (2022/2023)
- Preparation of documentation for Building Permit (2023)
- Commencement of Building Permit Proceedings for the first sections of high-speed line (2023/2024)
- Commencement of construction of the first section of the high-speed line (2025)
- Start of operation on the first section of the high-speed line (2028)

The figure shows the planned high-speed line network in the Czech Republic. Správa železnic (Railway Administration) expects to put into operation High-Speed Line VRT South Moravia, VRT Moravská Brána and VRT Polabí in 2029. By 2031, VRT Vysočina 1st Phase, VRT Central Bohemia and VRT Podřipsko will be put into operation according to the plan. Realization of the VRT Vysočina 2nd phase is expected in 2034, the next year (2035) VRT Poohří will be put into operation. Two more high-speed lines – VRT East Bohemia and VRT Podkrkonoší - will be built in 2040. VRT Haná will be put into the operation after 2045.

Fig. 14. High-speed lines in the Czech Republic

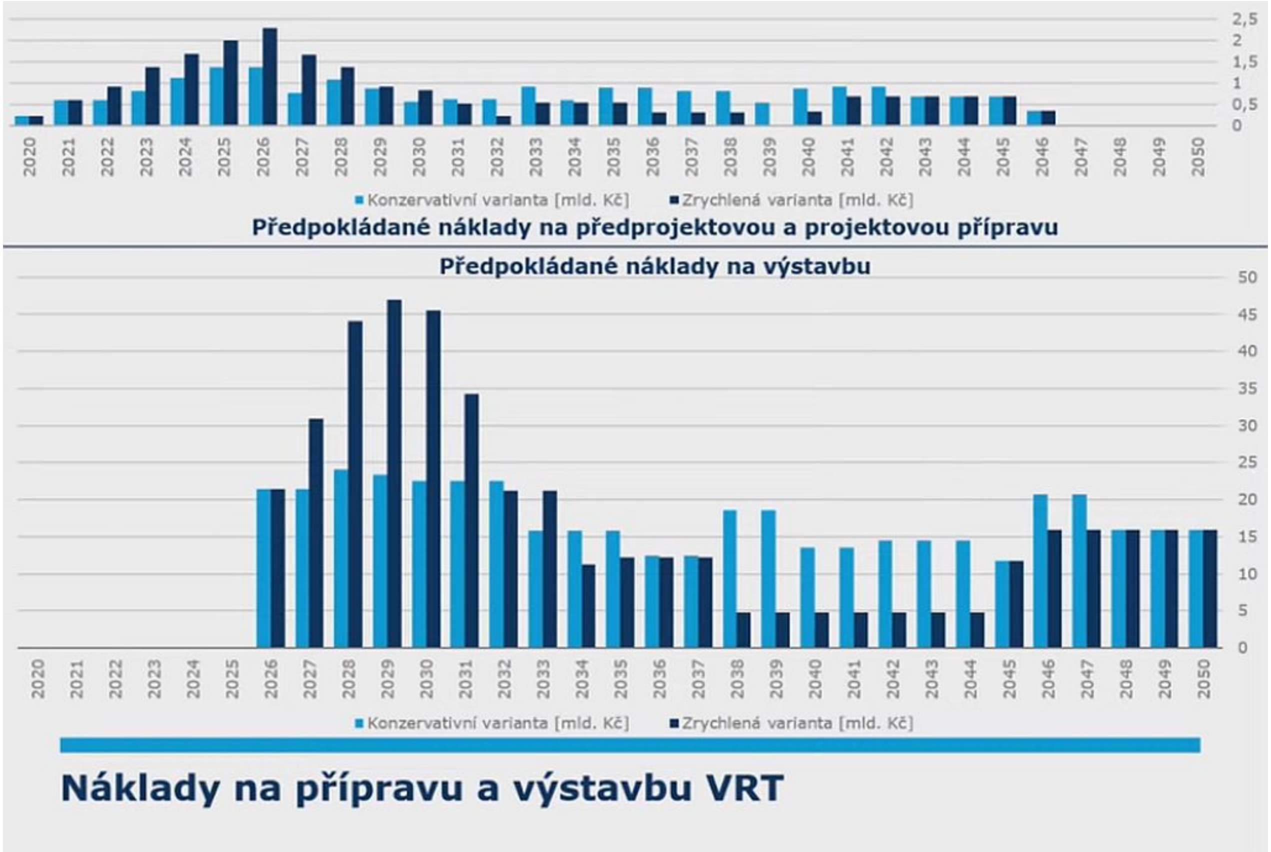


Source: Správa železnic (Railway Administration) - www.spravazeleznic.cz

The expected costs for the preparation and construction of high-speed line is divided into two cost variants: (1) expected costs for pre-project and project preparation and (2) expected construction costs. Each of the variants is further divided into a conservative variant and an accelerated variant. In the cost of pre-project and project preparation, the highest costs are estimated in 2025-2027, further they will be reduced from 2 milliard CZK to half a million CZK.

In the conservative variant, the costs are almost the same - 0.5 to 1 milliard CZK. As for the cost of construction, in the accelerated variant, the highest costs are in 2028 - 2030, then they are reduced from 45 milliard to 15 milliard CZK. In the conservative variant, the costs are almost the same, approximately 20 milliard CZK.

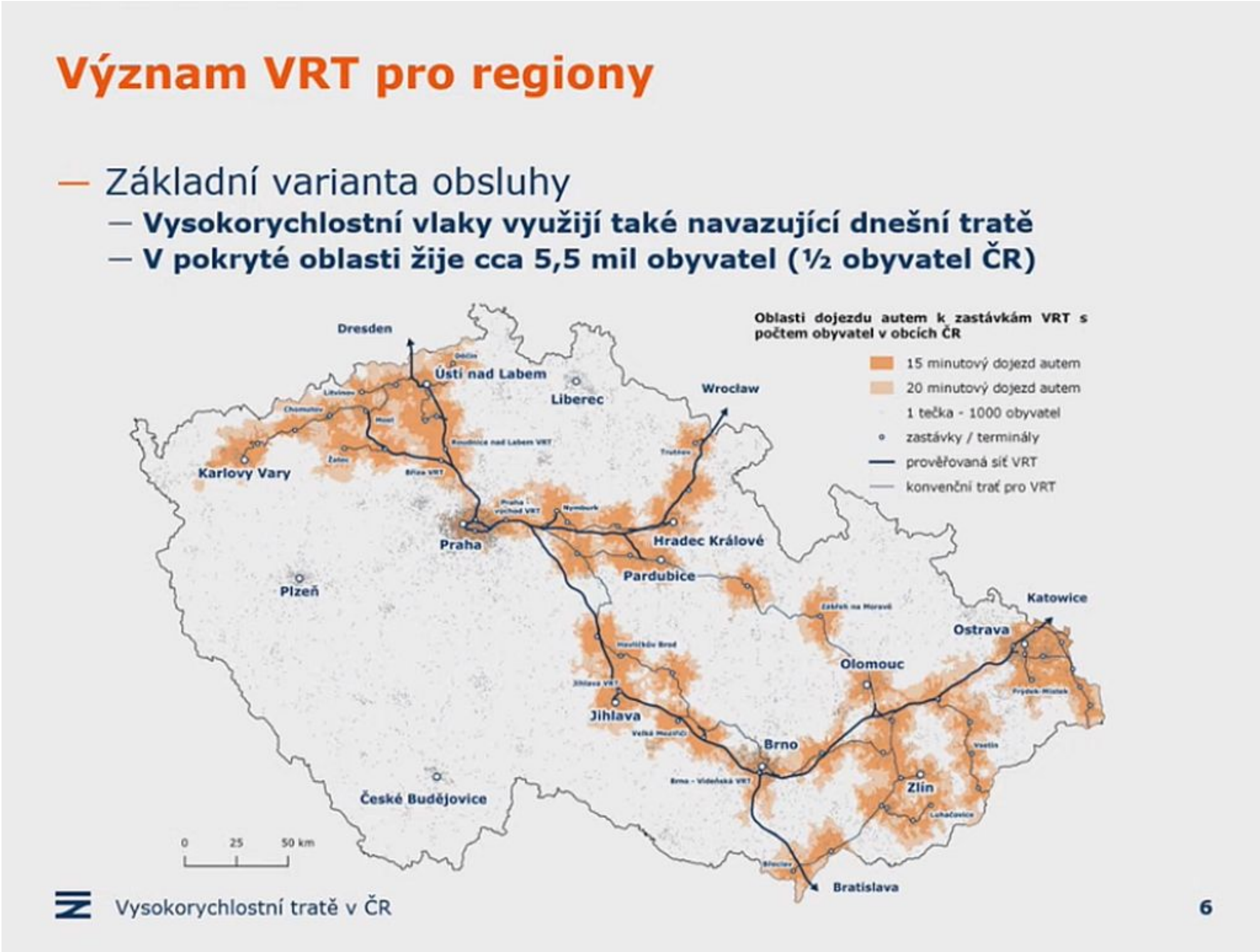
Fig. 15. Costs of preparation and construction of high-speed line



Source: Správa železnic (Railway Administration) - www.spravazeleznic.cz

The figure illustrates the benefits for the regions. Orange-coloured areas indicate places where it takes 15-20 minutes by car to reach the high-speed line station. The total area of the orange area is 5.5 million inhabitants, which is half the population of the Czech Republic.

Fig. 16. Importance of high-speed line for regions



Source: Správa železnic - www.spravazeleznic.cz

High-speed lines in the South Moravian Region

The high-speed line VRT South Moravia in the South Moravian Region is one of the first prepared sections of the high-speed line.

The length of the high-speed line VRT South Moravia section is 34 km. It will speed up the train connection between Břeclav and Brno. According to Správa železnic (Railway Administration) VRT South Moravia will be primarily used for long-distance services, while the original line will remain in operation for local and regional trains. Commissioning is expected in 2029.

Another high-speed line in the SMR is VRT Vysočina and VRT Haná. VRT Vysočina will pass between Prague and Brno and will lead through the entire territory of the Vysočina Region. On the territory of the SMR in the section Velká Bíteš – Brno with a length of 33 km. The expected year of operation is 2031.

According to Správa železnic (Railway Administration), VRT Haná is in the process of feasibility studies. The aim of the studies is to examine the provision of possible additional capacity in the long term. The exact length of the line is not known, and the year of commissioning is 2045. This line will significantly improve the connection between Brno and Ostrava and reduce the total travel time between these cities to 30 minutes.

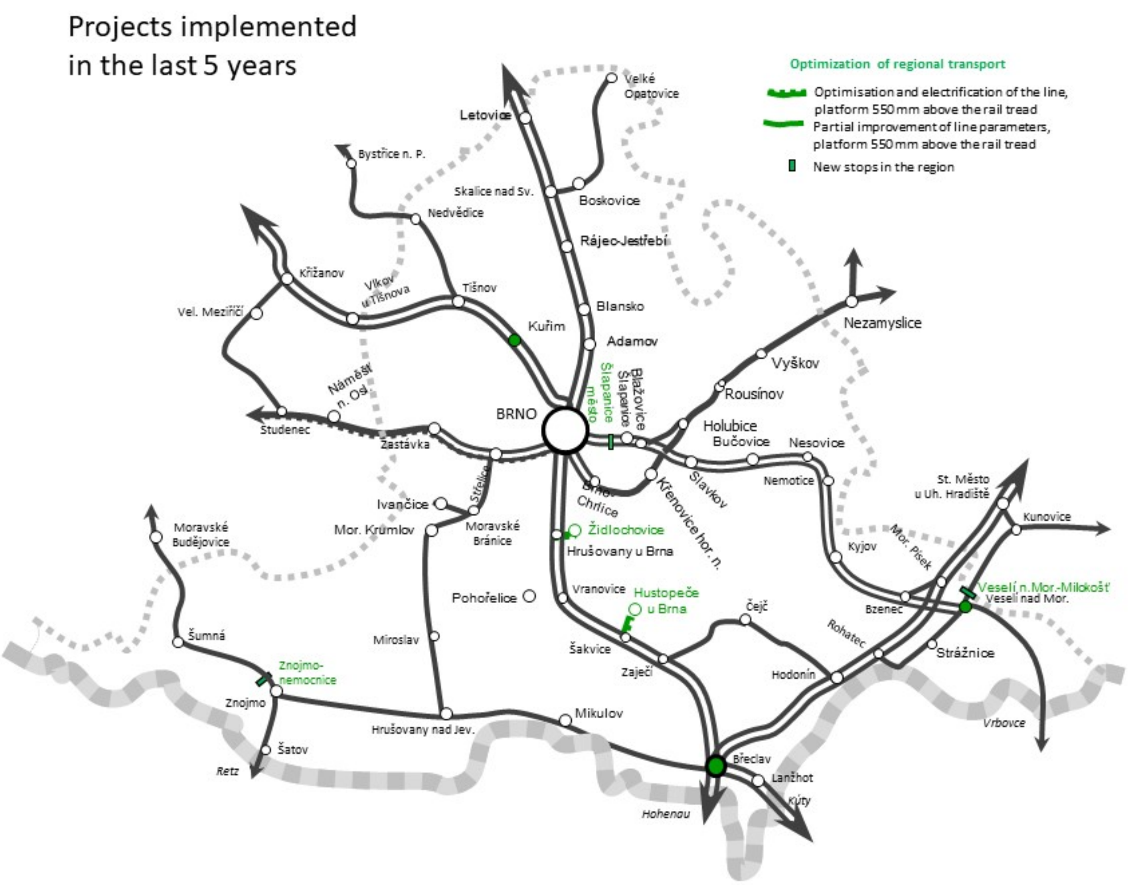
Regional rail transport

Regional rail transport is of great importance for the South Moravian Region. Within the integrated transport system, the SMR supports the development of passenger rail transport, modernization, and electrification of lines. In some directions, passenger rail transport is faster than passenger car connections, which is reflected in high passenger demand. However, a number of lines in the SMR are outdated, very difficult to pass and affected by frequent closures. The South Moravian Region is striving to modernize them with some success.

Regional rail transport – projects implemented in the last 5 years

The following figure shows the projects that have been implemented in the field of regional rail transport in the last 5 years. These are the construction of new stops Znojmo nemocnice, Šlapanice-město, Veselí nad Moravou – Milokošť and Brno dolní nádraží. The stations Břeclav, Veselí nad Moravou and Kuřím were fundamentally modernized. The operation of regional trains was significantly influenced by the modernization and electrification of the Hrušovany u Brna – Židlochovice track and the modernization and electrification of the Šakvice – Hustopeče u Brna track. The reconstruction of the railway junction in Břeclav, where higher safety and reliability of operation is currently ensured, had a major impact on freight rail transport.

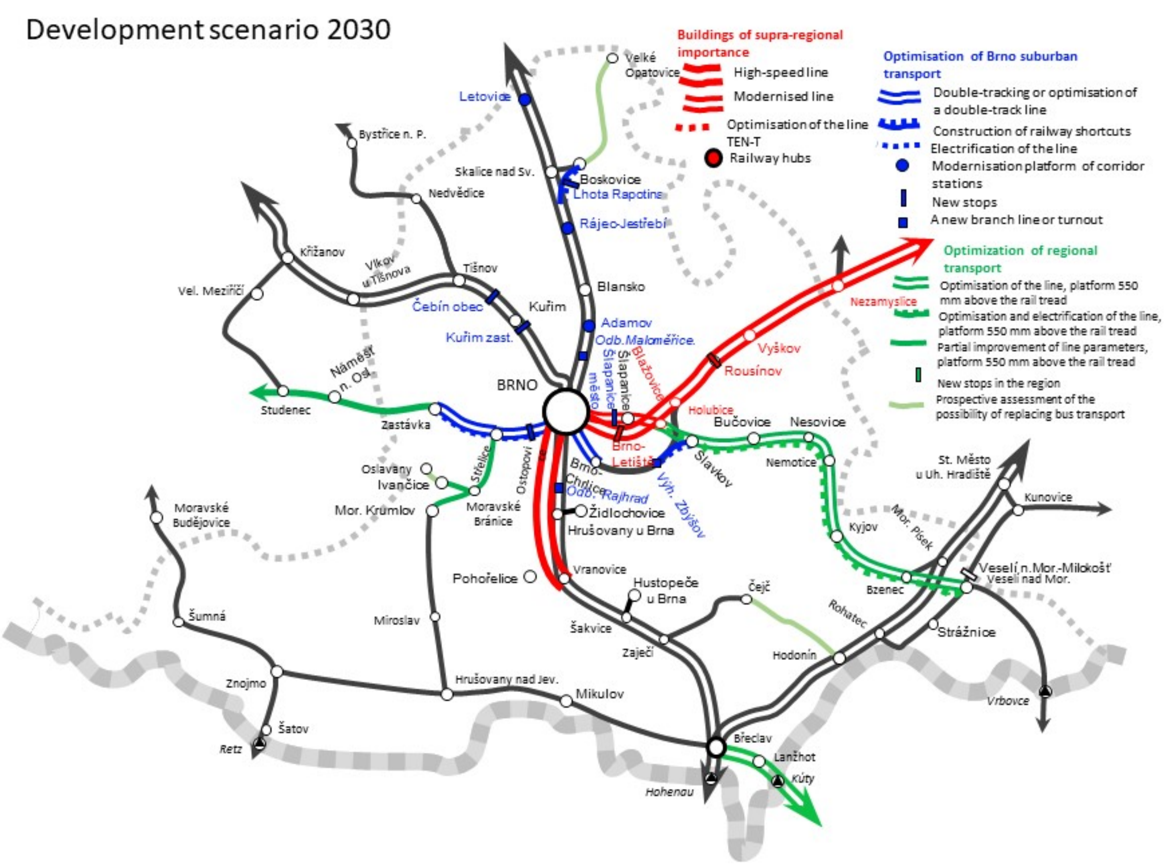
Fig. 17. Projects implemented in the last 5 years



Development scenario 2030

The picture shows the scenario of railway development in the South Moravian Region by 2030. In 2030, according to the Správa železnic (Railway Administration), the construction of the high-speed line VRT South Moravia and the modernization of the Brno – Přerov line (to 200 km/h) are expected to be completed. By 2030, the modernization of the Letovice, Rájec – Jestřebí and Adamov stations will be completed. The quality of the public transport will be improved by adding two new branches to Maloměřice and Rajhrad. The construction of two new stops in Brno - Čebín obec and Kuřím stop is being considered. Improvements of the parameters of the section Zastávka - Třebíč and the section Střelice - Moravský Krumlov / Ivančice are being prepared. The double track will be completed on the section Brno – Zastávka and Brno – Brno-Chrlice. There will be a new connection between Zbýšov and Slavkov. A new electrified connection will be created between the new Lhota Rapotina stop and Boskovice.

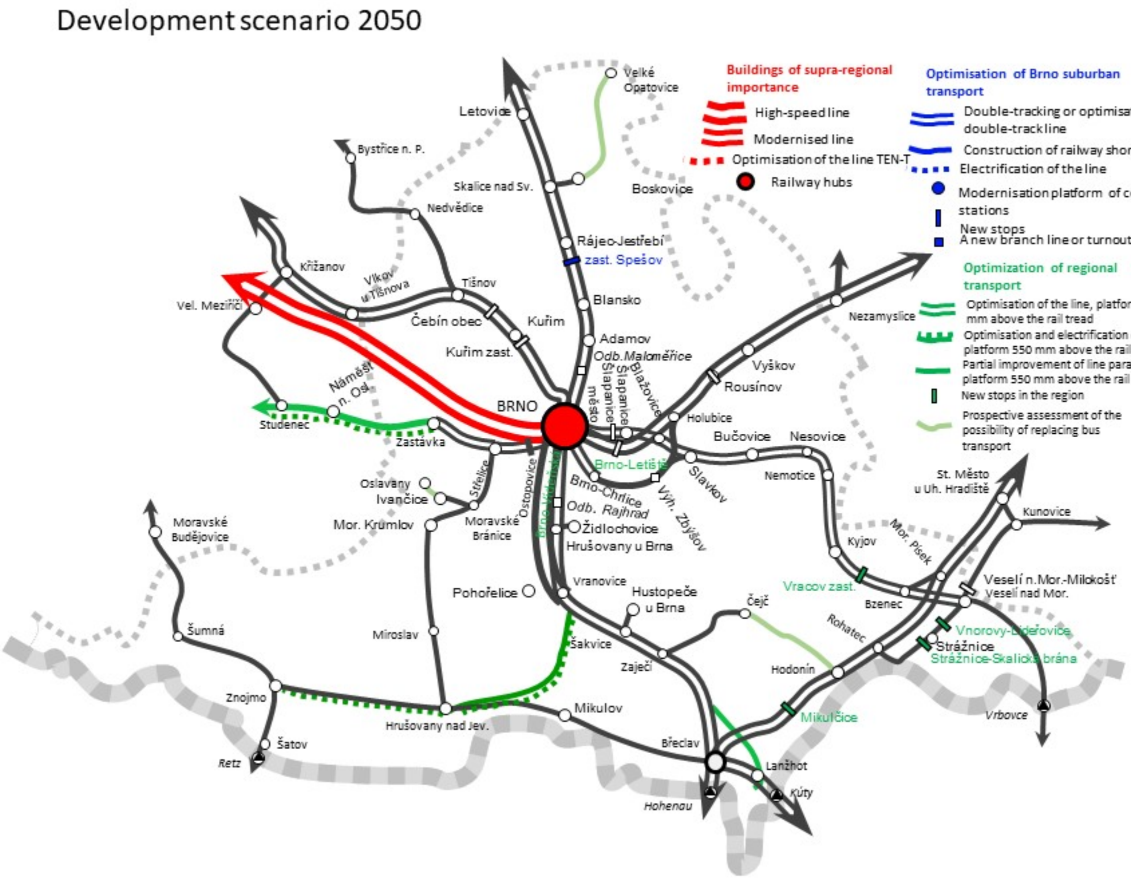
Fig. 18. Development scenario 2030



Development scenario 2050

Based on the plan of Správa železnic (Railway Administration) by 2050, the construction of high-speed line VRT Vysočina - Phase 1 in the direction to Prague will be carried out. The possibility of building a new line connecting Znojmo with Brno from Hrušovany nad Jevišovkou to Vranovice is currently being examined. The construction of a new freight connection between Lanžhot and Ladná, which would allow a quick bypass of the Břeclav node is also possible. The electrification of the Zastávka – Třebíč section will be completed. New stops will be created: Mikulčice, Strážnice – Skalická brána, Vnorovy-Lideřovice, Vracov zastávka and Spešov. The Brno Railway Node will be completed.

Fig. 19. Development scenario 2050



The main benefit of high-speed line construction both in the Czech Republic and in the South Moravian Region is the increase in capacity of regional tracks. These will get enough capacity for freight, regional and suburban trains. Increase in capacity of regional and suburban trains will guarantee more connections and better linking to other transport modes. It will also enable better freight transport in the region and in the Czech Republic as well.

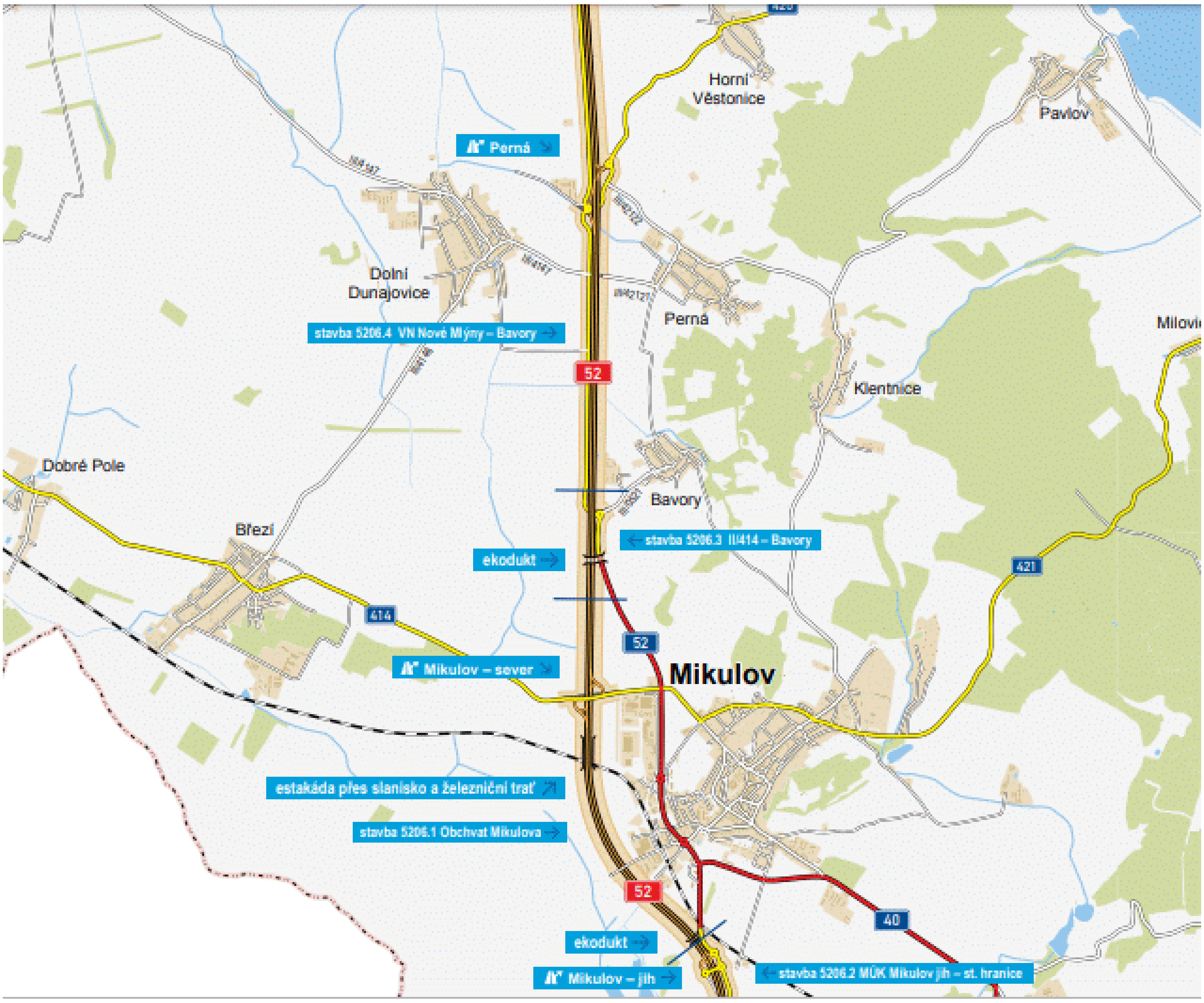
Regardless of the construction of high-speed line, it is necessary to modernize the Brno Railway Node. As part of the construction of the railway junction in Brno, new stops Brno-Vídeňská, Brno-Černovická Terasa and Brno-Letiště Tuřany will be built. Stations of Brno-Židenice and Brno-Slatina will be modernized.

3.5.2. Road transport

Development scenario 2030

The largest road transport construction in the South Moravian Region is the D52 motorway from Brno southwards in direction to Vienna. This road connection is of international importance and within the transport infrastructure of the TEN-T Baltic Adriatic corridor (PL/CZ – Ostrava – Brno – CZ/AT) and Orient/East-Med corridor (DE/CZ - Prague – Brno – CZ/SK).

Fig. 20. Motorway D52 in direction to Vienna



Source: https://zdopravy.cz/pravni-bitva-o-d52-mikulova-rsd-ma-opet-uzemni-rozhodnuti-ktere-napadl-rakousky-spolek-69781/

Currently the D1 motorway in the section around Brno is overloaded. Constantly, drivers encounter long waits in traffic congestions. According to the intention of the Ředitelství silnic a dálnic ČR (Road and Motorway Directorate of the Czech Republic - www.rsd.cz), it was decided to enlarge the motorway from four-lane to six-lane. The six-lane motorway should be located in the section Kývalka – Brno.

Other small constructions according to the project of Ředitelství silnic a dálnic ČR (ŘSD) that await the inhabitants of the SMR in the next 10 years are bypasses of municipalities. One of them is bypass of the city of Znojmo, which will improve the overall traffic situation and at the same time bring a positive impact on the ecological situation in the city. The bypass will serve drivers of individual car traffic as well as freight transport driving between the Czech Republic and Austria. Another bypass in the SMR will be in Bučovice. This bypass will serve primarily for drivers who continue their journey towards Slovakia and improve the traffic situation in Bučovice.

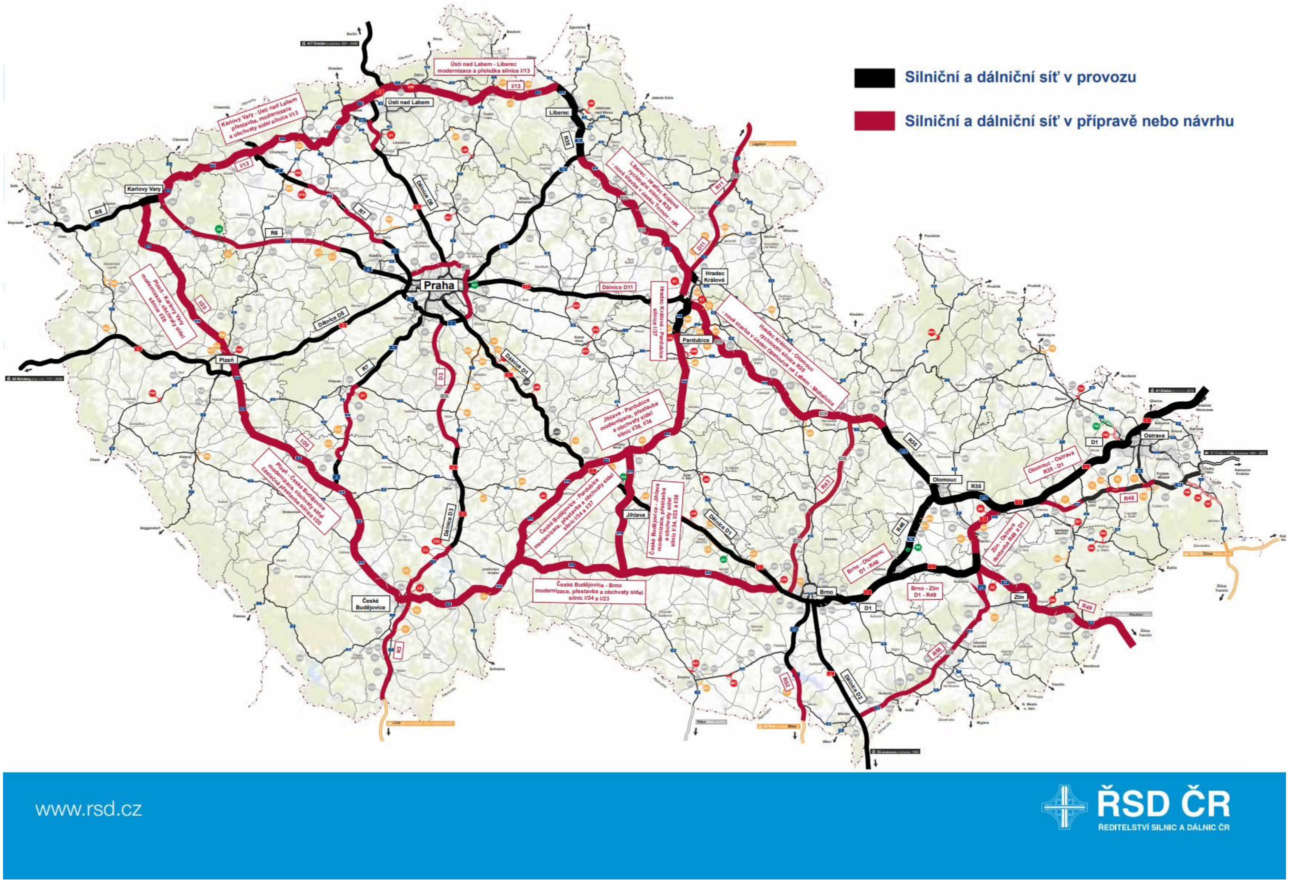
Development scenario 2050

By 2050, according to the project of Ředitelství silnic a dálnic ČR (Road and Motorway Directorate of the Czech Republic), the Břeclav bypass will be completed. Traffic from Svitavy towards Vienna will be resolved by the D43 expressway. This road will be connected to the D1 motorway.

Fig. 21. Motorway D43

Source: https://zdopravy.cz/jihomoravsti-zastupitele-uvolnili-cestu-pro-d43-prisly-tisice-pripominek-60677/

Fig. 22. Motorway and road network according to the ideas of the Road and Motorway Directorate of the Czech Republic



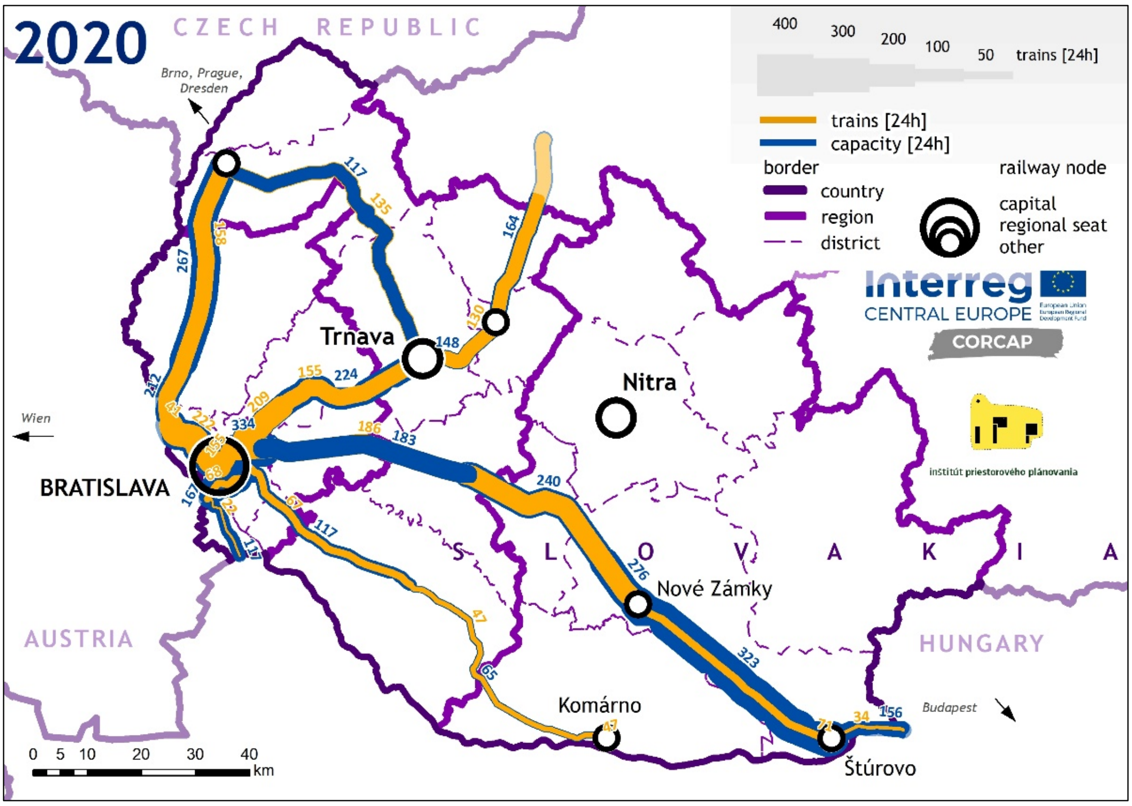
Source: https://zpravy.aktualne.cz/ekonomika/doprava/nova-sit-dalnic-ma-spojit-krajska-mesta-a-vynechat-prahu/r~5d223bc058dd11e894960cc47ab5f122/

3.6. Development scenarios in the region of South-West Slovakia

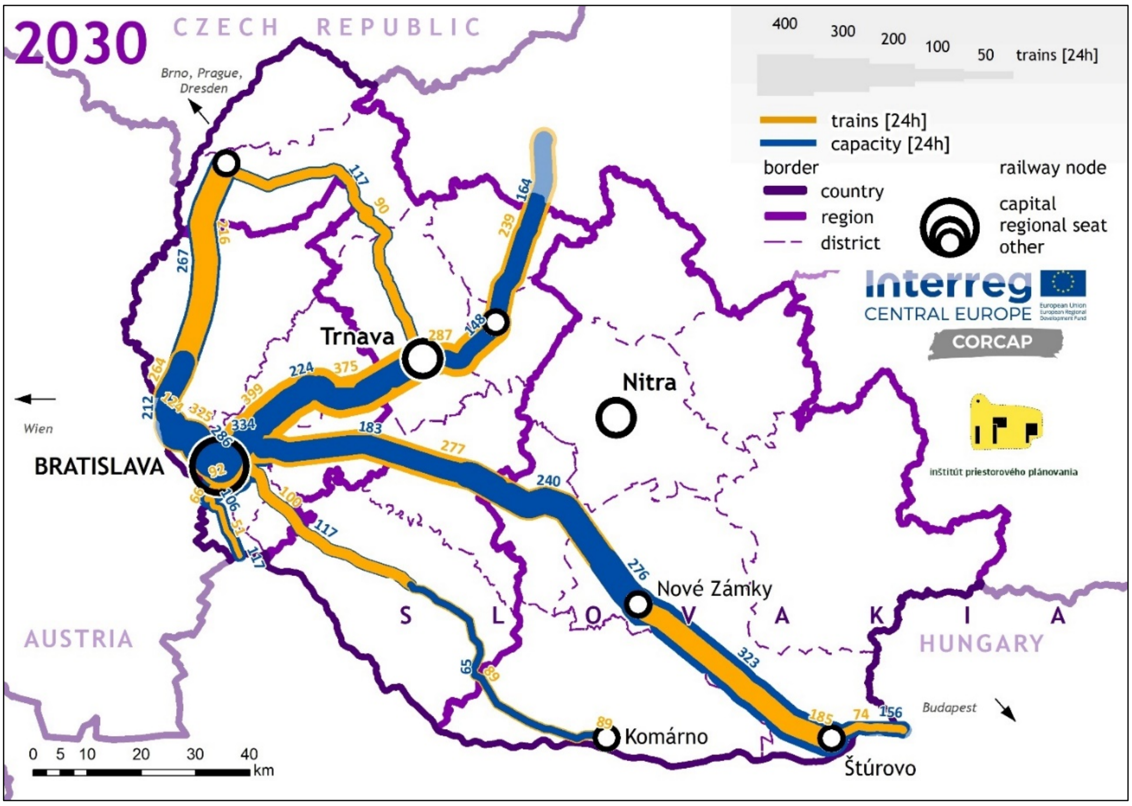
The Regional Sustainable Mobility Plan of Bratislava Region (SGS 2019) foresees a substantial increase in supply in the regional passenger transport, together with a more significant reduction of individual car transport so that in 2050 the sharing of transport work between public and individual passenger transport in a ratio of 50%:50% is achieved. This target has also been set in line with the EU's carbon footprint reduction target. Such an intention will essentially require existing as well as further capacity of railway lines and facilities in this region devoted precisely to passenger transport. This will directly result in a very large lack of transport capacity on central railway lines in Bratislava (especially main railway station and station Bratislava–Nové Mesto) for the needs of the rail freight transport.

Due to this reason a quantitative analysis of the use of these lines was carried out and a comparison of the existing number of trains and the established throughput of the track sections was carried out (based on the data of ŽSR - Slovak Railway Company). This overall assessment did not consider the sub-limit of throughput, especially in station sections. Analyses show that without further development of the transport structure of the Bratislava Railway Node, the existing volume of rail freight transport will decrease. This is documented by the following maps – for years 2020, 2030 and 2050.

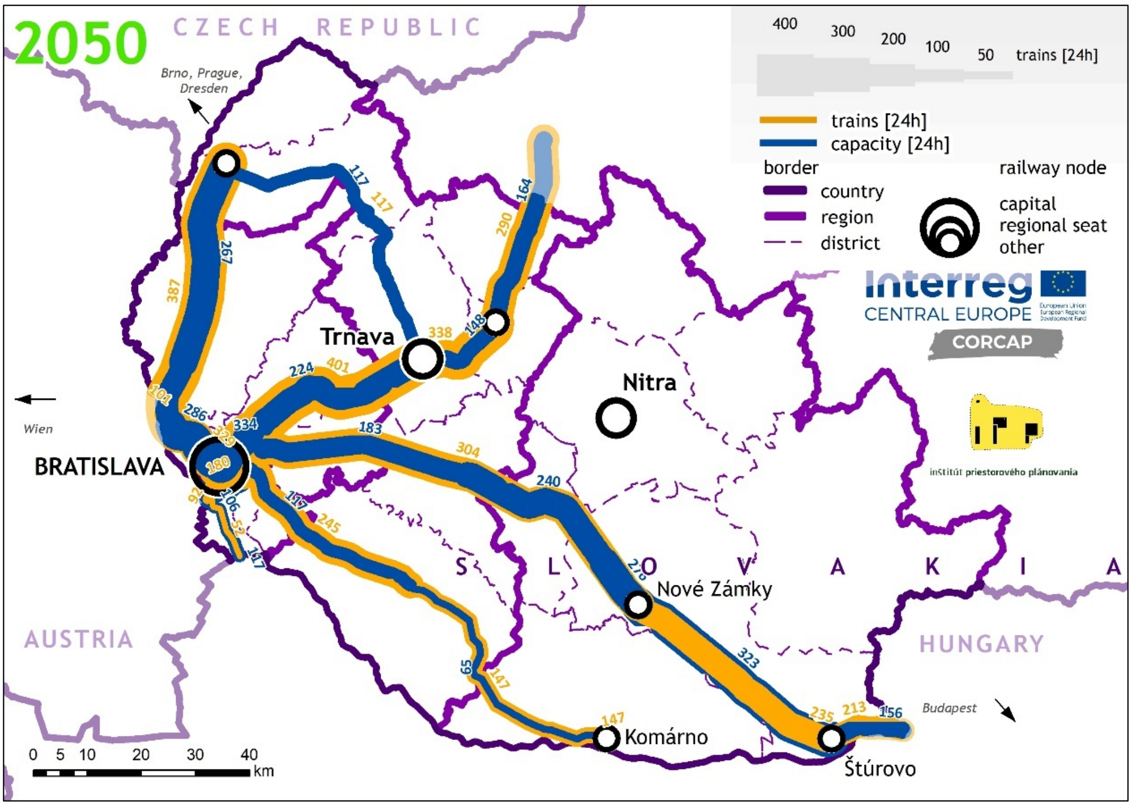
Map 15. Load capacity of individual track sections – 2020



Map 16. Load capacity of individual track sections – prognosis 2030



Map 17. Load capacity of individual track sections – prognosis 2050



Quantitative analyses were the basis for setting road and rail freight development **scenarios** for 2030, 2050 and 2070. In each scenario several **variants for possible development of railway network** were set for SW Slovakia:

- Scenario 2030
    - Variant 0 - without any additional investment activities and without interference with natural cargo growth, without limiting and interfering to the modal split between rail and road freight transport. Only the approved investment plans have been considered
    - **Variant 1** - this variant includes the possibility of partially adding new rail freight capacities via the 128 (116) track between Kúty and Senica. In this case, targeted restrictions on road freight transport can already be considered.
- Scenario 2050
    - Variant 0 - practically identical to Variant 0 in scenario 2030
    - The Tangential Variant is based on the operation of rail freight along perimeter track Nr. 116. This variant seems more appropriate from the point of view of the substantial segregation of long-distance freight transport, especially from passenger transport passing through the territory of Bratislava
    - The basis of the **Radial Variant** is the focus on the Bratislava Railway Node, in particular the routing of rail freight transport using the line Nr. 126 (110) and the provision of a bypass of key point - Bratislava main railway station.
- Scenario 2070
    - **Tangential-Radial Variant** – its aim should be a combination of Tangential And Radial Variant.

The time horizon 2070 has character of a prognosis, for setting of which it will be necessary to proceed after discussion of the above-mentioned development scenarios by 2050.

The fulfilment of the forthcoming aims of Bratislava Self-governing Region with its requirements to strengthen passenger rail transport in the Bratislava Region will also have a major impact on the permeability of railway tracks. This intention with the goal of limitation of individual car transport on regular journeys for work, school, and leisure, will result in the use of all available permeability reserves of railway lines (especially in the section of the track Devínska Nová Ves – Bratislava main station – Rača) for the needs of regional rail passenger transport. This will cause a need of searching for another route in the direction NW – SE through this territory.

3.6.1. Development scenario 2030

In the railway sector, the investment activity is extremely time consuming, given the linear nature of these buildings, which are extremely difficult to place in highly urbanized areas. The estimated period from its drawing in the valid urban spatial plan to its implementation and commissioning takes 7 to 12 years. Separate problem is to reconstruct and modernise existing transport facilities for achieving better transport performance and speed. In all measures and proposals only current transport technology is involved.

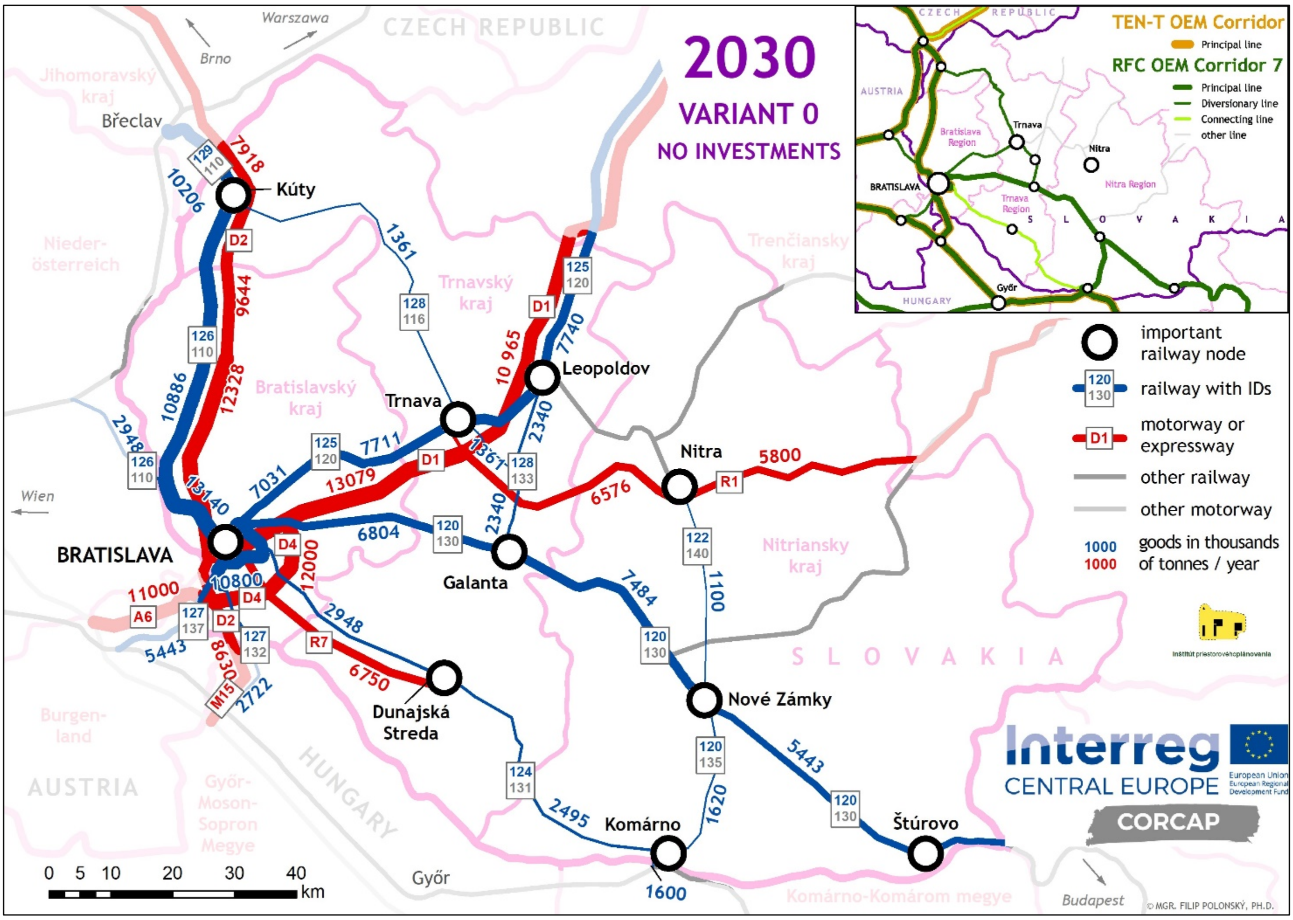
VARIANT 0 – DO NOTHING (EXC. ALREADY APPROVED)

Scenario 2030 - Variant 0 – no investments, excl. the already approved investments

Only those actions which are part of the existing railway infrastructure development plans and were already approved are included at this stage.

- Full utilization of the existing lines
- Construction of the third track on the Bratislava main station - Devínska Nová Ves, including the 3rd Lamač Tunnel
- Upgrading the existing lines and infrastructure, line speeds 140 km/h
  - Track Nr. 120 (130) Bratislava – Nové Zámky – Štúrovo – SK/HU
  - Track Nr. 126 (100) Devínska Nová Ves – Marchegg (AT), electrification and adding a second rail
  - Track Nr. 126 (110) Bratislava - Kúty – SK/CZ

Map 18. Rail and motorway network load forecast (density of trains/lorries in mil. t/year) for Variant 0 by 2030



Source: Institute of Spatial Planning

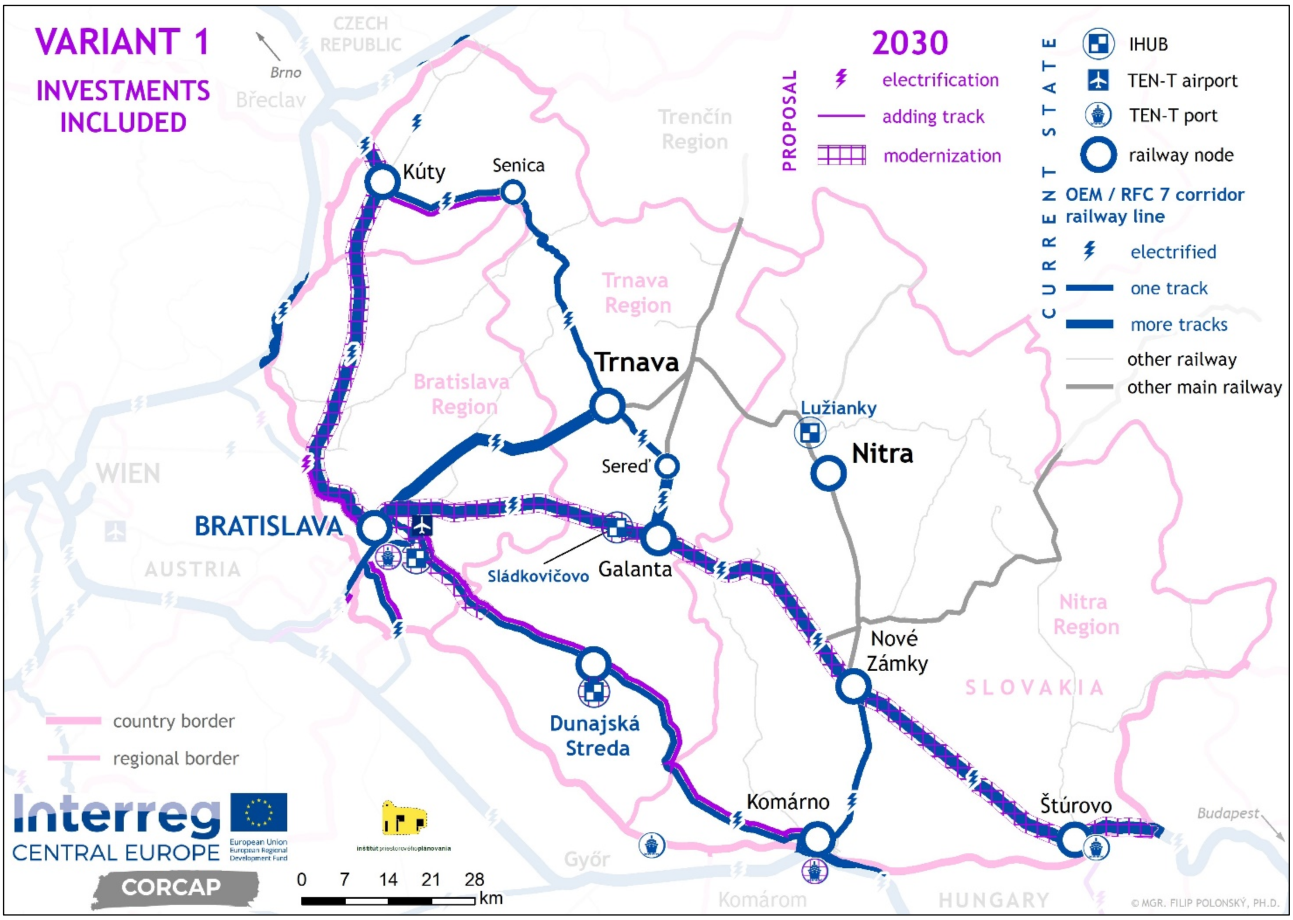
VARIANT 1 – INVESTMENTS INCLUDED

This variant includes the possibility of adding new rail freight capacities via the Kúty – Trnava – Galanta track.

Investments include:

- Construction of the third track on the section Bratislava main railway station - Devínska Nová Ves, including the 3rd tunnel in Lamač
- Upgrading of existing tracks and its equipment, track speed of 140 km/h (unless otherwise specified)
    - Track Nr. 120 (130) Bratislava – Nové Zámky – Štúrovo – SK/HU
    - Track Nr. 124 (131) Bratislava – Dunajská Streda – Komárno, second track construction, track speed 110 km/h, partially modernization (within Bratislava region)
    - Track Nr. 126 (100) Devínska Nová Ves – Marchegg (AT), electrification and second track construction
    - Track Nr. 126 (110) Bratislava - Kúty – SK/CZ
    - Track Nr. 128 (116) Kúty – Senica – Trnava, partial second track construction (to Senica), track speed 110 km/h

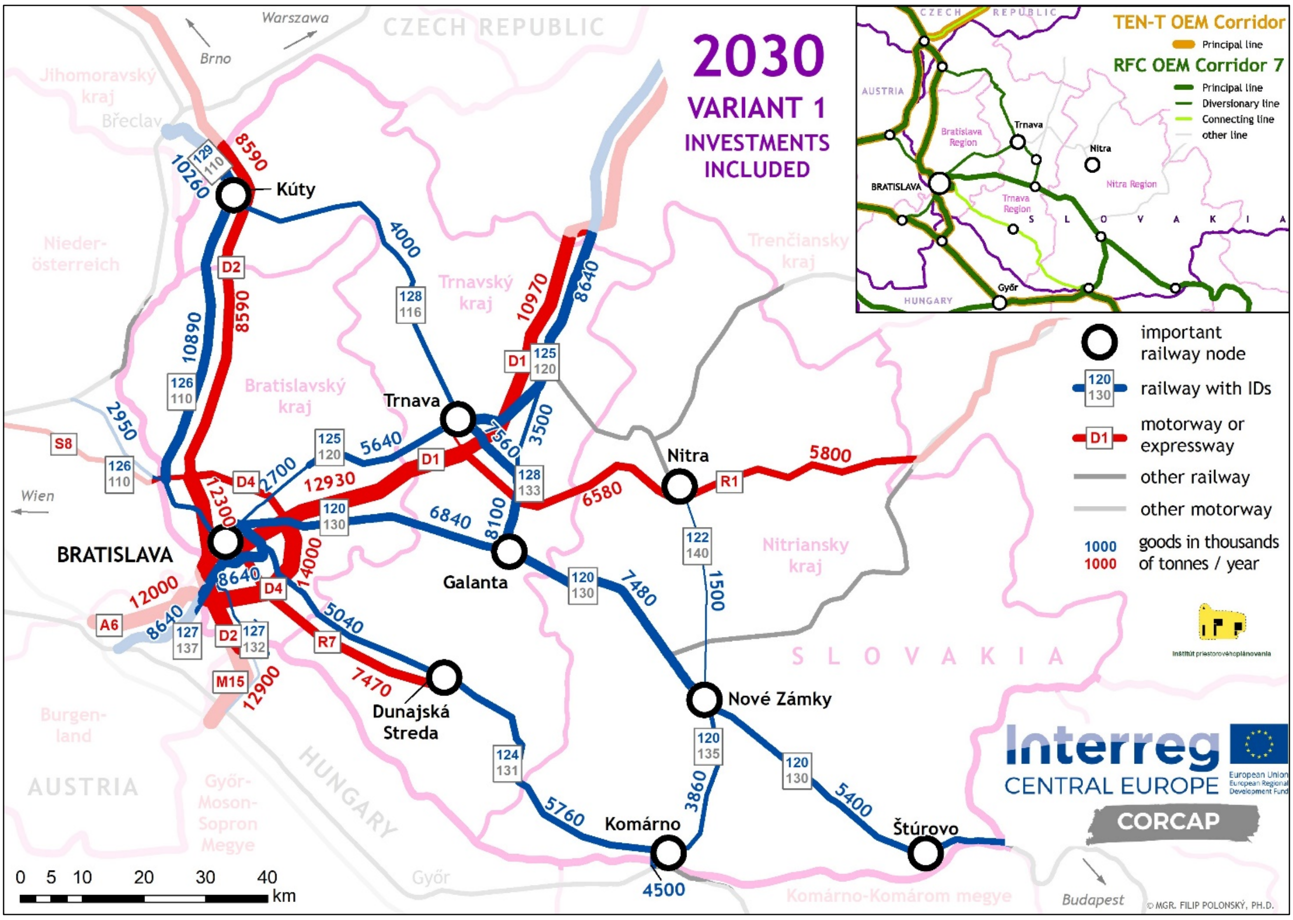
Map 19. Necessary investments in railway infrastructure for implementation of the Variant 1 by 2030



Source: Institute of Spatial Planning

- Construction of a branch (triangel) from track Nr. 124 (131) Bratislava – Dunajská Streda – Komárno, near Komárno towards Hungary
- Modernization of the Danube ports in Bratislava and Komárno
- Improvement of intermodal terminals in Bratislava, Dunajská Streda and Sládkovičovo

Map 20. Rail and motorway network load forecast (density of trains/lorries in mil. t/year) for Variant 1 by 2030



Source: Institute of Spatial Planning

3.6.2. Development scenario 2050

In the vision of 2050, possible variants for ensuring the sufficient capacity for rail freight transport in the NW – SE direction were assessed. The key area that rail freight transport has to bypass is the Bratislava main railway station as well as the follow-up sections of the railway lines. Three variants and two subvariants were examined.

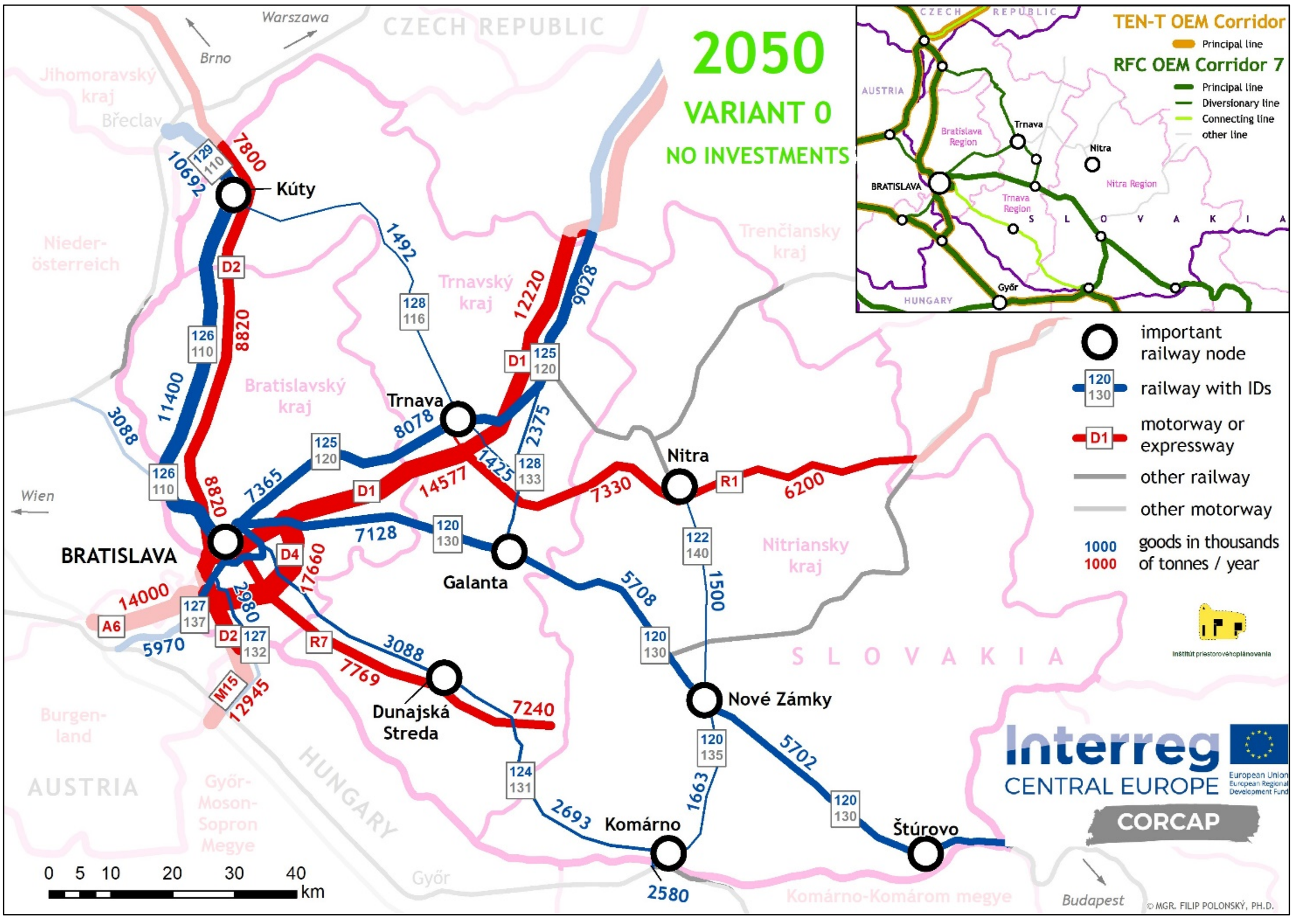
Variant 0 – DO NOTHING (EXCL. ALREADY APPROVED)

Variant 0 (do nothing) uses existing railway lines in the direction to and through Bratislava

The entire railway infrastructure concerned and analysed is almost without investment activity. The natural development of traffic flows as well as the utilisation rate of individual lines are examined. The existing arrangement of the railway infrastructure is naturally of radial nature to/from the Bratislava Railway Node.

- there will be no new investment construction in the future period, except for the necessary operational maintenance ensuring safe and smooth transport
- without interfering into the natural growth of cargo, without limiting and interfering with the sharing of the modal split between rail and road freight
- only those investment actions that are already under construction or their implementation is already agreed are included

Map 21. Rail and motorway network load forecast (density of trains/lorries in mil. t/year) for Variant 0 by 2050



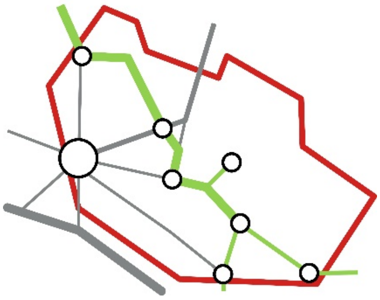
Source: Institute of Spatial Planning

The decisive track section in the whole area is the crossings through the **territory of the Bratislava Railway Node**, in particular the connection from Devínska Nová Ves via Bratislava main station – track Nr. 126 (110) and direction to Pezinok – Trnava, track Nr. 125 (120). These sections are expected to be used as much as possible for suburban passenger and long-distance transport in the future.

For Variant 0, it can be stated that the outlook freight flows will be very significantly restricted to the area of the Bratislava Railway Node. At this state, there is no additional alternative route of sufficient quality and capacity.

Crucial activities are focused on maintaining the continuity of traffic with the as much traffic permeability of tracks and facilities throughout the railway infrastructure as possible.

TANGENTIAL VARIANT



Proposal of the **Tangential Variant** of the railway network development is based on the basic assumption that the railway tracks in the Bratislava Railway Node will be gradually fully utilized for the needs of passenger rail transport of all kinds, or, in addition, the high-speed line corridor will be located here. This assumption was defined by the Regional Sustainable Mobility Plan of the Bratislava Region (SGS 2019).

The Regional Sustainable Mobility Plan of the Bratislava Region (SGS 2019) foresees a substantial increase in supply in the regional passenger transport, together with a more significant reduction of individual car transport so that in 2050 the modal split between public and individual passenger transport is achieved in a ratio of 50:50. This target has also been set in line with the EU's overall carbon footprint reduction target. Such an intention will essentially require both existing and future capacity of railway tracks and facilities in the region to devote precisely to passenger transport. This requirement will directly result in a very large lack of transport capacity on central railway tracks on the territory of Bratislava (passing through the main station and Bratislava main station – Bratislava-Nové Mesto section) mainly for the needs of freight rail transport.

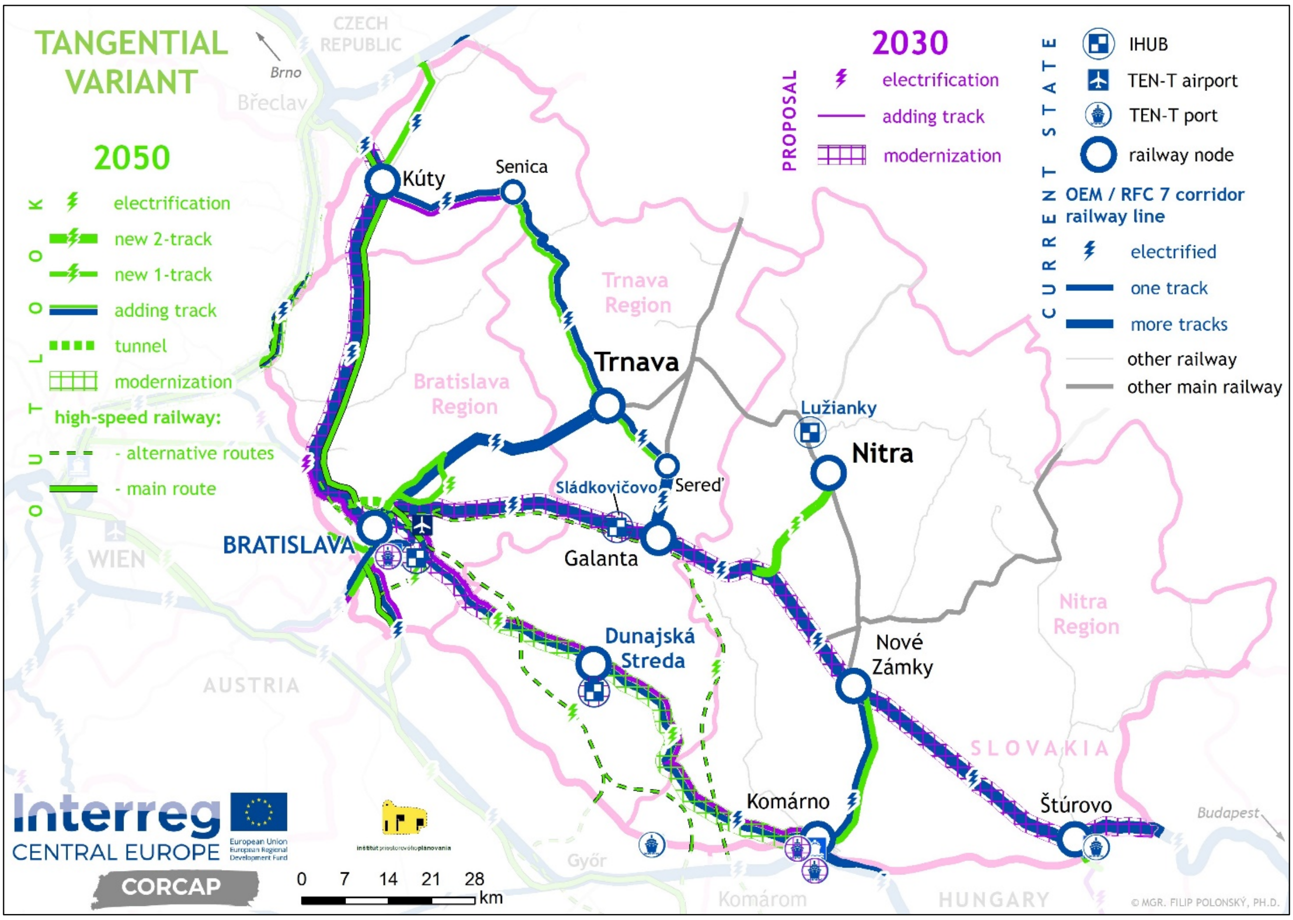
The basis of the **Tangential Variant** is the routing of transit rail freight along the perimeter line CZ/SK - Kúty – Senica – Trnava – Galanta – Nové Zámky – Štúrovo – SK/HU. If this variant is to be used, track Nr. 128 (116) would have to be upgraded to be capable of carrying out the required loads of cargo. This variant seems more appropriate from the point of view of the substantial segregation of long-distance freight transport, especially from passenger transport, which will require a maximum share of throughput for its needs in the Bratislava area.

The decisive **investment/construction** of the **Tangential Variant** is the completion of the second track, modernization, and improvement of the track Nr. 128 (116) Kúty – Senica – Trnava, as well as track Nr. 128 (133) Trnava – Sereď.

Other important constructions, that are necessary to ensure the full functionality of the **Tangential Variant** are the following (using *italics* indicates the activities that are solely part of the above-mentioned Variant 1 for 2030; the projects proposed by this study are marked in **colour**; the standard text indicates the constructions/projects that are part of the existing planning documents):

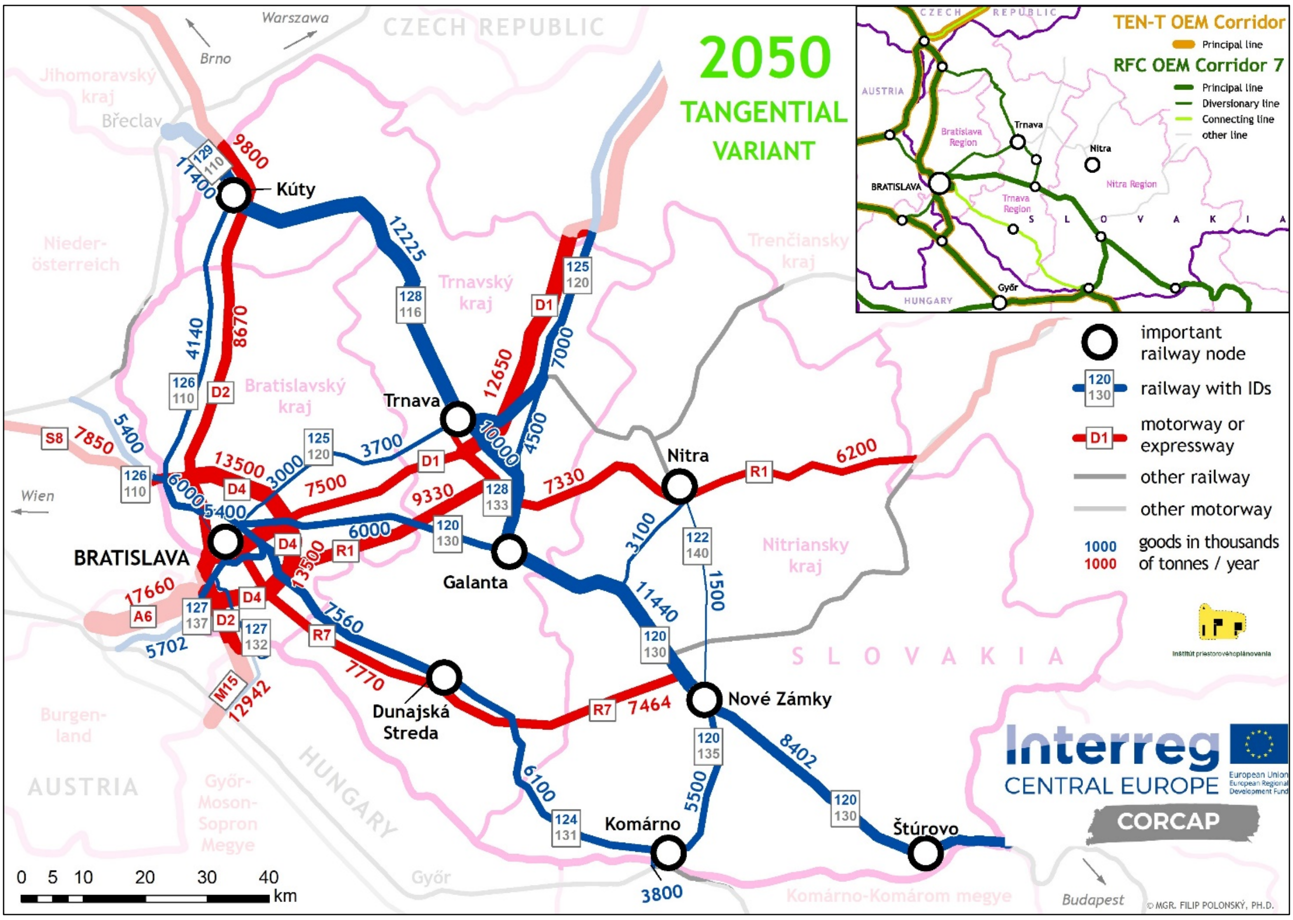
- *Construction of the third track between Bratislava main railway station - Devínska Nová Ves, including the 3rd Bratislava-Lamač Tunnel*
- *Upgrading of existing tracks and infrastructure, line speeds 140km/h (unless otherwise specified):*
  - *Track Nr. 120 (130) Bratislava – Nové Zámky – Štúrovo – SK/HU*
  - *Track Nr. 124 (131) Bratislava – Dunajská Streda – Komárno, second track construction, track speed 110 km/h*
  - *Track Nr. 126 (100) Devínska Nová Ves – Marchegg (AT), electrification and second track construction*
  - *Track Nr. 126 (110) Bratislava - Kúty – CZ*
  - ***Track Nr. 128 (116) Kúty - Senica - Trnava, partially second track construction (to Senica), track speed 110 km/h***
- ***Branch line (triangel) from track Nr. 124 (131) Bratislava - Dunajská Streda - Komárno, near Komárno towards Hungary***
- *Modernization of the Danube ports in Bratislava and Komárno*
- *Improvement of intermodal terminals in Bratislava, Dunajská Streda and Sládkovičovo*
- Rebuilding and modernisation of railway tracks:
  - **Track Nr. 120 (135) - Nové Zámky - Komárno - Komárom (HU), second track construction, including the railway bridge over the Danube**
  - Track Nr. 124 (131) Bratislava – Dunajská Streda – Komárno, electrification
  - **Track Nr. 125 (120) third track on the section Bratislava main railway station - Pezinok**
  - Track Nr. 127 (137) Bratislava-Petržalka – Kittsee (AT), modernization and second track construction
  - **Track Nr. 128 (116) Kúty - Senica - Trnava, fully second track construction - finalisation of the section Senica - Trnava and track Nr. 128 (133) Trnava - Sereď**
  - **Track Nr. 129 (114 a 115) Kúty - Holíč** and **Holíč - Hodonín, modernization**
  - ŽST Bratislava-Filiálka – Bratislava Predmestie, use for the needs of passenger transport
- New sections:
  - New track Bratislava – Vajnory – Pezinok with the dominant use for suburban public transport, which will allow a significant release of the main tracks Nr. 125 (120) and Nr. 120 (130) for long-distance and transit transport
  - New track Trnovec nad Váhom (Nr. 120 [130]) – Nitra, double track with track parameters 120 (130)
  - New railway tunnel under the Little Carpathians between Bratislava-Lamač and Bratislava-Vinohrady
  - High-speed line for passenger and freight rail transport

Map 22. Necessary investments in railway infrastructure for implementation of the Tangential variant by 2050



Source: Institute of Spatial Planning

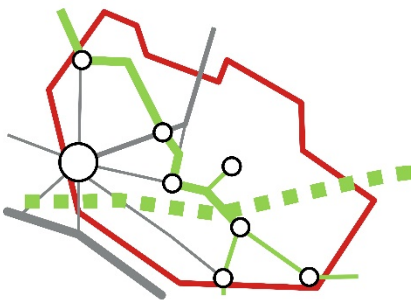
Map 23. Rail and motorway network load forecast (density of trains/lorries in mil. t/year) for Tangential Variant by 2050



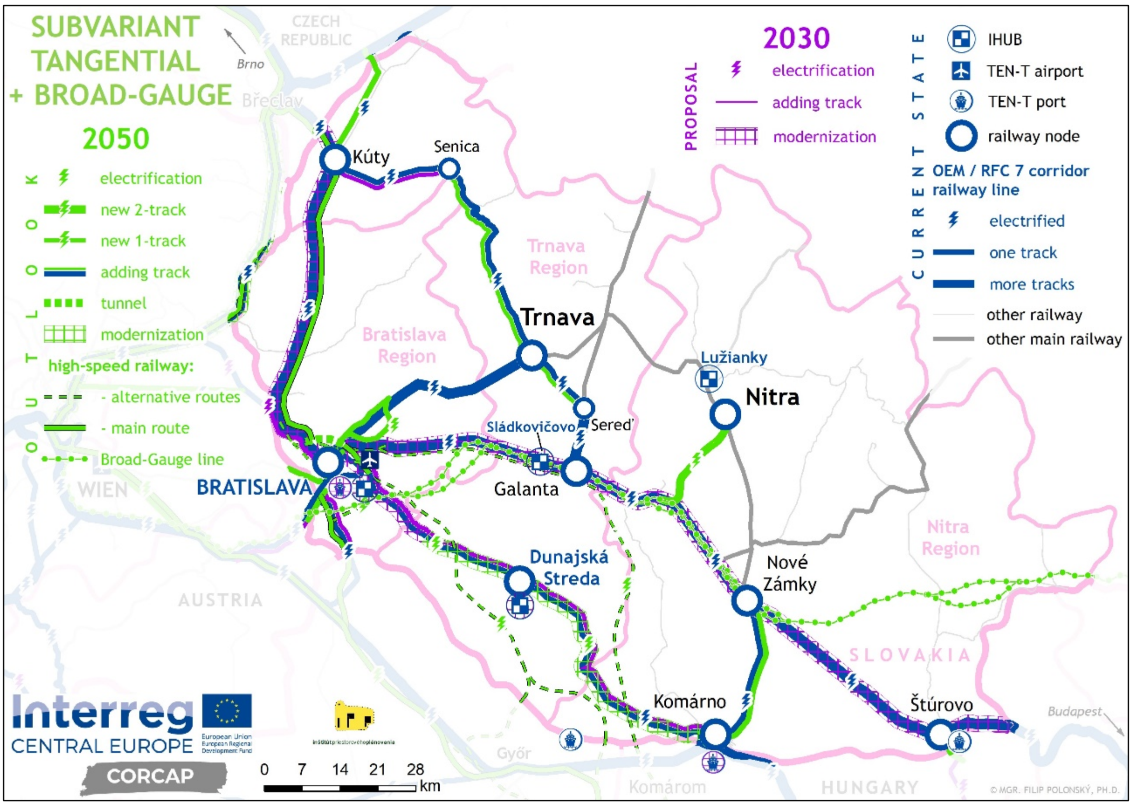
Source: Institute of Spatial Planning

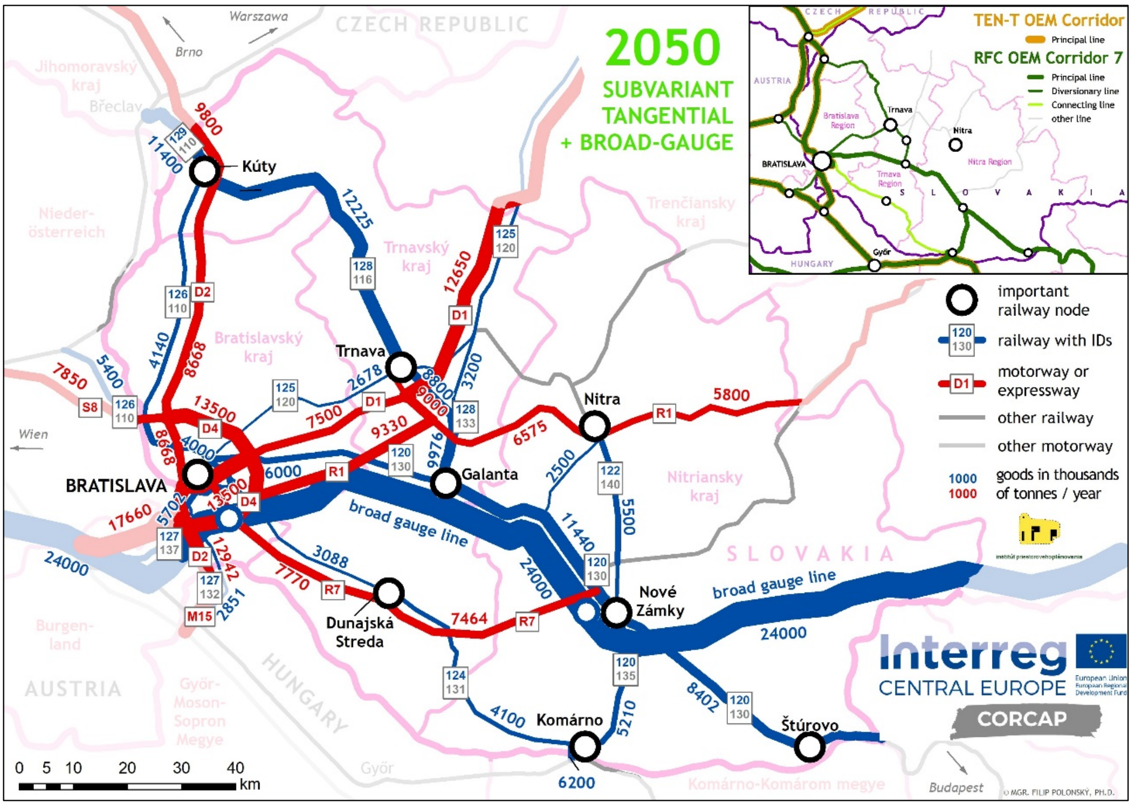
SUBVARIANT TANGENTIAL + BGL

Tangential + BGL Subvariant represents development incorporating the operation of the broad-gauge line, on which load up to 24,000 mil.t/year in two-way operation is assumed.



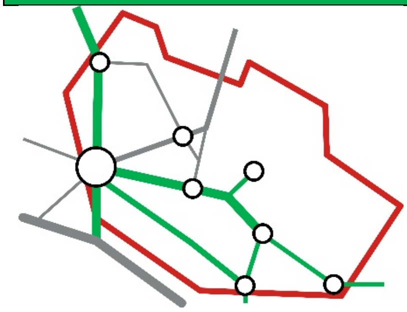
Map 24. Necessary investments in railway infrastructure and rail and motorway network load forecast (density of trains/lorries in mil. t/year) for implementation the Tangential + BGL Subvariant by 2050





Source: Institute of Spatial Planning

RADIAL VARIANT



The basis of the **Radial Variant** is the routing of transit rail freight transport on track Nr. 126 (110) in the direction to Bratislava and the provision of a bypass of a key point (Bratislava main station) by means of a tunnel through the Small Carpathians between Bratislava-Lamač and Bratislava-Vinohrady and further along existing tracks in the direction of Galanta – Nové Zámky – Štúrovo – SK/HU, respectively in the direction Bratislava-Petržalka - Kittsee (AT)/ Rajka (HU). In case of using this variant, it is also necessary to modernize the track Nr. 128 (116) Kúty – Senica – Trnava in order to be able to transfer the required share of freight transport, as well as in case of provision of a suitable alternative in case of reduction of the throughput of railway lines by passenger transport in the Bratislava area. On this track, capacity will not be fully required, as with the Tangential Variant, but it is expected to increase by about 50% on sufficiently long sections.

Main investment actions:

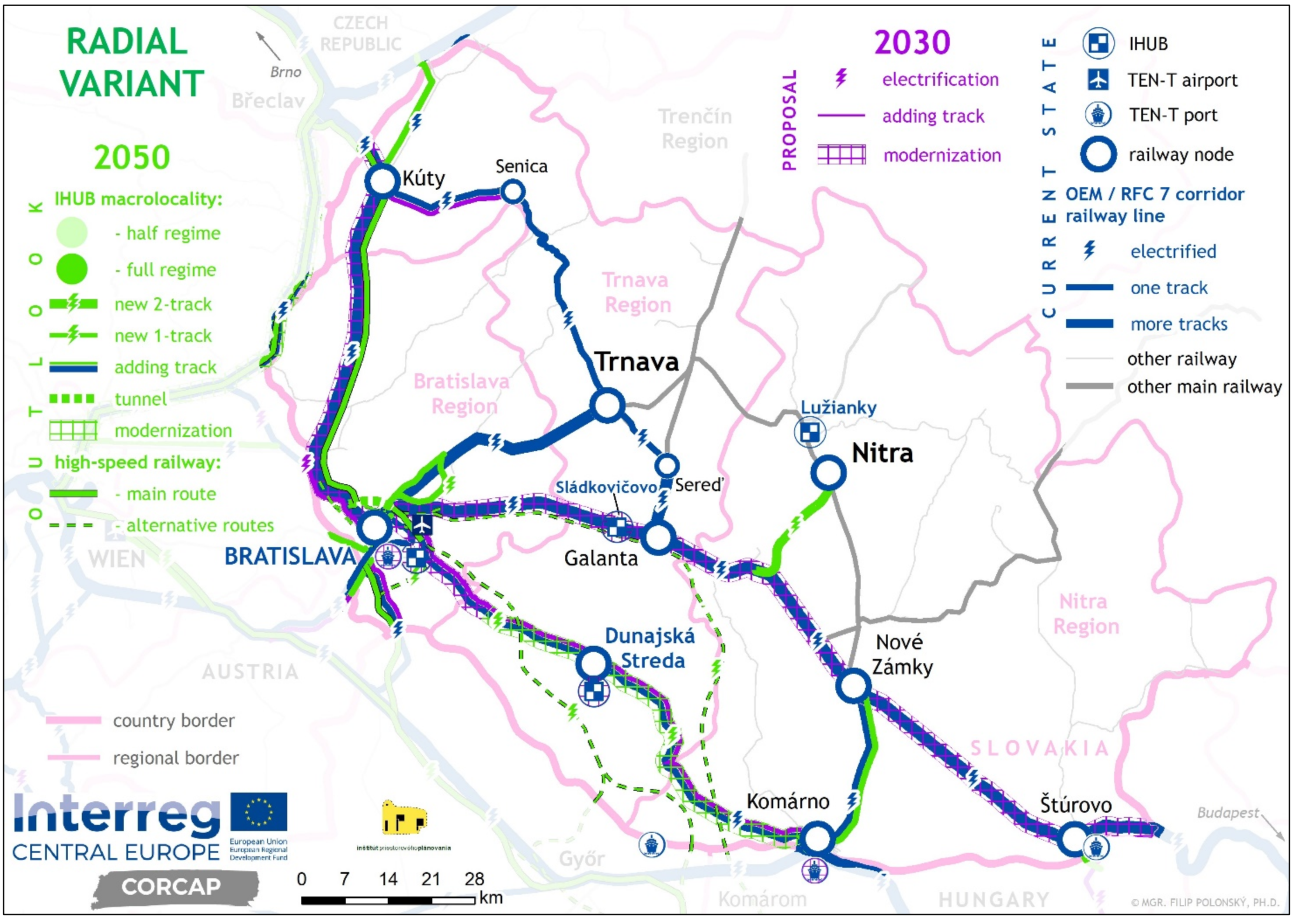
- realization of the Bratislava-Lamač – (Bratislava)-Vinohrady railway tunnel
- investment to radial-led railway lines in the direction to and from Bratislava Railway Node
- increase in capacity of track Nr. 128 (116), construction of second track in the Kúty - Senica section, as an alternative line for rail freight transport, which will not be needed in full capacity as required in the Tangential Variant

Other important constructions, that are necessary to ensure the full functionality of the **Radial Variant** are the following (using of *italics* indicates the activities that are solely part of Variant 1 for 2030; the projects proposed by this study are marked in **colour**; the standard text indicates the constructions/projects that are part of the existing planning documents):

- *Construction of the third track Bratislava main railway station - Devínska Nová Ves, including the 3rd tunnel in Bratislava-Lamač*
- *Upgrading of existing tracks and equipments, line speeds 140km/h (unless otherwise specified):*
  - *Track Nr. 120 (130) Bratislava – Nové Zámky – Štúrovo – HU*
  - *Track Nr. 124 (131) Bratislava – Dunajská Streda – Komárno, second track construction, track speed 110 km/h*
  - *Track Nr. 126 (100) Devínska Nová Ves – Marchegg (AT), electrification and second track construction*
  - *Track Nr. 126 (110) Bratislava - Kúty – CZ*
  - ***Track Nr. 128 (116) Kúty - Senica - Trnava, partially second track construction (to Senica), track speed 110 km/h***
  - ***Branch line (triangel) from track Nr. 124 (131) Bratislava - Dunajská Streda - Komárno, near Komárno towards Hungary***

- *Modernization of the Danube ports in Bratislava and Komárno*
- *Improvement of intermodal terminals in Bratislava, Dunajská Streda and Sládkovičovo*
- Rebuild and modernisation of railway tracks:
    - **Track Nr. 120 (135) Nové Zámky – Komárno – Komárom (HU), second track construction, including the railway bridge over the Danube**
    - Track Nr. 124 (131) Bratislava – Dunajská Streda – Komárno, electrification
    - Track Nr. 125 (120) third track on the section Bratislava main railway station - Pezinok
    - Track Nr. 127 (132) Bratislava-Petržalka – Rajka (HU), modernization and second track construction
    - Track Nr. 127 (137) Bratislava-Petržalka – Kittsee (AT), modernization and second track construction
    - **Track Nr. 128 (116) Kúty - Senica - Trnava, throughput increase, partial modernization**
    - **Track Nr. 129 (114 a 115) Kúty - Holíč a Holíč - Hodonín, electrification and modernization**
    - ŽST Bratislava-Filiálka – Bratislava-Predmestie, use for the needs of passenger transport

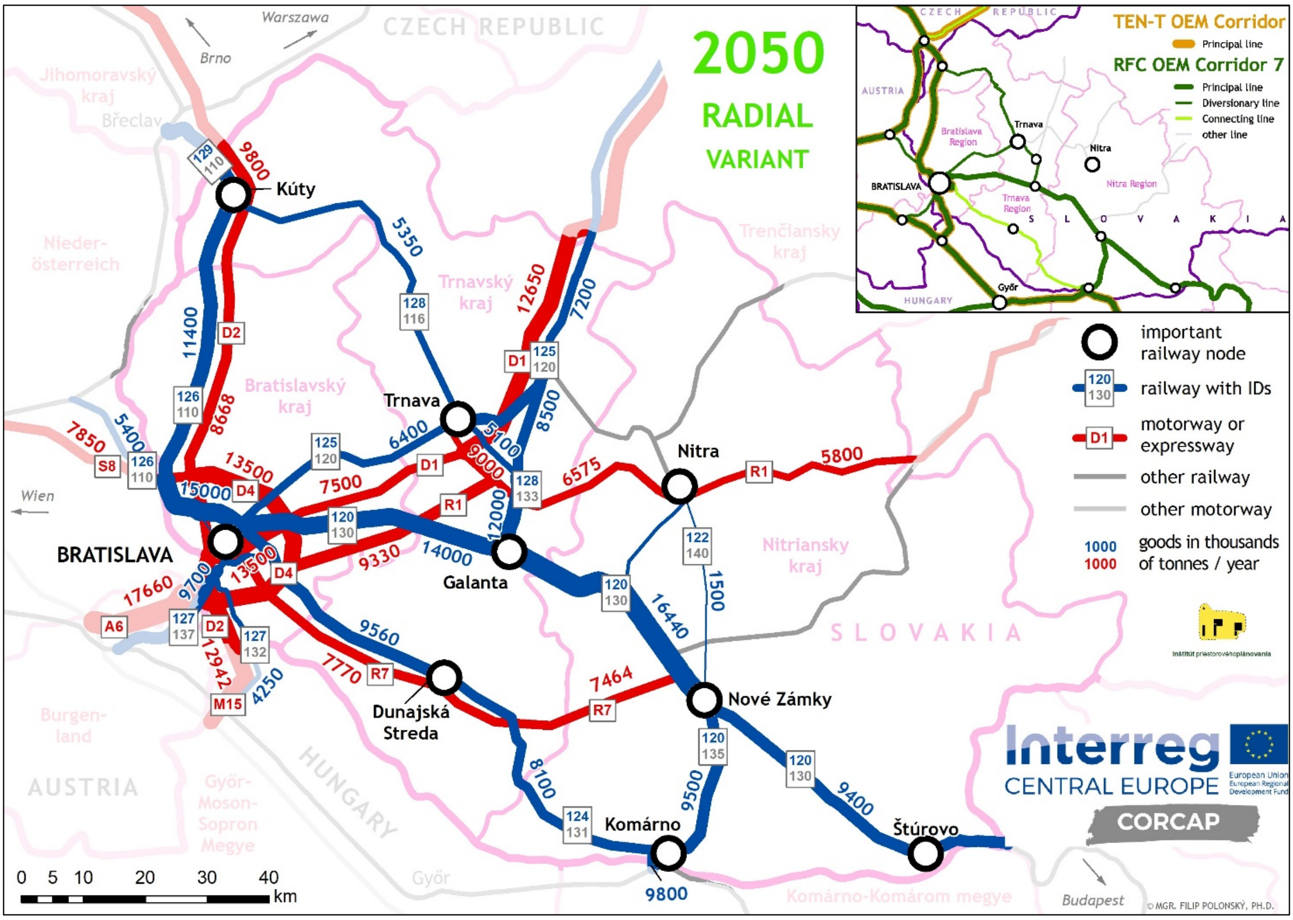
Map 25. Necessary investments in railway infrastructure for implementation of the Radial variant by 2050



Source: Institute of Spatial Planning

- New sections:
    - Railway tunnel Bratislava–Lamač – (Bratislava)-Vinohrady
    - New track Trnovec nad Váhom (track Nr. 120 [130]) – Nitra, double track with track parameters 120 (130)
    - New track Bratislava – Vajnory – Pezinok with the main use for suburban public passenger transport, allowing substantial release of major tracks Nr. 125 (120) and 120 (130) for long-distance and transit traffic
    - High-speed line for passenger and freight rail transport

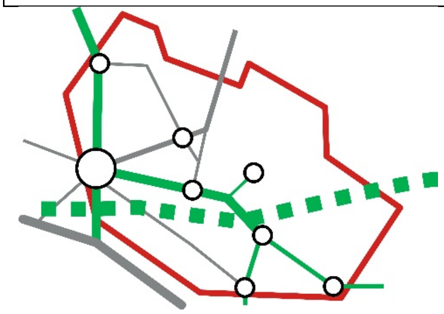
Map 26. Rail and motorway network load forecast (density of trains/lorries in mil. t/year) for Radial Variant by 2050



Source: Institute of Spatial Planning

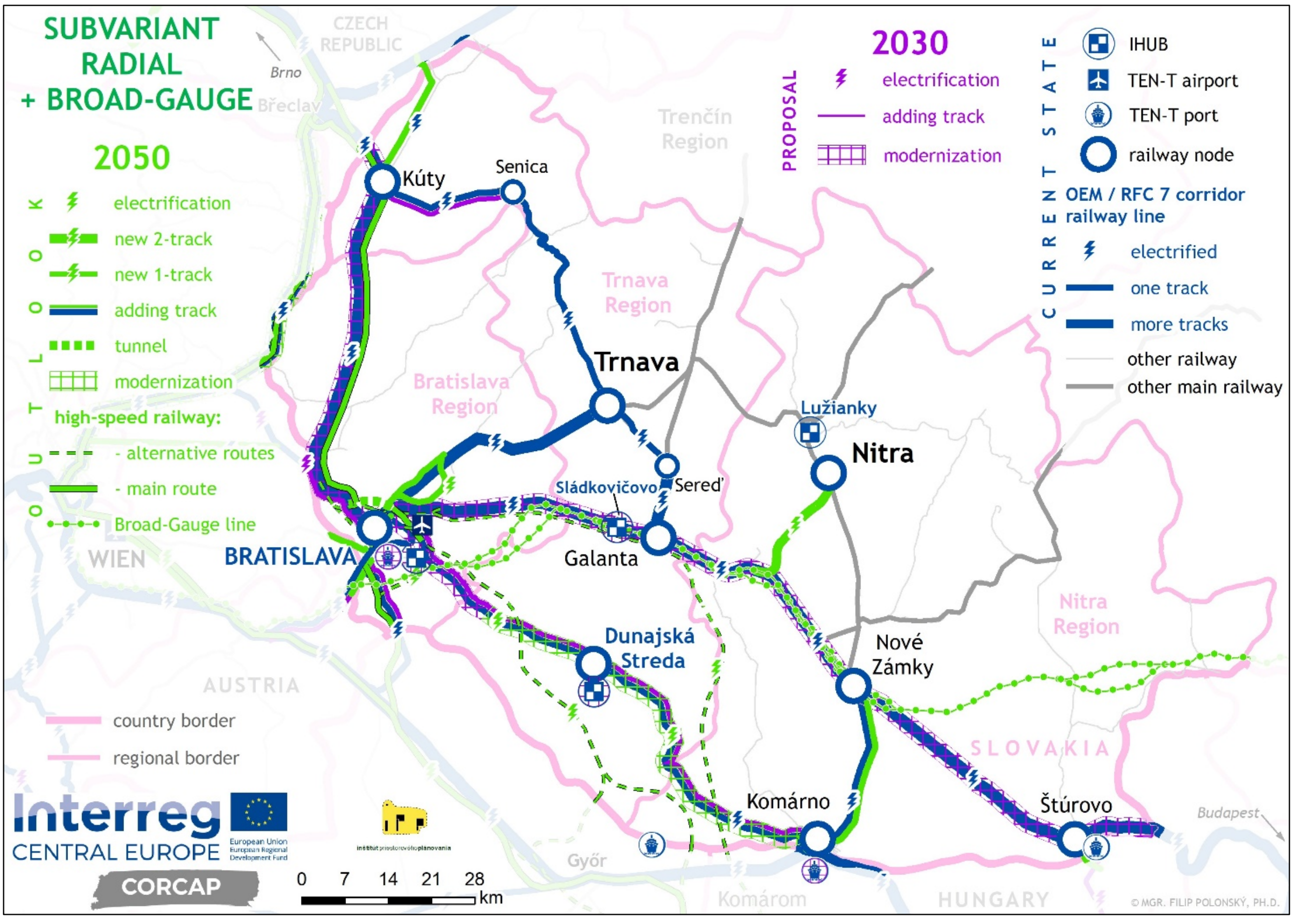
The selection and decision of implementation from the presented variants will mean their comprehensive evaluation, especially from the points of view of transport, technical feasibility, investment intensity, environmental impacts and, in particular, in terms of preference for the overall direction of rail freight transport. The implementation of the broad-gauge line in the east-west direction will bring completely new perspectives and requirements for the future direction of freight transport in the region.

SUBVARIANT RADIAL + BGL



Subvariant Radial + BGL (broad gauge line) represents a combination of Radial Variant with the addition of a new broad-gauge line (in E-W direction). This subvariant creates greater possibilities and flexibility in the area of the Bratislava Railway Node as well as the involvement of the port in Bratislava in cargo transport in connection with long-distance transport.

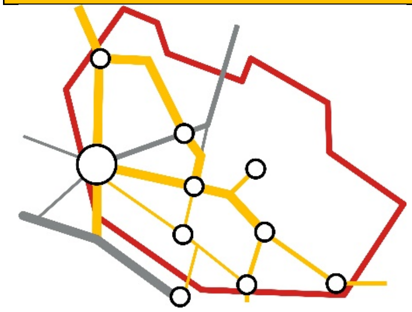
Map 27. Necessary investments in railway infrastructure for implementation the Radial + BGL Subvariant by 2050



Source: Institute of Spatial Planning

3.6.3. Development scenario 2070

TANGENTIAL-RADIAL VARIANT

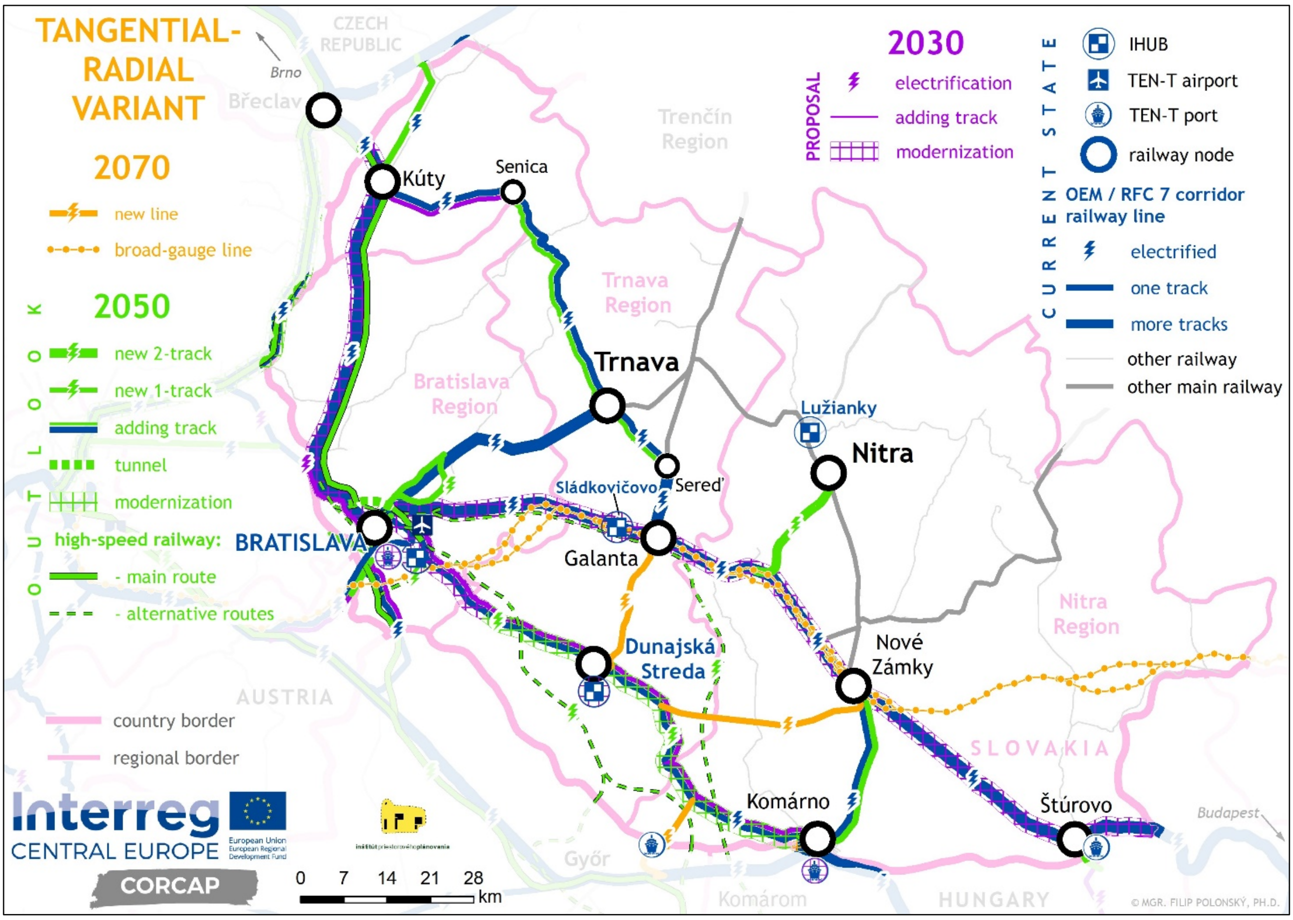


In a more distant view - **vision** (until 2070) we consider a combination of the Radial and Tangential Variants into the so-called **Radial-Tangential Variant**. The basis is to conduct rail freight transport on track Nr. 126 (110) in the direction to Bratislava and to ensure the bypass of a key place (Bratislava main railway station) by a new railway route, a tunnel through the Little Carpathians between Bratislava-Lamač – railway tunnel – Bratislava-Vinohrady and further along existing tracks in the direction of Galanta – Nové Zámky – Štúrovo – SK/HU, respectively in the direction Bratislava-Petržalka - Kittsee (AT) / Rajka (HU).

In addition, other projects will need to be considered in 2070:

- New track interconnections – Galanta with Dunajská Streda and Győr, and Dunajská Streda with Nové Zámky
- Use of new transport and cargo technologies
- Railway bridges over the Danube in Komárno (second bridge in the east of the city, or alternatively a railway bypass on the north of the city) and Medveďov with adjacent sections of railway tracks
- Broad-gauge line (if not built by 2050)
- High-speed line for passenger and freight rail transport (if not built by 2050)

Map 28. Necessary investments in railway infrastructure for the implementation of Tangential-Radial Variant by 2070



Source: Institute of Spatial Planning

4. CONCLUSIONS AND RECOMMENDATIONS

The aim of the study was to model the development of rail and road freight transport within the CE CENTROPE region by 2050, respectively with a vision for 2070, with a more detail for South Moravian Region and SW Slovakia.

Within CE CENTROPE region, analyses of the accessibility of municipalities to individual points of the transport network were carried out.

Within the South Moravian Region, a quantitative and qualitative survey of long-distance road freight transport was carried out. Survey was supplemented by a basic analysis of rail freight transport. A quantitative analysis was carried out for the territory of Southwest Slovakia. Using the extrapolation of current data, it was possible to set projected capacities of transport networks, their load and usability, with a particular focus on rail transport.

The analyses were the basis for establishing **scenarios for the road and rail freight transport development** by 2050 for South Moravian Region and by 2030, 2050 and 2070 for SW Slovakia.

4.1. Summary and conclusions for South Moravian Region

Part of the South Moravian Region (SMR) analyses was also a **quantitative survey of long-distance road freight transport** with the aim of mapping the **intensity of road freight transport** on the main roads of the SMR (processed by the Masaryk University in Brno). This was followed by a **qualitative survey of long-distance road freight transport** (the processor was KORDIS), the purpose of which was to find out information about **the origins and destinations of trucks** passing through the SMR, primarily along the axis of the Orient/East-Med Corridor and to find out other necessary data on cargo, drivers, etc.

Břeclav - Prague route can be considered as the busiest, while routes Břeclav – Ostrava, Prague – Ostrava and Vienna – Ostrava are the other busy routes. The largest number of respondents were drivers who headed from Hungary to Germany and vice versa. These were followed by drivers from Romania or Slovakia to Germany and from Hungary to the Czech Republic. In terms of commodities, it can be concluded that materials, raw materials, car parts, food and cars predominate. The research has clearly confirmed the **strong demand for the TEN-T corridor route** from the Balkan to northern Germany and partly to Western Europe (Nuremberg and Stuttgart).

On the basis of the above-mentioned analyses, the following development in the network of railways and roads were assessed for the South Moravian Region:

- Development scenario 2030
    - the **key project** is the completion of the **construction of high-speed line VRT South Moravia** (Vranovice – Brno) and the **modernization of the Brno - Přerov line** (enabling speed up to 200km/h)
    - local projects (new branches and connectors, improvement of parameters and construction of second tracks of selected lines)
    - in road transport, the largest construction is the D52 motorway to Vienna, but also bypasses of municipalities (Znojmo, Bučovice)

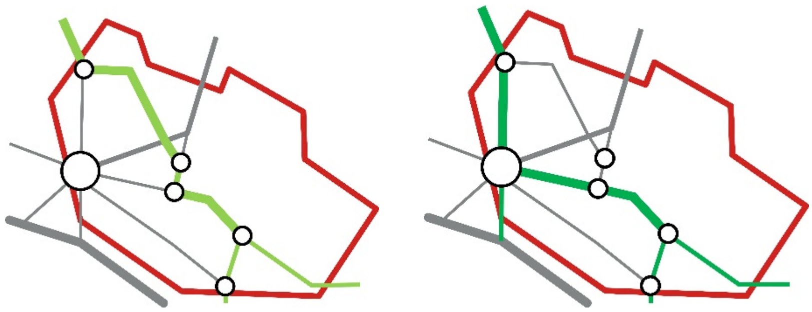
The main benefit of the high-speed line construction is to increase the capacity of regional lines. These will get enough capacity for freight, regional and suburban trains. This will allow better cargo transport not only in the region, but also throughout the Czech Republic.

- Development scenario 2050
    - construction of the high-speed line VRT Vysočina - Phase 1 towards Prague
    - freight connection between Lanžhot and Ladná, which will allow a bypass of the Břeclav node
    - local projects – new line Hrušovany nad Jevišovkou – Vranovice and completion of electrification of the line Zastávka – Třebíč
    - the Brno Railway Node will be completed
    - in road transport, the largest construction is the D43 motorway – Svitavy – D1 motorway, but also the Břeclav bypass

4.2. Summary and conclusions for the region of South-West Slovakia

On the basis of the analyses mentioned in the Chapter 3, **variant solutions** for possible **network development** have been established for the region of SW Slovakia:

- Scenario 2030
    - Variant 0 - represents a situation where no additional investments are made in the development of railway infrastructure, except of already approved projects. It is clear from the analyses that staying in the current state will result in a lack of permeability on several railway lines
    - **Variant 1** - includes the possibility of adding new rail freight capacities via the 128 (116) track between Kúty and Senica
- Scenario 2050
    - Variant 0 - practically identical as Variant 0 in the scenario 2030 (in this variant it is expected a continuous increase in cargo even after 2030)
    - The basis of the Tangential Variant is the routing of transit rail freight transport using bypass outside the Bratislava Region, through the territory of Trnava Region. This variant seems more appropriate from the point of view of the substantial segregation of long-distance freight transport from passenger transport passing through the territory of Bratislava. The **key project** is **construction of second track** and **improving the railway tracks 128** (116, partly 133) **Kúty - Senica - Trnava - Sereď - Galanta**
    - The basis of the **Radial Variant** is the focus on the Bratislava Railway Node, in particular the routing of rail freight transport using the line Nr. 126 (110) and the provision of a bypass of key point - Bratislava main railway station. The **key investment** of this variant is the **construction of railway tunnel Bratislava-Lamač - Bratislava-Rača**
    - It is also meaningful to consider the intention to extend the broad-gauge line from Ukraine to Austria through the south of Slovakia. This is considered in the subvariants of the Tangential and Radial Variant.
- Scenario 2070
    - **Tangential-Radial Variant** – its aim should be to complete transport infrastructure projects defined both in the Tangential and Radial Variants.



In addition, also other projects necessary to ensure the continuity of freight transport in the outlook were identified:

- Modernizations of key railway lines 126 (110) and 120 (130), 120 (135) Nové Zámky – Komárno – Komárom, and 124 (131) Bratislava – Dunajská Streda – Komárno
- New railway line Trnovec nad Váhom – Nitra, which will "make accessible" the regional city of Nitra and the entire industrial region of Upper Nitra Region by rail transport
- Road transport - D4 motorway tunnel through Little Carpathians with connection to the motorway network in Austria and expressway R7 Holice – Nové Zámky
- Modernization of ports in Bratislava and Komárno and increasing the quality of intermodal terminals in Bratislava, Dunajská Streda and Sládkovičovo.

4.3. Recommendations

Recommendations at transnational and cross-border level

- We propose to transfer the transit of the freight rail transport of OEM corridor via bypass along the route CZ/SK - Kúty - Senica- Trnava – Sereď - Galanta - Nové Zámky - Komárno / Štúrovo - SK/HU
- In the cross-border areas of Břeclav - Kúty, in Bratislava, Komárno and Štúrovo surroundings we recommend making modifications of railway lines and rail facilities to make cross-border freight transport more efficient
- We recommend adoption of legislation at EU level that favours, in particular, long-distance rail freight transport over road transport
- We recommend considering connecting the TEN-T OEM corridor by extending the broad-gauge line routing from Ukraine through the south of Slovakia to Austria by creating an intermodal terminal of international importance in the Nitra region (Nové Zámky)
- Support the construction of high-speed line for passenger as well as freight transport
- Align and synchronize large investment projects of high-speed line and broad-gauge line in project and implementation phases

Recommendations at national level

- The results of the project and its further development should be incorporated into the national spatial planning documentation - Slovak Spatial Development Perspective (AUREX 2012) as well as in other national documents in the fields of regional policy, transport, legislation, economic development, and financial policy

- We recommend adopting legislation at national level that will favor and prefer rail freight transport instead of road transport in order to achieve a minimum of 50% share of rail freight transport

Recommendations at regional level

- Develop spatial technical documents mapping related factors of the settlement environment quality by means of a database development for better identification of necessary projects
- Include key projects defined in this study into the regional planning documents in the field of spatial planning, regional policy, and transport
- We recommend the development of rail freight infrastructure for the SW Slovakia region in three stages:
    - By 2030 to focus on Variant 1 aimed at effectively connecting Bratislava as well as preparing the Tangential Variant (until 2050)
    - By 2050 to focus on the completion of the Tangential Variant, as well as on the construction of a new tunnel under Little Carpathians in Bratislava, that will allow Tangential-Radial Variant development (until 2070)
    - Completion of Tangential-Radial Variant by 2070

Recommendations at local level

- Within the individual regions of the South Moravian Region and the SW Slovakia we recommend focusing on the preparation and implementation of railway infrastructure projects
- Increasing the attractiveness of rail freight transport will have a positive impact on the social and economic development of the municipalities. This development process has to be supported by preparation or updating of the relevant planning documents

5. ANNEXES

5.1. Bibliography

AF-CITYPLAN (2019): Plán udržateľnej mobility Trnavského samosprávneho kraja: časť 1 – Zber údajov. Regional Sustainable Mobility Plan of Trnava Self-governing Region: 1. Part – Data Collection. Trnava: AF-CITYPLAN, TTSK (Trnava Self-governing Region). URL: www.trnava-vuc.sk/12133-sk/plan-udrzatelnej-mobility

AUREX (2012): Slovak Spatial Development Perspective: Based on the Slovak Spatial Development Perspective 2001, as amended by the Slovak Spatial Development Perspective 2011 – Amendment No. 1 to the Slovak Spatial Development Perspective 2001. Bratislava: Ministry of Transport, Construction and Regional Development of the Slovak Republic (MTCRD SR), AUREX. ISBN 978-80-971053-3-4

AUREX (2013a): Územný plán regiónu Bratislavský samosprávny kraj [Spatial Regional Plan of Bratislava Self-governing Region]. Bratislava: Bratislava Self-governing Region, AUREX.

AUREX (2013b): Program hospodárskeho rozvoja a sociálneho rozvoja Bratislavského samosprávneho kraja na roky 2014 – 2020: Analyticko-strategická časť. Programme of economic and social Development of Bratislava Self-governing Region 2014 – 2020: Analytical-strategic Part. Bratislava: AUREX, BSK (Bratislava Self-governing Region).

AUREX (2014): Územný plán regiónu Trnavského samosprávneho kraja [Spatial Regional Plan of Trnava Self-governing Region]. Trnava, Bratislava: Trnava Self-governing Region, AUREX.

AUREX (2015a): Štúdia pre hodnotenie a monitorovanie ÚPN-R NK s využitím SEE projektu Donauregionen+ [Study for evaluation and monitoring of the Regional Spatial Plan of the Nitra Self-governing Region using SEE project Donauregionen+]. Nitra, Bratislava: Nitra Self-governing Region, AUREX.

AUREX (2015b): Územný generel dopravy Trnavského samosprávneho kraja do roku 2020 s výhľadom do roku 2030 [Territorial Masterplan of Transport of Trnava Self-governing Region to 2020 with the Vision up to 2030]. Trnava, Bratislava: Trnava Self-governing Region, AUREX. URL: www.trnava-vuc.sk/11760-sk/uzemny-generel-dopravy

AUREX (2015c): Územný plán regiónu Nitrianskeho samosprávneho kraja [Spatial Regional Plan of Nitra Self-governing Region]. Nitra: Nitra Self-governing Region, AUREX.

AUREX (2017a): Územný generel dopravy Nitrianskeho samosprávneho kraja [Territorial Masterplan of Transport of Nitra Self-governing Region]. Nitra, Bratislava: Nitra Self-governing Region, AUREX. 11/2017. URL: www.unsk.sk/zobraz/sekciu/uzemnoplanovacie-dokumenty-a-uzemnoplanovacie-podklady-kraja

AUREX (2017b): Územný plán regiónu v znení zmieny a doplnkov - Bratislavský samosprávny kraj [Spatial Regional Plan of Bratislava Self-governing Region as amended]. Bratislava: BSK, AUREX.

Beňová, D., Gnap, J., Tuková, P. (2020): Logistické centrá a logistické parky na území Slovenskej republiky. Logistika 7 Jan 2020. URL: www.svetdopravy.sk/logisticke-centra-a-logisticke-parky-na-uzemi-slovenskej-republiky

BPG (2018): Predĺženie širokorozchodnej železničnej trate na území Slovenska s prepojením na územie Rakúska - ZÁMER [Extension of the broad-gauge railway line in the territory of Slovakia with connection to the territory of Austria – A Plan]. Wien, Bratislava: Breitspur Planungsgesellschaft mbH, BVO Joint Venture Company Broad Gauge Bernard – Valbek – Obermeyer.

COPERNICUS (2020): CORINE Land Cover. Web source. URL: https://land.copernicus.eu/pan-european/corine-land-cover

ESPON (2013): TRACC - Transport Accessibility at Regional/Local Scale and Patterns in Europe. Applied Research 2013/1/10. Inception Report | Version 30/07/2010.

Grosch, M. (2018): Orient/East-Med: Third Work Plan of the European Coordinator. EU: European Commission. https://ec.europa.eu/transport/sites/transport/files/web_2018_04_16_final_oem_wp_iii.pdf

Holzner, M. et al. (2018): A European Silk Road. Research Report 430. Wien: The Vienna Institute for International Economic Studies (WIIW). URL: https://wiiw.ac.at/a-european-silk-road--p-4608.html

Illustrated Glossary for Transport Statistics – Ilustrovaný anglicko – slovenský slovník pre dopravnú štatistiku. 4 th edition - 4. vydanie. ITF, EUROSTAT, UNEC for Europe. URL: https://www.mindop.sk/statistiky-15/doprava/dopravna-terminologia-vykladovy-slovnik

IPP (2018): Územný plán regiónu Nitrianskeho kraja – Štúdia pre hodnotenie a monitorovanie Územného plánu regiónu Nitrianskeho kraja – aktualizácia údajov [Spatial Regional Plan of the Nitra Region - Study for Evaluation and Monitoring of the Spatial Regional Plan of the Nitra Region - Data Update]. Nitra, Bratislava: Nitra Self-governing Region, IPP.

IPP (2019): Program hospodárskeho rozvoja a sociálneho rozvoja Bratislavského samosprávneho kraja na roky 2021 – 2027: Analytická časť [Programme of economic and social Development of Bratislava Self-governing Region 2021 – 2027: Analytical part]. Bratislava: IPP, BSK (Bratislava Self-governing Region).

IPP (2020): Regional Needs and Challenges Analysis for the South-West Slovakia. https://ipp-oz.sk/corcap

Križan, F., Gurňák, D. (2008): Vybrané kartografické a grafické metódy znázorňovania dostupnosti. Acta Geographica Universitatis Comenianae No. 51, pp. 71-82.

KÚRS (2001): Koncepcia územného a rozvoja Slovenska - KÚRS 2001.

Levine, J., Grengs, J., Shen, Q. & Shen, Q. (2012): Does Accessibility Require Density or Speed? Journal of the American Planning Association, 78(2), pp. 157–172. https://doi.org/10.1080/01944363.2012.677119

Lu, H., Li, L., Zhao, X., Cook, D. (2018): A model of integrated regional logistics hub in supply chain, Enterprise Information Systems, 12:10, pp. 1308-1335, DOI: 10.1080/17517575.2018.1533588

MDPT SR (2010): Aktualizácia koncepcie rozvoja verejných prístavov 2010 - Verzia po zapracovaní pripomienok VP a.s. a MDPT SR [The Update of the Development Perspective of Public Ports 2010 - Version after incorporating comments by VP a MDPT SR]. Bratislava: Deloitte, MDPT SR.URL: https://www.mindop.sk/index/open_file.php?file=doprava/dopinfra/program/Dokumenty/fondyeu20142020/StrategickyPlan2030/Strategicky_plan_2030.pdf

MDV SR (2020a): Nákladná doprava – Freight Transport. web pages. Bratislava: Ministry of Transport and Regional Development of the Slovak Republic. URL: https://www.mindop.sk/files/statistika_vud/preprava_nakl.htm

MDV SR (2020b): Intermodálne promočné centrum. URL: www.intermodal.sk

MDV SR (2020c): Návrh opatrení na podporu rozvoja intermodálnej prepravy v SR [Proposal for Measures to Support the Development of Intermodal Transport in the SR] - Opatrenia na podporu rozvoja intermodálnej prepravy v Slovenskej republike [Measures for Support of the Development of Intermodal Transport in the Slovak Republic]. Web source. URL: http://www.intermodal.sk/opatrenia-na-rozvoj-intermodalnej-prepravy/605s

MDV SR (2020d): Aktualizácia koncepcie rozvoja kombinovanej dopravy s výhľadom do roku 2010 [Update of the Strategic Combined Transport Development Plan with a View to 2010]. URL: http://www.intermodal.sk/ext_dok-kd_aktual/403c

MDVRR SR (2016a): Sčítanie v železničnej doprave 2015: E – RAIL TRAFFIC CENSUS 2015, November 2016. Bratislava: MDVRR SR. URL: https://www.mindop.sk/statistiky-15/doprava/statisticke-udaje/scitanie/scitanie-v-zeleznicnej-doprave/rok-2015-pdf-2-3-mb

MDVRR SR (2016b): Strategický plán rozvoja dopravy SR do roku 2030 – Fáza II. Bratislava: Ministerstvo dopravy, výstavby a regionálneho rozvoja Slovenskej republiky. URL:

https://www.mindop.sk/index/open_file.php?file=doprava/dopinfra/program/Dokumenty/fondyeu20142020/StrategickyPlan2030/Strategicky_plan_2030.pdf

MDVaRR SR (2016c): Dopravný model SR - Záverečná správa [Transport Model SR - Final Report]. Bratislava: Ministerstvo dopravy, výstavby a regionálneho rozvoja Slovenskej republiky, AF&partners, represented by AF-CITYPLAN. URL: https://www.mindop.sk/ministerstvo-1/doprava-3/dopravne-modelovanie/dopravny-model-sr/zaverecna-sprava

METRANS (2020): Terminal Operations Rail Hub Terminal Dunajská Streda. Web page. URL: https://www.metrans.eu/terminal-operations/rail-hub-terminal-dunajska-streda-sk

NASES (2020): data.gov.sk. Web source. Open portal. Národná agentúra pre sieťové a elektronické služby [National Agency for Network and Electronic Services]. URL: https://data.gov.sk

NSK (2020): Regionálny plán udržateľnej mobility NSK: Analýzy – Revízia A. Regional Sustainable Mobility Plan of Nitra Self-governing Region. Nitra: Nitriansky samosprávny kraj, NDCon, Mott MacDonald CZ.

Pászto, V., Jürgens, C., Tominc, P., & Burian, J. (Eds.). (2020). Spationomy. https://doi.org/10.1007/978-3-030-26626-4

RFC 7 (2020): RFC 7 - Interactive Map v201. URL: rfc7.eu

RFC 7 (2021): Transport Market Study Rail Freight Corridor Orient/East-Med. URL: https://www.interreg-central.eu/Content.Node/CORCAP/RFC7-Transport-Market-Study.pdf

Rodrigue. J.-P., Comtois, C., Slac, B. (2006): The Geography of Transport Systems. London and New York: Routledge.

SGS (2019): Regionálny plán udržateľnej mobility Bratislavského samosprávneho kraja – Časť IV. Analýzy. Regional Sustainable Mobility Plan of Bratislava Region – Part IV. Analyses. SGS Czech Republic

SSC (2019): Cestná databanka. Web source. URL: www.cdb.sk

RNE RailNetEurope (2020): RailNetEurope. Web source. URL: www.rne.eu

SOSR (2020): Statistical Office of the Slovak Republic. Web source. URL: statistics.sk

Stadt Wien (2020): CENTROPE - Central European Region. Wien: Magistrat der Stadt Wien. URL: https://www.wien.gv.at/wirtschaft/eu-strategie/centrope.html

Šveda, M., Šuška, P. (2019): Suburbanizácia: Ako sa mení zázemie Bratislavy? Bratislava: Geografický ústav SAV.

TENtec (2020): TEN-T Geoportal. Web source. URL: https://ec.europa.eu/transport/infrastructure/tentec/tentec-portal/map/maps.html

UIRR (2020): UIRR International Union of Combined Road-Rail Transport Companies. URL: http://www.uirr.com

UN (2001): Terminology on Combined Transport (English-French-German-Russian). European Conference of Ministers of Transport. New York and Geneva: UN/ECE, the European Conference of Ministers of Transport (ECMT) and the European Commission (EC). ISBN: 9789282102114. URL: https://doi.org/10.1787/9789282102114-en-fr

Verhetsel, A. et al. (2015). Location of logistics companies: a stated preference study to disentangle the impact of accessibility. Journal of Transport Geography, 42, 110-121. https://doi.org/10.1016/j.jtrangeo.2014.12.002

VÚD (2005): Postavenie a rozvoj jednotlivých druhov dopráv v dopravnom systéme (2005). Žilina: VÚD. URL: http://www.intermodal.sk/ext_dok-priloha_4/620c

West-Pannon (2020): Political Conference Kittsee 2003 – "Building a European Region". Web source. URL: https://centrope.gysev.hu/story/political-conferences/kittsee-2003

ŽSR (2018): Železnice Slovenskej republiky: Podmienky používania železničnej siete pre GVD 2019/2020. Schválené generálnym riaditeľom Železníc Slovenskej republiky pod číslom 27846/2018/O410-9, Účinnosť od dňa 09.12.2018. URL: https://www.ŽSR.sk/files/dopravcovia/zeleznicna-infrastruktura/podmienky-pouzivania-zel-infrastruktury/podmienky-pouzivania-zel-siete-2020/podm_pouzivania_zel_siete_2020.pdf

ŽSR (2020): Podmienky používania železničnej siete 2020. Príloha 4.3.A Kapacita infraštruktúry 2020 [Conditions for using the rail network 2020. Annex 4.3.A Infrastructure capacity 2020]. Web source. URL: https://www.ŽSR.sk/dopravcovia/infrastruktura/podmienky-pouzivania-zel-infrastruktury/podmienky-pouzivania-zel-siete-2020

ŽSR (2019): ŽSR, dopravný uzol Bratislava - štúdia realizovateľnosti [ŽSR, Transport Node Bratislava – Feasibility Study]. Bratislava: ŽSR, Reming, Sudop, Prodex, Dopravoprojekt. URL: https://www.zsr.sk/modernizacia-trati/studie-realizovatelnosti/uzol-bratislava.html

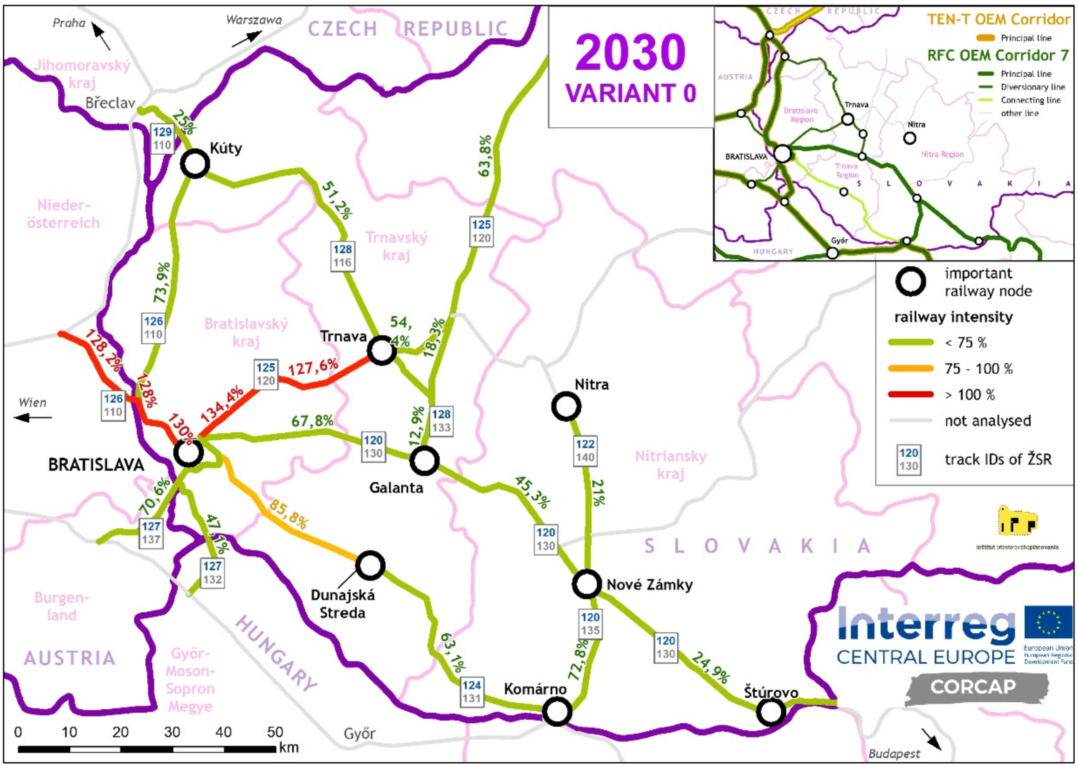
5.2. Abbreviations

- AT - Austria (Österreich)
- BA - Bratislava
- BSK - Bratislava Self-governing Region
- CE CENTROPE - Part of CENTROPE region defined in this study
- CENTROPE - Region in Central Europe
- CZ - Czech Republic
- DE - Germany (Deutschland)
- EIA - Environmental Impact Assessment
- HU - Hungary (Magyarország)
- IHUB - inter/multimodal hub
- IPP - Institute of Spatial Planning (Inštitút priestorového plánovania, o.z.)
- MDVaRR SR - Ministry of Transport, Construction and Regional Development of the Slovak republic
- NSK - Nitra Self-governing Region
- OEM - TEN-T Orient/East-Med corridor
- PL - Poland (Polska)
- SMR - South Moravian Region
- SR - Slovak Republic (Slovenská republika)
- SSC - Slovenská správa ciest (Slovak Road Administration)
- SW Slovakia - Southwest(ern) Slovakia
- ŠÚ SR - Statistics Office of the Slovak republic
- TEN-T - Trans-European Transport Networks
- TIOP - Terminal of Integrated Passenger Transport
- TTSK - Trnava Region
- UA - Ukraine (Україна)
- ÚPNR BSK - Regional Spatial Plan of the Bratislava Self-Governing Region
- VRT - vysokorychlostní trať - high-speed line
- ZSSK - Slovak Railway Company (Železničná spoločnosť Slovensko, a.s.) - joint stock company - national railway carrier of passenger transport
- ŽSR - Slovak Railways (Železnice Slovenskej republiky)
- ŽST - railways station

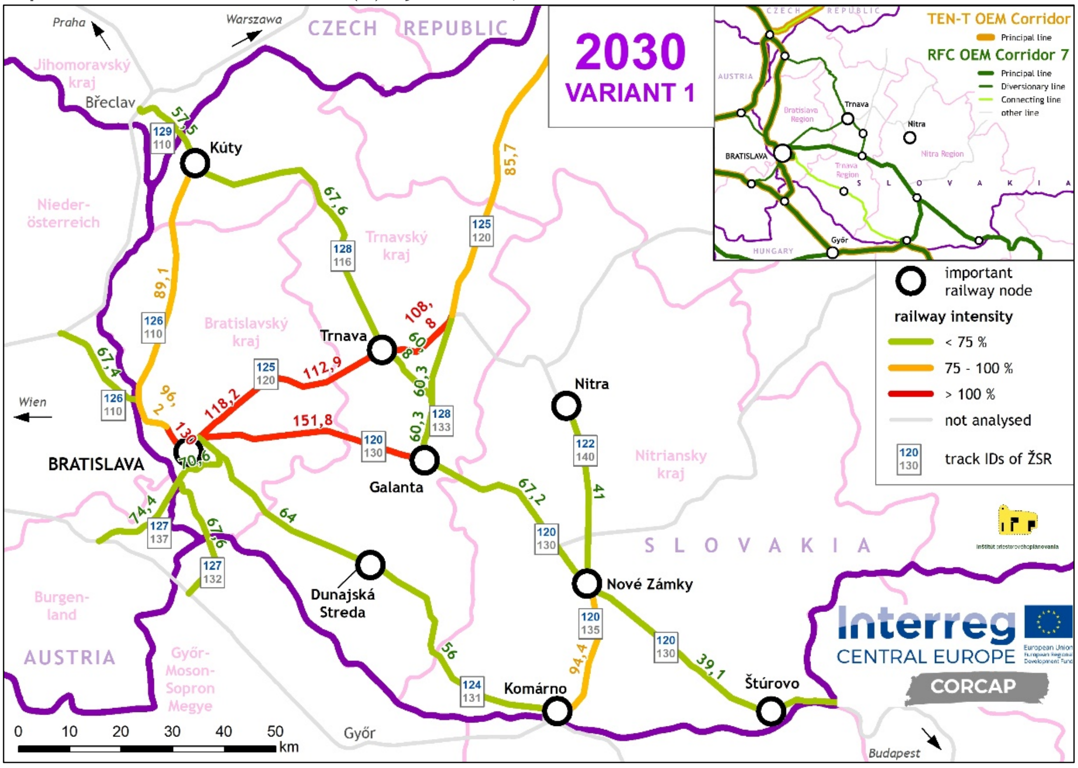
5.3. Utilization of tracks in the region of South-West Slovakia

The following maps show the potential utilization of individual track sections based on the envisaged traffic quantities for the individual variants as described in Chapter 3.6. Utilization means the percentage (%) of utilization of a given capacity of individual tracks. For investment variants (Variant 1, Tangential and Radial Variants), a **gradual increase in the capacity** of these tracks was envisaged, as well as an increase in the weight of freight trains when introducing new transport technologies. This would mean an increase in **transport performance** and reducing the use of a given section of the railway track at the same time.

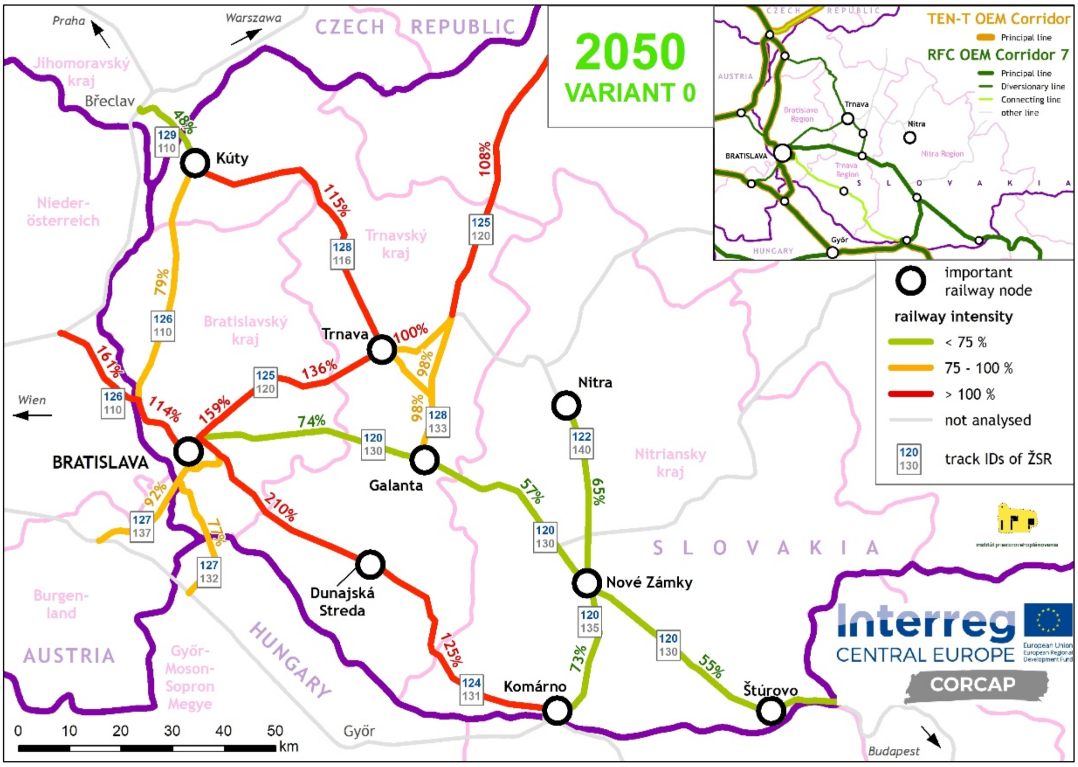
Map 29. Utilization of rail tracks (%) – year 2030, non-investment Variant 0



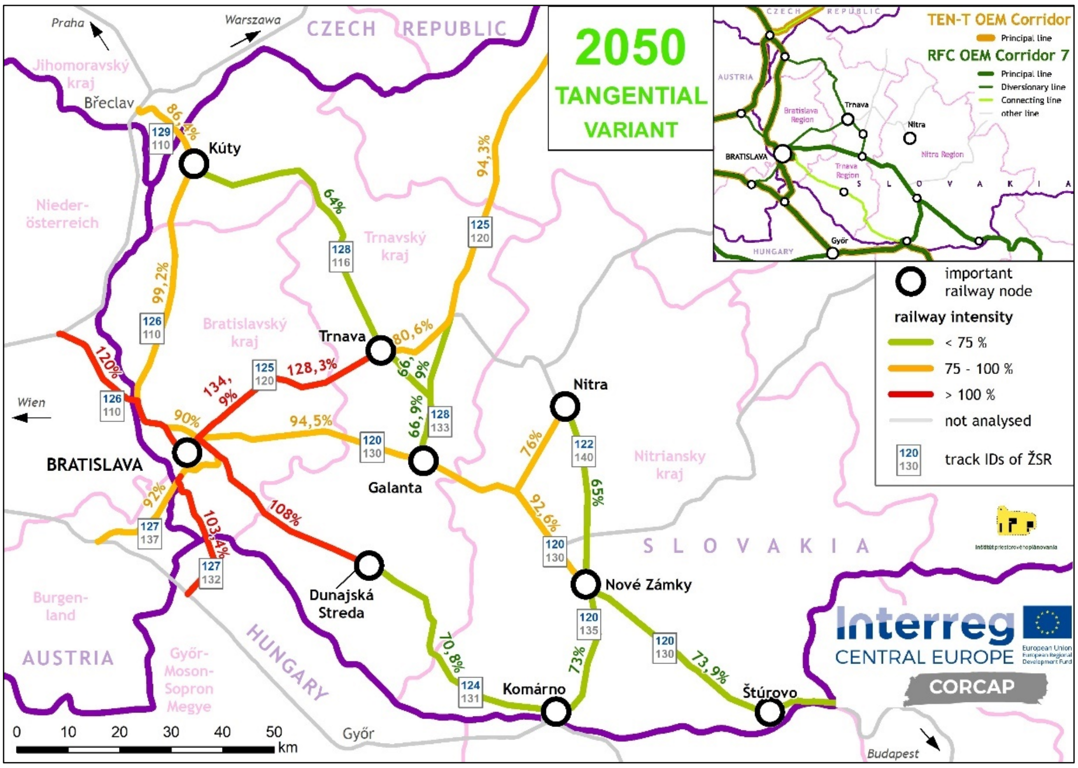
Map 30. Utilization of rail tracks (%) – year 2030, investment Variant 1



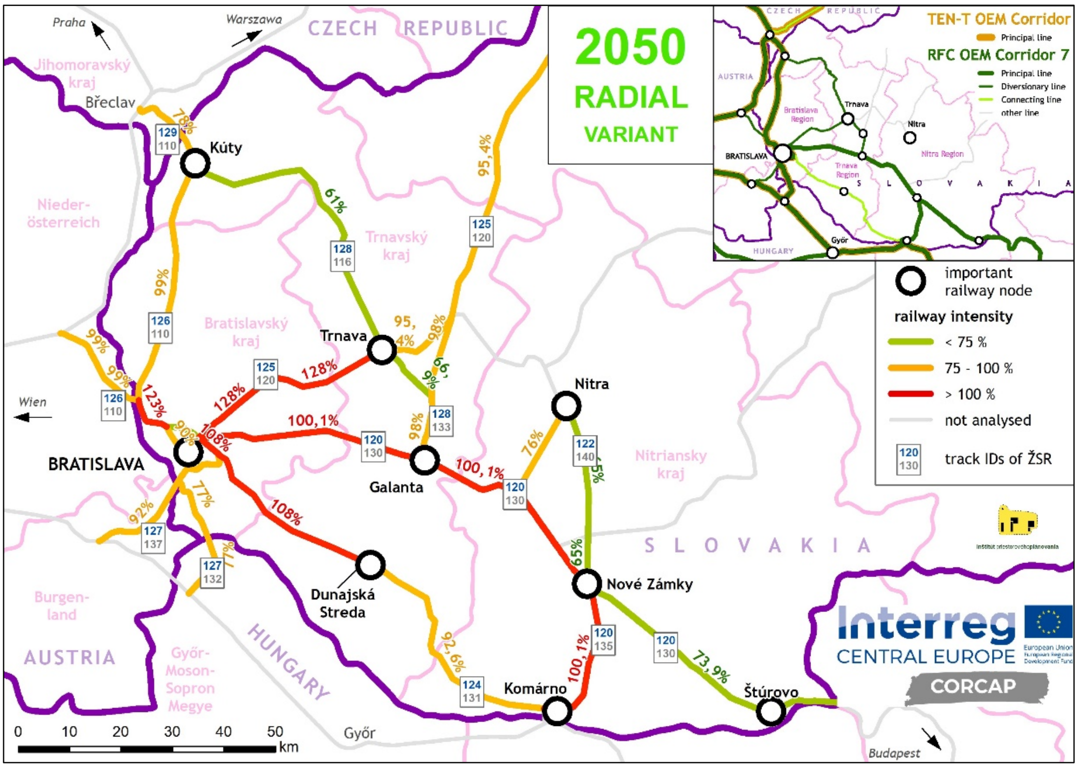
Map 31. Utilization of rail tracks (%) – year 2050, non-investment Variant 0



Map 32. Utilization of rail tracks (%) – year 2050, investment Tangential variant



Map 33. Utilization of rail tracks (%) – year 2050, investment Radial variant



5.4. SWOT analysis of rail freight transport possibilities in the region of South-West Slovakia

SWOT analysis has been compiled to simplify the view on the possibilities of developing rail freight transport in the long term.

Strengths:

- The territory of SW Slovakia lies directly on the route of international connections in the northwest – southeast direction and offers railway tracks of quality routing with the upcoming modernization from today´s speed 110-120km/h to the 140km/h
- Quality marshalling yards with sufficient capacity (in accordance with RFC 2021 document): Bratislava–Východné, Devínska Nová Ves, Nové Zámky, Komárno zr. st. and Štúrovo
- Existing and expanding container terminals Bratislava-Pálenisko, Bratislava-ÚNS, Dunajská Streda, Sládkovičovo, Lužianky
- Danube ports (Bratislava, Komárno) with direct connection to the rail and road network
- EU support for the development of the region

Weaknesses

- Insufficient throughput at the Bratislava Railway Node
- Unfinished motorway connection D4 through The Little Carpathians
- Low use of railway marshalling yards
- Low use of Danube ports in Bratislava and Komárno
- A large share of road transport in total modal split

Opportunities

- Implemented and upcoming modernization of railway tracks Nr. 126 (110) and 120 (130), which strengthen transport possibilities in the European direction northwest – southeast
- The upcoming doubling of the railway track Nr. 124 (131) Bratislava – Dunajská Streda – Komárno strengthens the transport capacity of the connection of the container terminal in Dunajská Streda to the European railway network
- Creation of an international transport HUB in the territory of Bratislava Region and Bratislava city, with the catchment areas involving the eastern federal states of Austria, the north-western county of Győr-Moson-Sopron in Hungary, Southern Moravia, and Western Slovakia
- The concept of the broad-gauge line route from Ukraine through southern Slovakia to ports in Bratislava and Vienna
- Reducing the carbon footprint as required by the EU

Threats

- Interruption of the realization, uncompletion or crucial change of concept in investment plans in the construction of railway structures
- Inadequate transport pricing policy

The changes (many times fundamental) in the orientation of state transport policy have always been in favour of car transport

5.5. List of Tables

5.6. List of Figures

5.7. List of Maps