UIC Atlas 2008

of Infrastructure in the ERIM Network

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UIC ATLAS 2008
of Infrastructure, Investments, Traffic and Capacity in the ERIM network

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Prepared by	Aleksandra Perkuszewska
Checked by	Erika Nissi
Approved by	Gerard Dalton

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Content

Index of Figures

Index of Maps

Index of Tables

Foreword

ERIM was conceived in 2003 within the Market and Development Sector of the UIC Infrastructure Forum, following previous work on individual corridor studies at UIC. The objective was to build a high-level overview of the major international rail corridors, mainly for freight, on which a European Rail Infrastructure Masterplan could be built on.

At the first stage the major traffic flows needed to be identified with regard to their current traffic volumes and their growth potential. Seen from the UIC perspective, it was also clear that the scope had to stretch beyond the EU boundaries and therefore 32 European Countries were included into ERIM network. Also the need for precise and up-to-date data was recognised and therefore UIC initiated, in collaboration with its Member Railways, the data collection in a standardised format to be recorded into a common database, namely the ERIM Database.

ERIM has tried to contribute, in its modest way, to the progress of the freight oriented network and corridor development by confronting and exchanging ideas with its Member Railways and other Stakeholders on wide range of items, such as different geographical approaches, upgrading targets, the investments needs and the need for leadership beyond national boundaries. ERIM has also contributed to the foundations of the ERTMS work as the ERIM network was taken as such to define the ETCS network from which the ERTMS corridors were extracted.

ERIM issued in January 2008 its Final Report which concluded the strategic vision for a European Rail Infrastructure Masterplan, whereas another document UIC Atlas described the status of the ERIM network with maps and figures. This present document is the second edition of UIC Atlas including some additional data which was previously integrated into the Final Report.

I take this opportunity to thank all ERIM correspondents for their valuable contribution as well as Mrs Dagmar Haase, DB Netz, Chairperson of the Market & Development Sector of UIC Infrastructure Forum and Gerard Dalton, Director of UIC Infrastructure Department for supporting and steering the ERIM work. We endeavour to keep the ERIM database up-to-date and complete it according to the new information needs and data sources. Indeed, it has been such a long process to build this database up, that it would be short-sighted not to develop it further on. We sincerely hope that the ERIM database can continue to contribute to future activities of European Railway Community and we set ourselves the challenge to do this in an ever enhanced manner.

Erika NISSI
Project Manager
UIC Infrastructure Department

Executive Summary

UIC Atlas of infrastructure in the ERIM Network is a **high-level infrastructure supply side overview** of major international rail corridors, mainly for freight, within and between 32 countries. The ERIM network does not cover all the priority routes of each individual country but seeks to provide each country with a connection to the remainder of the European network.

The first chapter of this Atlas provides a brief overview of the important technical and operational parameters having an influence on the interoperability. Subsequently, current 2008 status of ERIM infrastructure as well as the projected 2020 status is presented in some key figures and maps.

The second chapter is dedicated to the current and future traffic loads. The ERIM network covers about **50 000 km** which represent only 22% of the total route length but it carried, in 2007, approximately 50% of all passenger-kms and 59% of all tonne-kms in the 32 countries.

ERIM has also established, in collaboration with its Member Railways, an estimation of traffic growth by 2020. The ERIM growth forecast for **passenger traffic** for the period 2007-2020 is 30%, with an average annual growth rate of 2.1 %. The ERIM growth forecast for **freight traffic** for the same period is 80**%,** with an average annual growth rate of 4.6% The expectation for freight growth is significantly higher this year than last year (with an average annual growth rate of 3.2%) due to increasingly optimistic projections from some railways. However, it is not known to which extent the recent economic downturn has been taken into account in these projections and whether such high expectations will be maintained next year.

The second chapter presents also some recent EU 27 figures on the Gross Domestic Product (GDP), the annual freight growth and the modal split between different transport modes.

The third chapter seeks to estimate the current and future capacity utilisation. In order to estimate the current capacity utilisation ERIM has compared the average number of daily trains with the theoretical capacity of the corresponding line sections, both figures being provided by the respective networks To assess the future capacity utilisation in 2020, ERIM has assumed that it will be possible to achieve a **20% improvement in load factors** (for those line sections, which are expected to grow by more than 20% by 2020). This assumption is incorporated into the calculation of the number of trains in each line section in 2020. In this way anticipated technological progress and improved operational efficiency are factored into the analysis.

ERIM has distinguished the more “heavily-utilised” line sections from the “less-utilised” by selecting the line sections displaying 70% or more of **capacity utilisation** over the full day. This 70% figure has been taken as an indicative threshold to define line sections with potential capacity constraints, especially in peak periods. In doing so, 16 000 Km of line sections, representing 32% of ERIM network appear to be constrained in 2020.

The final chapter offers a high-level overview of the railway investment plans up to 2020. Railways were asked about their investment plans in general and those coinciding with identified bottlenecks in particular. They were also asked about their plans to upgrade the key infrastructure parameters to the minimum upgrading target level proposed by ERIM. Up to date 27 countries communicated their **investment plans** to ERIM summing up to 173 Billion euros. From this amount only 28% have an approved financing, which however needs to be related to the relatively long time span up to 2020. In addition to these planned investments ERIM identified, due to missing responses, a supplementary **investment gap** of 15 Billion euros for upgrading the infrastructure to the minimum target level and another 14 Billion euros to relieve the capacity constraints. Consequently the total investment budget needed for ERIM network to prepare for the future traffic growth has been estimated to be around **202 Billion euros.**

ERIM has made a simple juxtaposition of the possibly capacity constrained line sections (16 000 Km) and the investment plans (relating to the 173 Billion euros) under the following working hypotheses : If an investment plan (whatever is its nature) is coinciding with a line section being capacity constrained, the possible bottleneck will be removed automatically by this investment measure. In this case only 3 000 Km of line sections (instead of 16 000) would face capacity constraints in the future and the estimated investment gap would be the aforementioned 14 Billion euros.

However, this working hypothesis is very optimistic as there is no certainty that the planned investment measures will remove all bottlenecks. Indeed some investment measures are more general and not designed specifically to enhance the capacity. Therefore the plausible amount of line sections facing capacity shortages in 2020 is somewhere between these two scenarios (3 000 – 16 000 Km). However, whatever is the actual amount of capacity constrained line sections, it is important to remind that **the bottlenecks affect not only the corresponding line sections, but can often reduce the usable capacity along the entire corridor or train path.**

In the Appendices of this Atlas, some additional maps on corridor configurations are included to contribute to the ongoing discussion on corridor development and to remind that the ERIM database, recorded in Geographic Information System, is composed of interrelated line sections allowing the extraction of any desired corridor definition within the ERIM Network.

1 The Infrastructure Details in the ERIM Network in 2008

The ERIM network represents the main rail routes within and between the EU and EFTA countries the Balkan countries and Turkey (32 countries all together). The network represents the routes which are most important on the basis of their potential to maintain and enhance the volume of international rail traffic, and in particular freight traffic. The ERIM network does not cover all the priority routes of each individual country but seeks to provide each country with a connection to the remainder of the European network along a number of defined corridors**.**

One of the main components of the ERIM project has been the creation, in collaboration with its Member Railways, of a database which covers, in 2008, **50,320 route km and 1 159 line sections.** Since the infrastructure inventory covers over 40 different data columns of information for each line section, only the main infrastructure parameters will be presented on the following thematic maps for the entire network.

The Map 1 shows the ERIM network with the six ERTMS corridors A-F distinguished.

1.1 Type of Line

The Map 2 shows the different types of lines within the ERIM network, and the following breakdown can be given:

- 3,066 km of High Speed lines dedicated to passenger trains;
- 6,639 km of Higher Speed lines for passenger and freight trains;
- 40,615 km of conventional lines.

The term “higher speed lines for passenger and freight trains” means that both passenger and freight trains are allowed to operate on these lines and Maximum Passenger Speed is at least 200 km/h. This definition also covers the most of High Speed lines in Italy, which are designed for mixed traffic.

1.2 Number of Tracks

A route is defined as the railway formation carrying individual tracks between one point and another along the corridor. Another set of tracks on a parallel, but separated formation represents, another route, although it may connect the same end points. The ERIM 50,320 route - kms can be broken down as follows:

- 12,569 km of **single track** route (about 25%);
- 35,374 km of **double track** route (about 70%);
- 2,376 km of **more than double track** route (about 5%).

Accordingly, it can be said that the area is predominately defined today by double track routes with a small proportion of routes of higher number of tracks in and around important cities and in some cases between some cities.

Map 3 shows the picture in 2008 for the European network route length.

1.3 Track Gauge

Track gauge is shown in Map 4. It identifies 5 types of track gauges. The European standard gauge of 1,435 mm predominates with the notable broad gauge area in the Iberian Peninsula and the Baltic States and Finland. Issues of gauge incompatibility are being overcome through the **use of gauge changing equipment in Spain and Poland** and through a comprehensive programme of new line construction in Spain conforming to the European Standard Gauge.

1.4 Loading Gauge

An important determinant of railway infrastructure capacity to carry traffic relates to the gauge to which vehicles can be loaded to conform to the construction gauge of the structures along the route. **These loading capacities have been identified in relation to the gauges defined in UIC leaflets 505-1 and 506**. The majority of the gauges fall into one of the three categories defined by the following figure 1. The French network has cleared many routes for an intermediate gauge between GB and GC, defined as GB+, which represents a clearance gauge defined by the maintenance of a uniform clearance, across the width of the track equivalent to the highest level of GB gauge (i.e. without reduction at the sides).

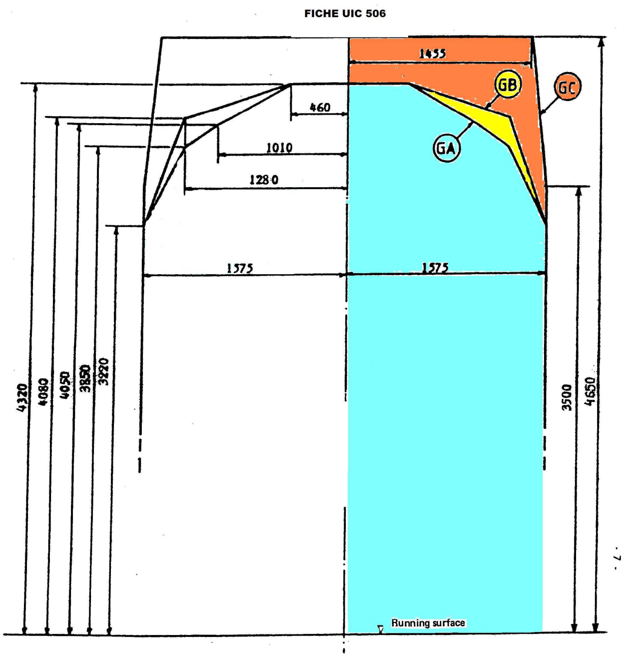


Figure 1 – GA, GB and GC Loading UIC Gauges (from leaflet 506)

The breakdown of the permitted loading gauge over the ERIM corridors is as follows:

- **GA:** **3,708** km (about 7%)
- **GB:** **22,995** km (about 46%)
- **GB+:** **4,036** km (about 8%)
- **GC:** **12,472** km (about 25%)
- **>GC:** **1,050** km (about 2%)
- **Other:** **6,059** km (about 12%).

Map 5 shows the picture in 2008 for the European network. For Austria GC indicate lines which allow for "profile 161". That means it covers all requirements listed as examples for GC gauge in the United Nations' treaty entitled European Agreement on important International Combined Transport Lines and related Installations (AGTC). The GB gauge indicates lines which allow for "profile 171". That means it covers all requirements listed as examples for GB in the AGTC treaty. In some cases there are local restrictions like speed reductions in tunnels, special track assignments in stations etc.

The European Agreement on Main International Railways lines (AGC), has defined in its Annex III, page 40, the “translation” of **UIC loading gauges B and C to the Combined Transport**, by giving examples of what kind of CT rolling stock are suitable to the UIC B and C gauges.

Vehicle loading gauge

The C gauge allows, for instance:

– The transport of road goods vehicles and road trains (lorry with trailer, articulated vehicle, tractor and semi-trailer) conforming to the European road loading gauge (height 4 m, width 2.5 m) on special wagons with a loading height of 60 cm above rail level;

– The transport of ordinary road semi-trailers 2.5 m wide and 4 m high on recess wagons with normal bogies;

– The transport of ISO containers 2.44 m wide and 2.9 m high on ordinary flat wagons;

– The transport of swap bodies 2.5 m wide on ordinary flat wagons;

– The transport of containers/swap bodies 2.6 m wide and 2.9 m high on suitable wagons.

The UIC B gauge allows, for instance:

– The transport of ISO containers, 2.44 m wide and 2.90 m high, on flat container-wagons with a loading height 1.18 m above rail level;

– The transport of swap bodies, 2.5 m wide and 2.6 m, high on ordinary flat wagons (loading height 1.246 m):

– The transport of semi-trailers on recess wagons;

– The transport of containers/swap bodies, 2.6 m wide and 2.9 m high, on special low-loader wagons.

Figure 2 – AGC: Combined Transport and UIC Loading Gauges

1.5 Signalling systems

Separate UIC studies [ETCS – Opportunities for European Rail Corridors (2003) and ETCS – Migration strategies on corridors – Cost / Benefit analysis (2004)] have identified over **twenty different signalling systems in Europe**. A separate ATLAS of ERTMS Implementation has been prepared by UIC (to be updated in 2009), which gives comprehensive information on ETCS and GSM-R. The ERIM analysis has sought to classify signalling systems more by their specific functionality than individual names, having regard to the additional assistance they provide to train drivers in terms of warnings or automatic stopping interventions and as to whether these functions are discrete (i.e. an intervention at specific locations) or continuously applied along the entire section of track. This approach has been applied in order to assess the current level of intervention applied throughout the ERIM network and to appreciate the change in characteristics of the same network with the introduction of ETCS, which is a cab signalling system with continuous supervision of train speed in accordance with line conditions.

In 2008 the ERIM network is characterised by the following signalling control command systems:

- **Warning / stop functions:** 12,046 km (about 24%)
- **Discrete speed supervision:** 18,378 km (about 37%)
- **Continuous speed supervision:** 13,877 km (about 28%)
- **ETCS:** 1,759 km (about 3%).

Map 6 shows the picture in 2008 for the European network.

The use of ETCS in actual service is 1 759 Km, representing about 3% of ERIM network (see Map 6). The coverage of **GSM-R** in actual service amounts to 17,181 km, corresponding to 34% of ERIM network (shown in Map 7). Many sections have been brought into commercial operation in 2008. In many areas GSM-R is not yet configured in all cases to carry both voice and data traffic sufficient to support ETCS Level 2 or higher applications. The GSM-R networks are configured either to cover the voice traffic or to cover also ETCS level 2.

1.6 Type of Current

There is a clear regional context to the types of traction systems installed on the ERIM network. The overall network displays a dominance of **AC** systems (Alternating Current): 25kV, 50Hz and 15kV, 16Hz, totalling about 27,301 km, which is 54% of the network with respect to **DC** systems (Direct Current): 1500V and 3000V, totalling about 17,147 km (34% of the network). There is also 84 km of lines with mixed system. The balance of 5,788 km (12%) is not electrified.

Map 8 shows the overall picture in 2008 for the European network.

1.7 Maximum speed

The ERIM survey distinguishes three types of maximum speed:

- the **designed line speed** which refers to the speed that the line is built for,
- the maximum **permitted passenger train speed,**
- the maximum **permitted freight train speed.**

In broad terms it may be said that the ERIM network is predominantly **designed** for a speed of 120 km/h or higher (42,931 km – 85%). Only about 9% (4,459 km) of the total network is currently designed and maintained for speeds of at least 250 km/h. Map 9 shows the picture of designed line speed in 2008 for the European network. The most predominant maximum permitted **freight** speed is 120 km/hr of higher, covering 36% of the ERIM network (see Map 10). The most common maximum permitted **passenger** speeds are in the ranges of 120-159 km/h and of 160-249 km/h, covering respectively 35% and 36% of the ERIM network (see Map 11). However, in some countries these permitted maximum speeds for freight and passenger are being reduced in real operations, due to the current lack of financial resources to maintain the tracks on their maximum speed level.

1.8 Maximum Axle Load and Line Classification

Axle Loads

The ERIM survey indicates that the network is predominantly designed to carry maximum axle loads of **22.5 tonnes (73% of total network** – 36,531 km). Heavier axle loads of 23 tonnes or higher are only accepted on 5,554 km (which represents only 11% of the current network).

The parts of the network most dedicated to heavier axle load (25 tonnes) are to be found in Sweden and the UK. In Sweden 30% of the main network is upgraded to 25 tonnes. Only one line in ERIM network accepts 30 tonnes, the "Malmbanan " (45 km) in Northern Sweden.

Map 12 shows the axle load picture in 2008 for the European network.

Line classification

Lines are generally classified in accordance with UIC Leaflet 700, which in addition to defining a maximum axle load also defines the maximum equivalent longitudinal distributed load which is acceptable. This leads to the classification reported in Figure 3.

This has an influence on the type of rolling stock which can be accepted on any route as it defines the spacing between axles in order to ensure that the longitudinal distributed load is not exceeded on any one wagon or traction unit in the train set.

Legend:

a	=	distance between axles
b	=	distance from end axle to the end of the nearest buffer
c	=	distance between the two inside axles
L	=	length of wagon over ends of buffers

Category	Mass per axle	Mass per unit length	Geometrical characteristics: b	a	c	a	b	L
A	P = 16 t	p = 5,0 t/m	1,50	1,80	6,20	1,80	1,50	L = 12,80
B1	P = 18 t	p = 5,0 t/m	1,50	1,80	7,80	1,80	1,50	L = 14,40
B2	P = 18 t	p = 6,4 t/m	1,50	1,80	4,65	1,80	1,50	L = 11,25
C2	P = 20 t	p = 6,4 t/m	1,50	1,80	5,90	1,80	1,50	L = 12,50
C3	P = 20 t	p = 7,2 t/m	1,50	1,80	4,50	1,80	1,50	L = 11,10
C4	P = 20 t	p = 8,0 t/m	1,50	1,80	3,40	1,80	1,50	L = 10,00
D2	P = 22,5 t	p = 6,4 t/m	1,50	1,80	7,45	1,80	1,50	L = 14,05
D3	P = 22,5 t	p = 7,2 t/m	1,50	1,80	5,90	1,80	1,50	L = 12,50
D4	P = 22,5 t	p = 8,0 t/m	1,50	1,80	4,65	1,80	1,50	L = 11,25
E4	P = 25 t	p = 8,0 t/m	1,50	1,80	5,90	1,80	1,50	L = 12,50
E5	P = 25 t	p = 8,8 t/m	1,50	1,80	4,75	1,80	1,50	L = 11,35

Figure 3 – Load Models Representing the Line Categories (UIC Leaflet 700)

Given the generally lower axle loads of passenger trains (excluding motive power unit) the imposition of limitations on maximum axle loads and line classification has a minor impact on passenger trains. The impact is greater on the configuration of wagon loading in freight trains and thus payloads of freight trains.

1.9 Maximum Train Load

About **88%** of the total ERIM network has maximum train load **lower that 3,000 tonnes** (in Germany it refers to trains without automatic coupling). Lines with maximum train load higher than 3000 tonnes are found in France, Latvia, Lithuania, Luxembourg, Poland, Sweden, and The Netherlands, see the following Map 13 for further details.

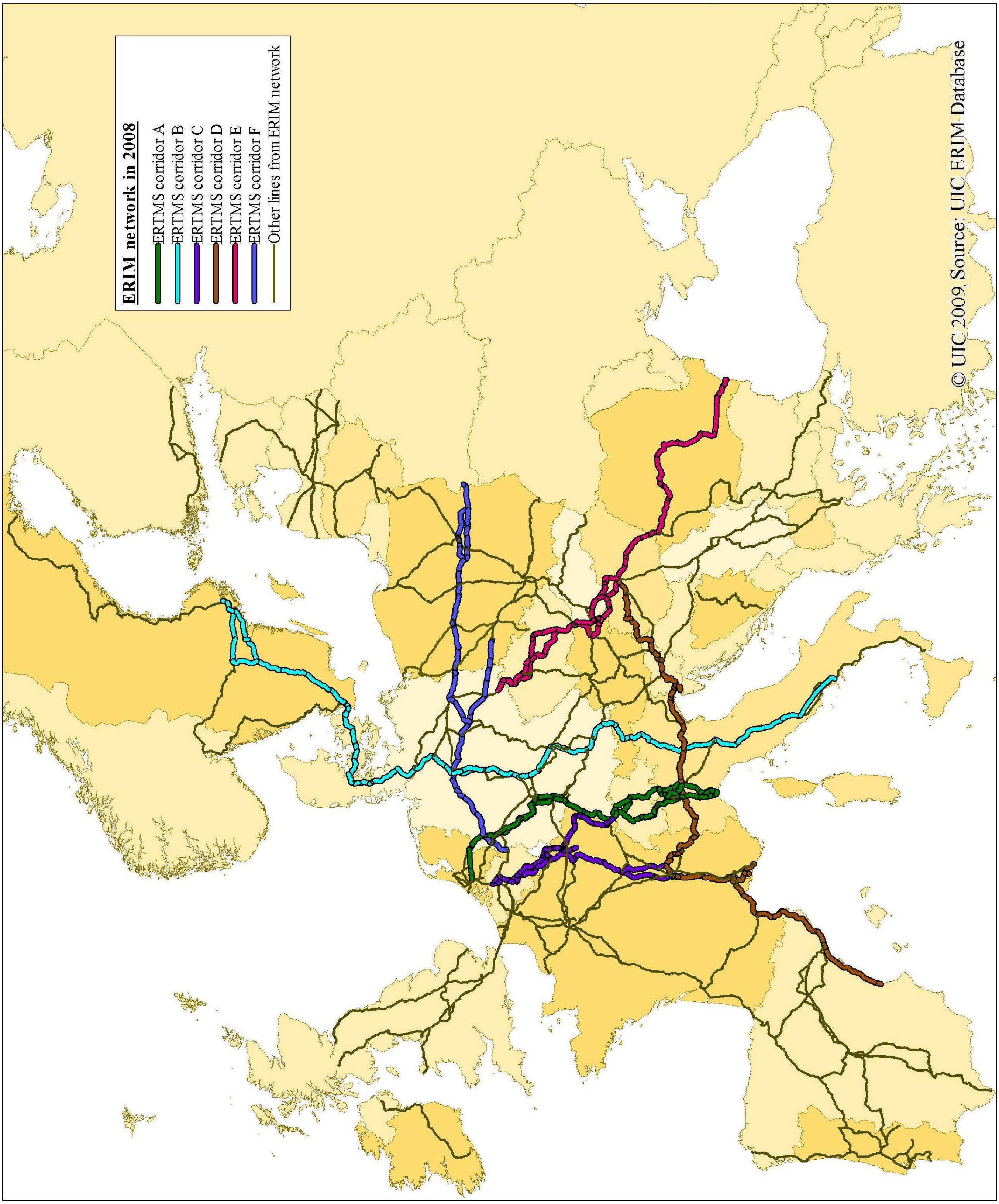
1.10 Maximum Train Length

Maximum train lengths are generally defined by the normal train configuration and length of platforms in the case of passenger trains and by the length of passing loops and sidings in the case of freight trains. Gradients and coupler capacity may also be influencing factors, particularly when long trains are combined with heavy individual wagon loads. For the ERIM project the key issue of restriction on maximum train length for international operations relates to freight trains. On conventional lines, provision needs to be made in the regular timetables and during operational disturbance, to park or divert freight trains to a holding loop or siding in order to allow faster or higher priority trains to pass during the course of the journey. Therefore the existing characteristics of the network have an important influence on the ability to accept long trains. **Currently about 39% of the ERIM network (19,736 km) can accommodate train lengths of 750 metres or higher**. However, some individual countries have lower limits, such as:

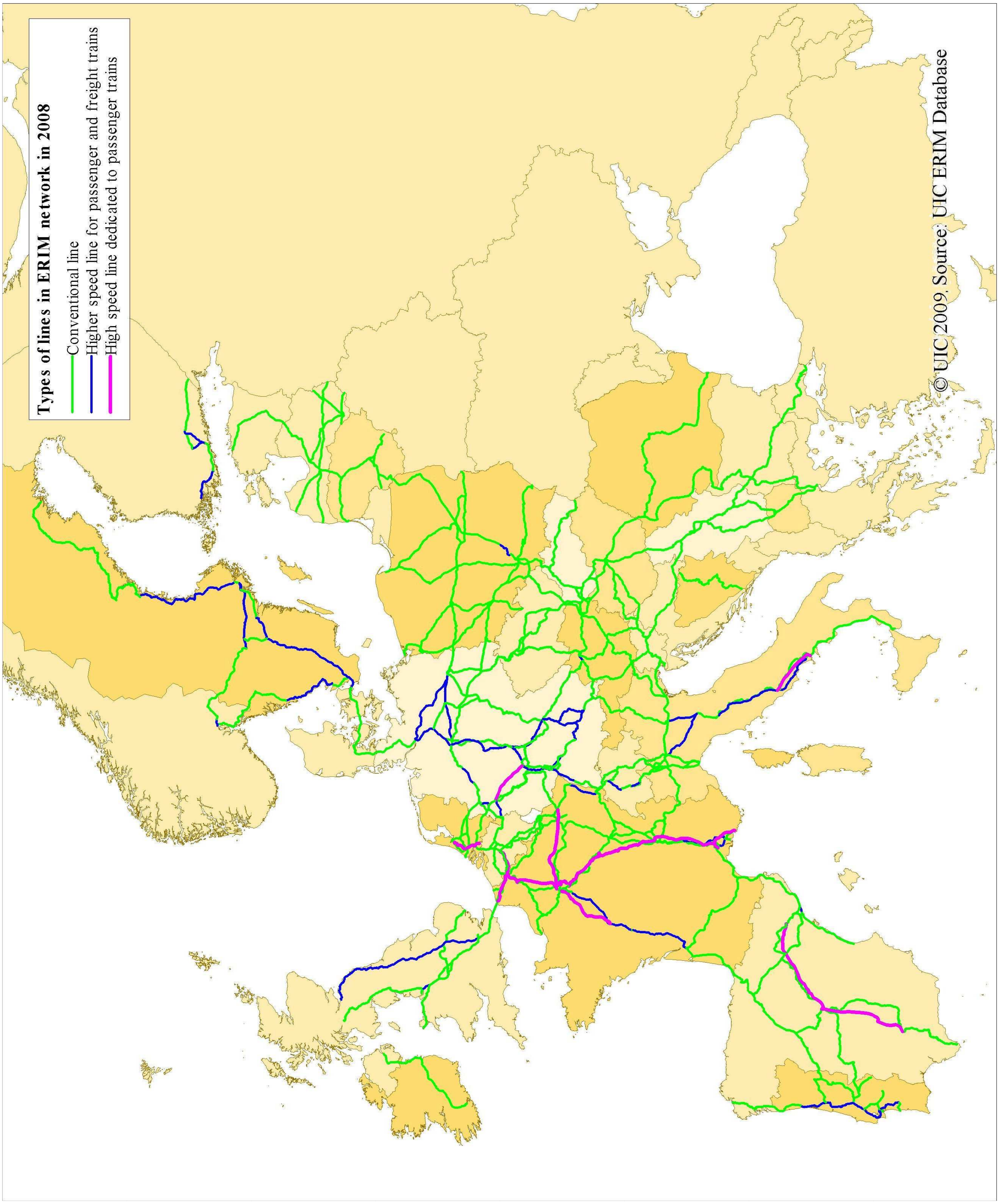
- Austria (700 m)
- Belgium (600 m)
- Bosnia-Herzegovina (500 - 650 m)
- Bulgaria (550 - 650 m)
- Croatia (500 - 600 m)
- Czech Republic (600 - 700 m)
- Finland (725 m)
- Hungary (500 - 700 m)
- Ireland (215 m)
- Italy (500 - 600 m; 355 m on Ovada-Genova)
- Luxembourg (600 - 700 m)
- Macedonia (525 m)
- Norway (600 m)
- Poland (400 - 740 m - mostly 600 m)
- Portugal (450 - 600 m)
- Romania (600 - 700 m)
- Serbia (500 - 600 m)
- Slovak Republic (650 - 725 m; 240 m on Skalite-Zwardon)
- Slovenia (550 - 600 m)
- Spain (450 - 600 m - mostly 500 m; 350 m on Redondela-Santiago)
- Sweden (630 m)
- The Netherlands (540 - 700 m).

According to several studies and experts the limitations on train lengths constitute a major constraint to the development and commercial viability of freight traffic. This has to be taken into consideration in parallel with constraints on axle loads, double stacking containers and on “piggy-backing” – rolling highway over large parts of the network.

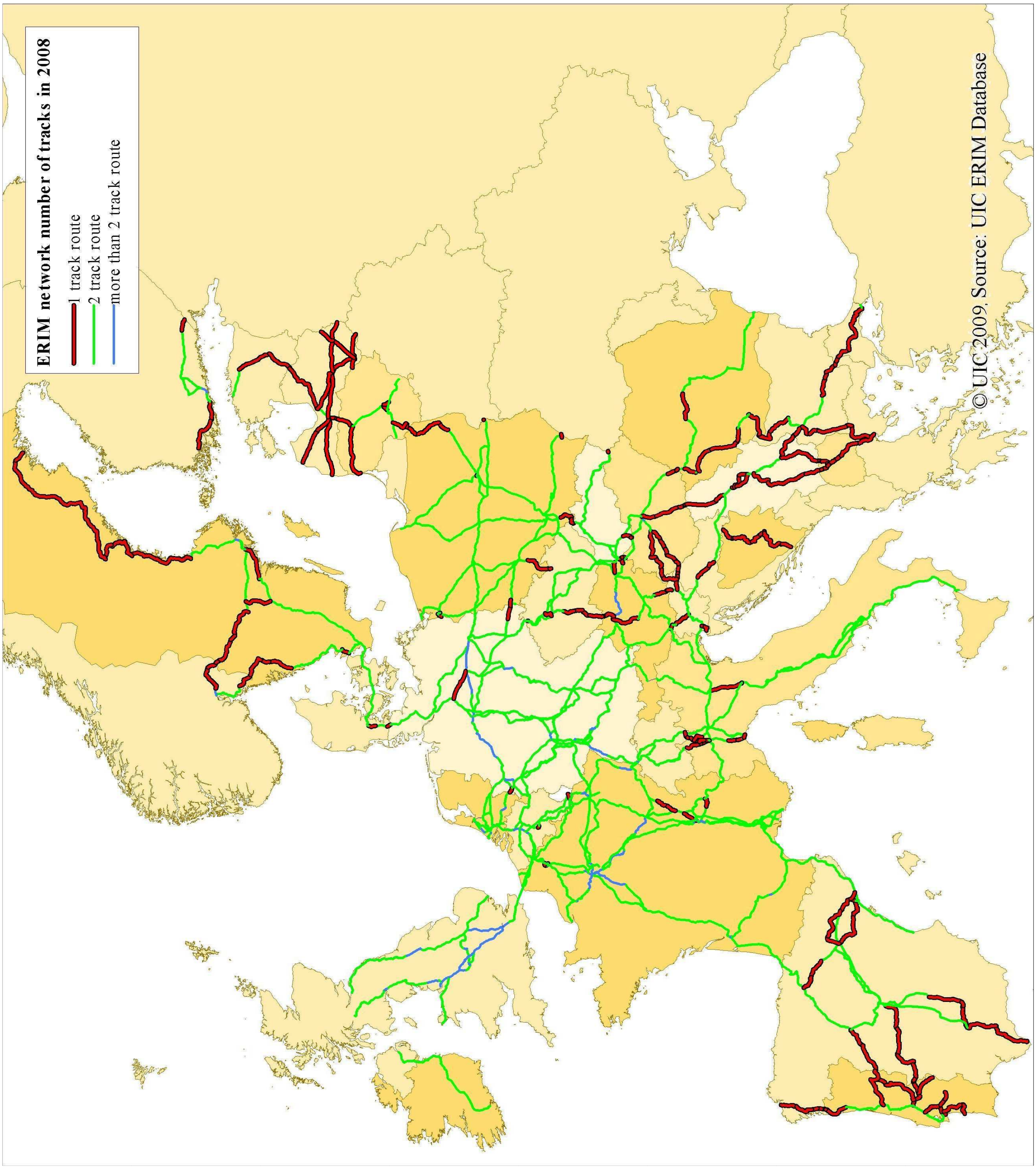
Map 14 shows the picture of maximum train length in 2008 for the European ERIM network.



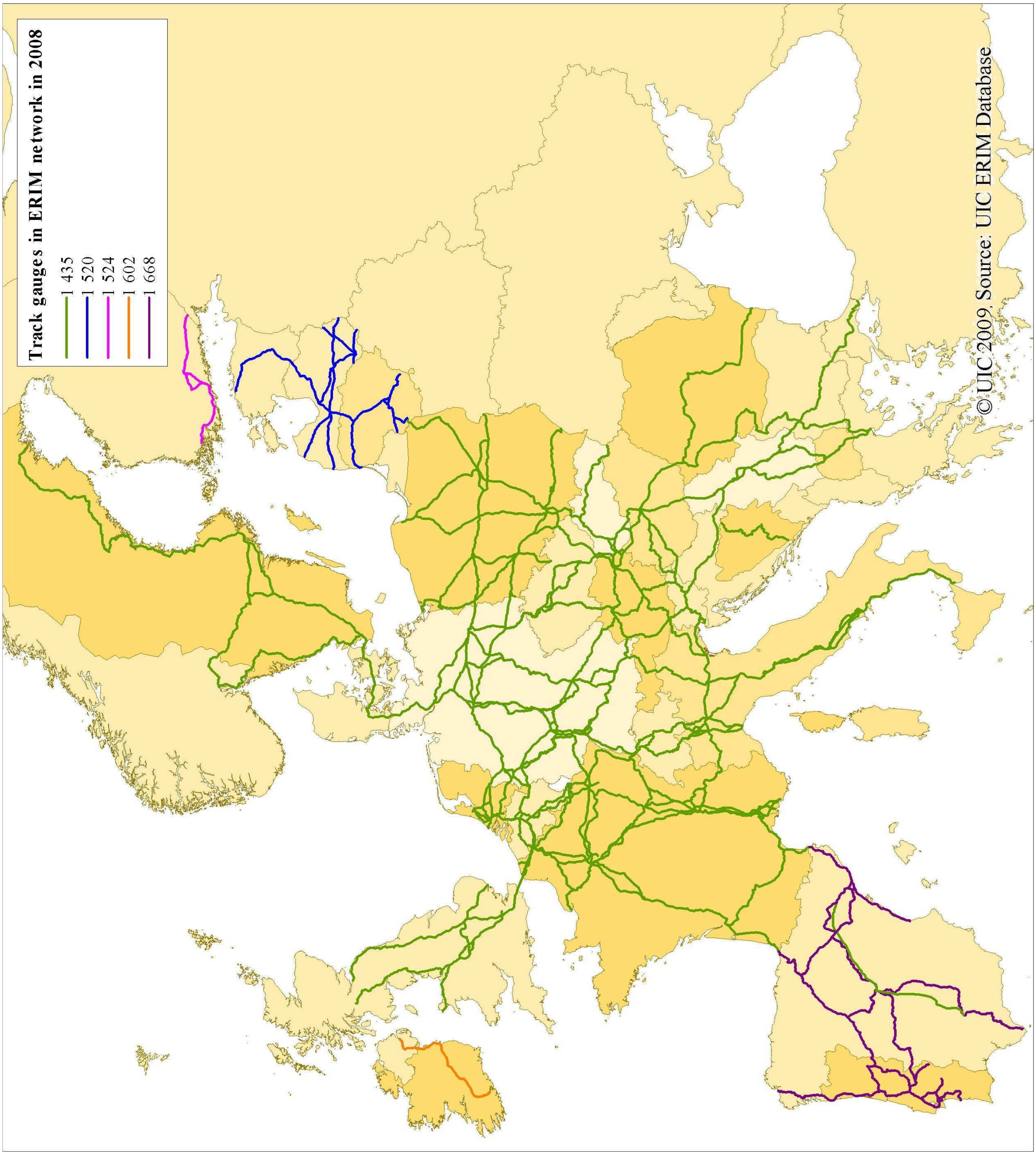
Map 1 – ERIM Network in 2008



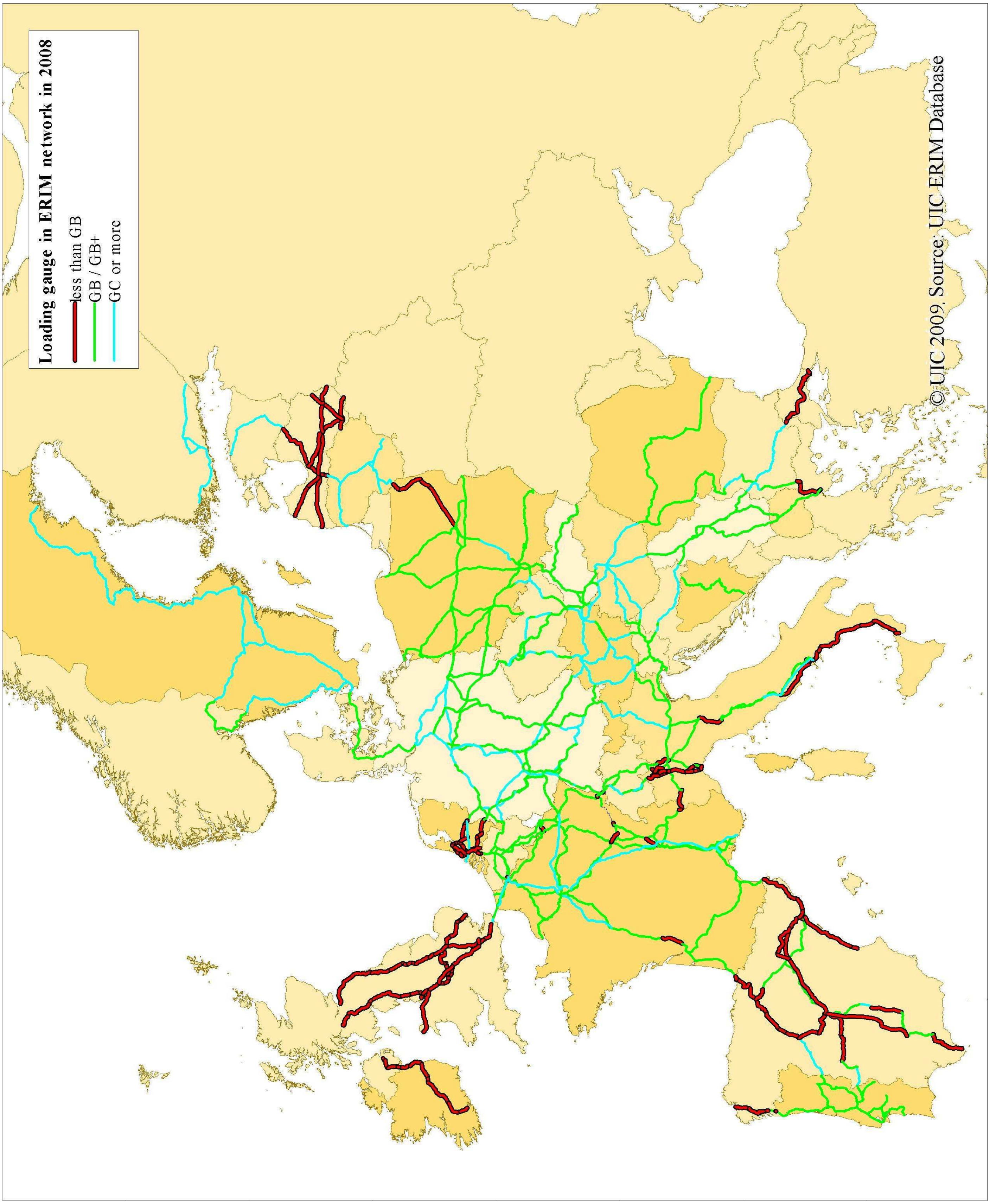
Map 2 – Types of Lines in 2008



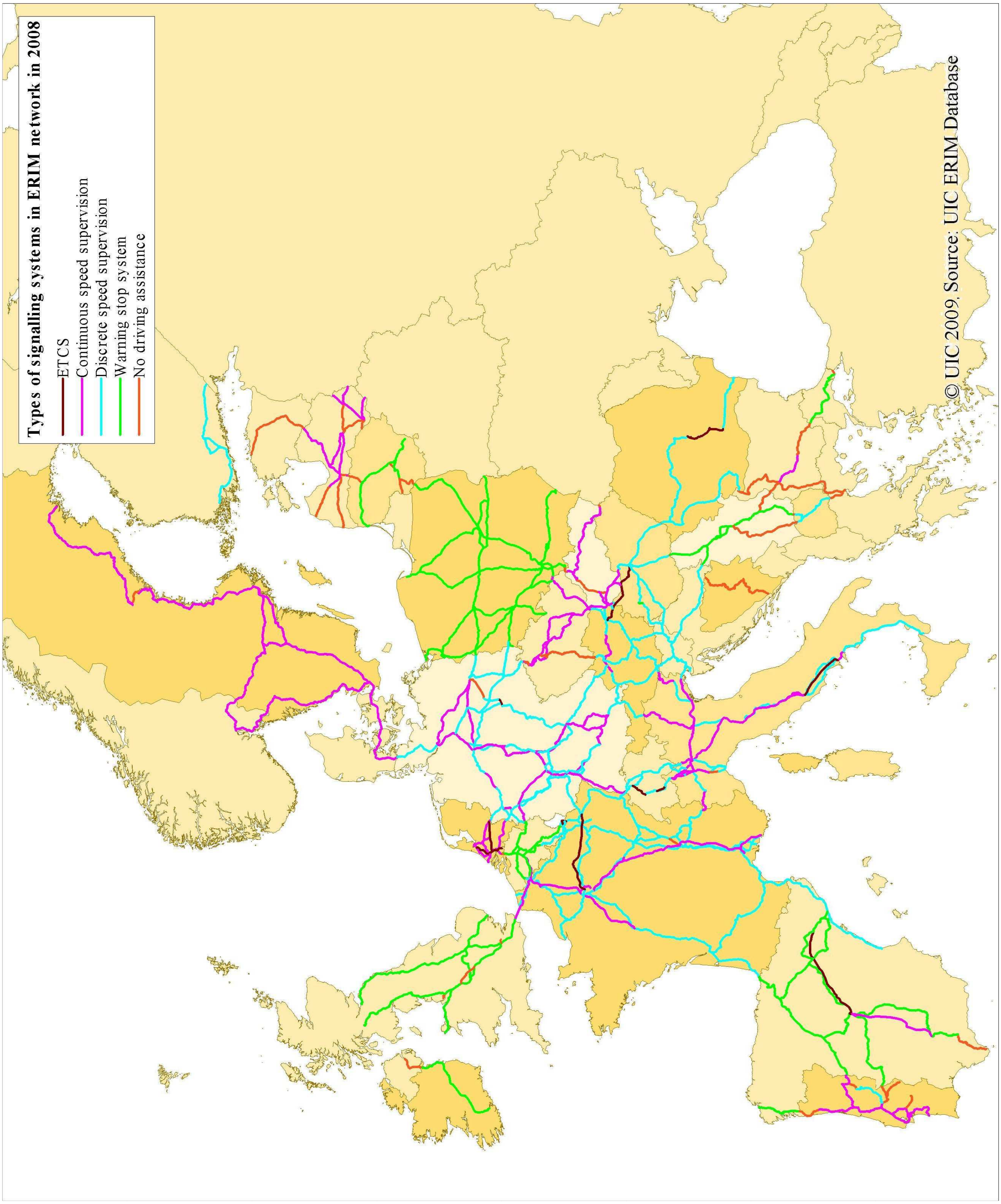
Map 3 – The Number of Tracks in 2008



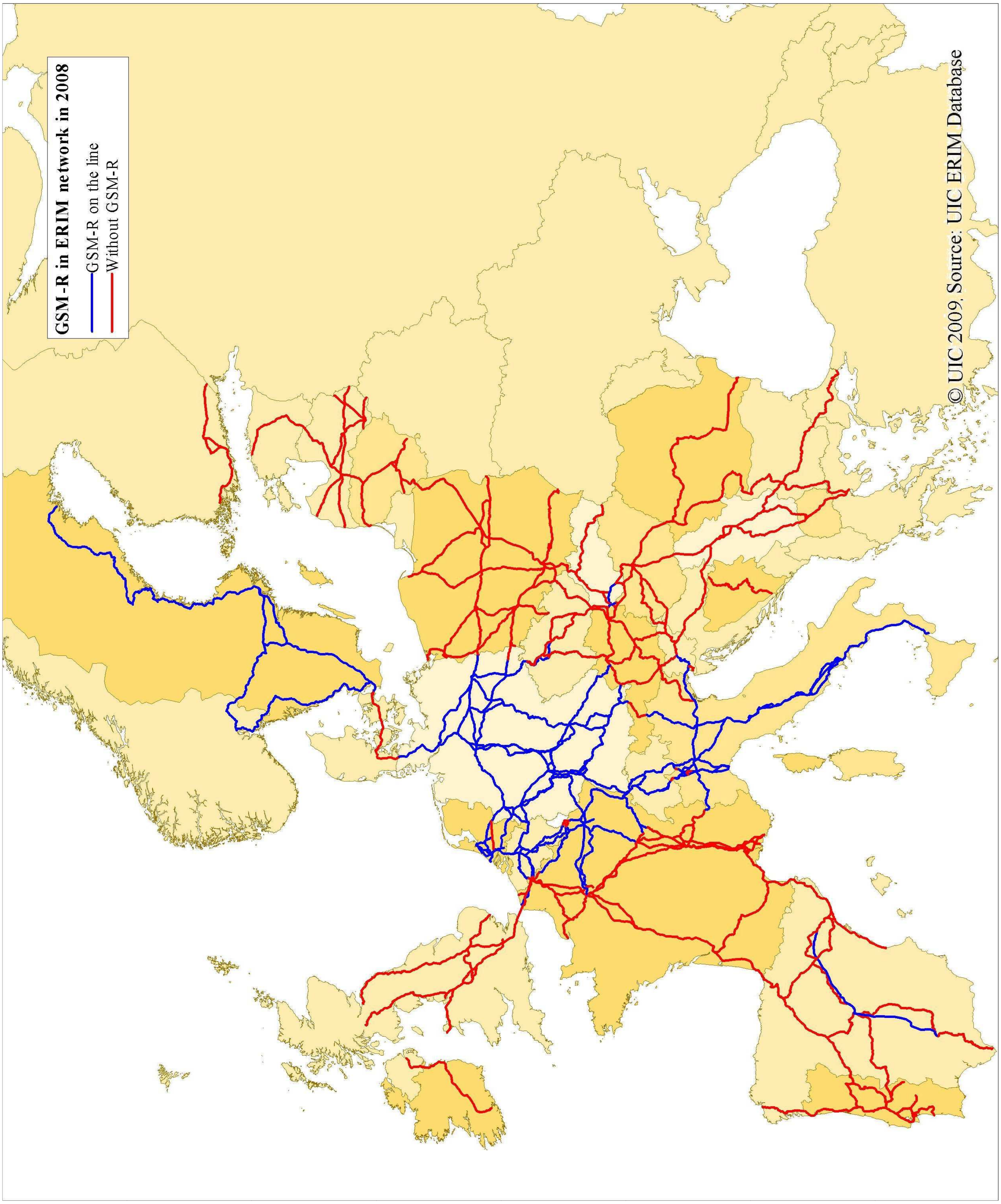
Map 4 – Track Gauges in 2008



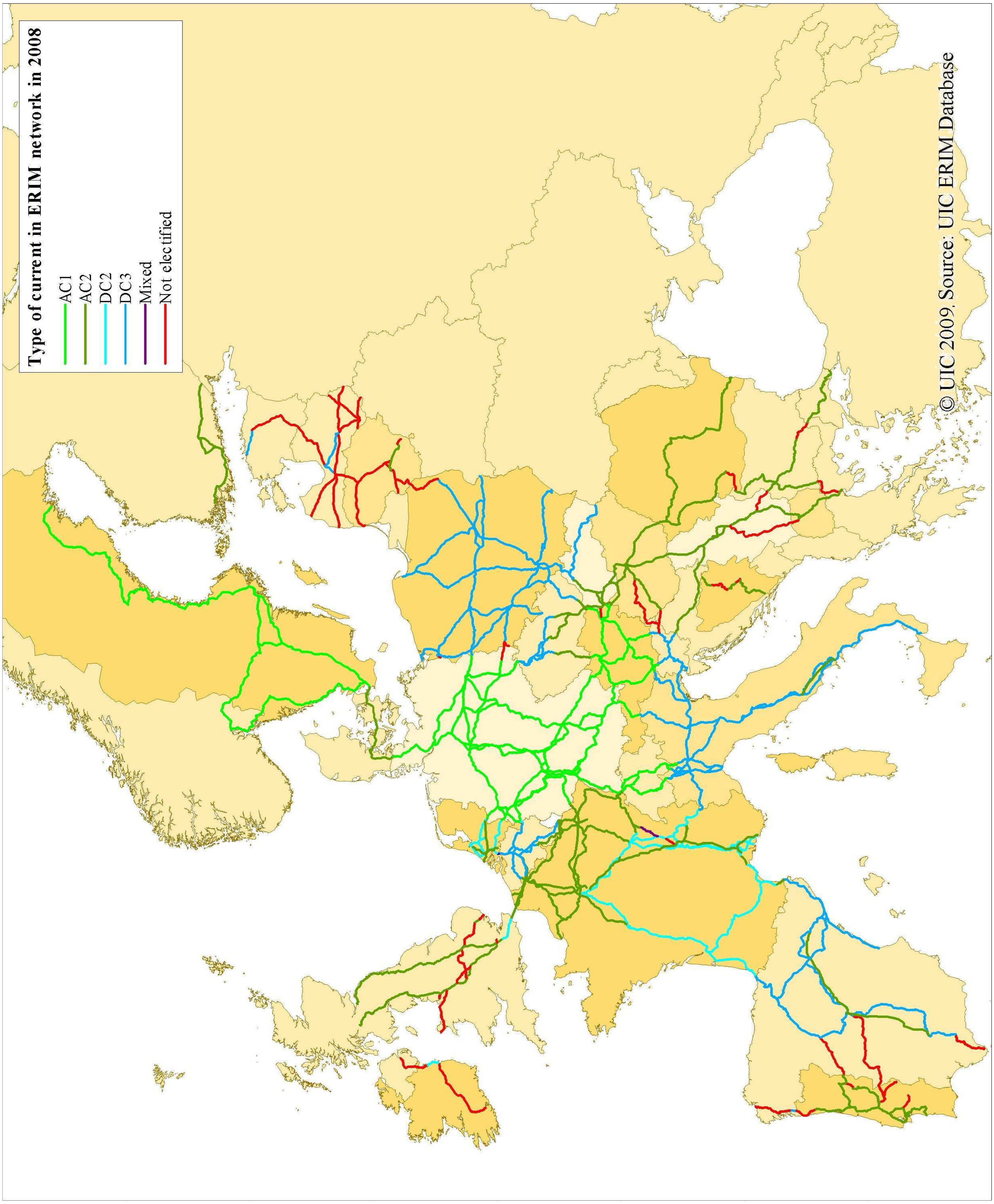
Map 5 – Loading Gauge in 2008



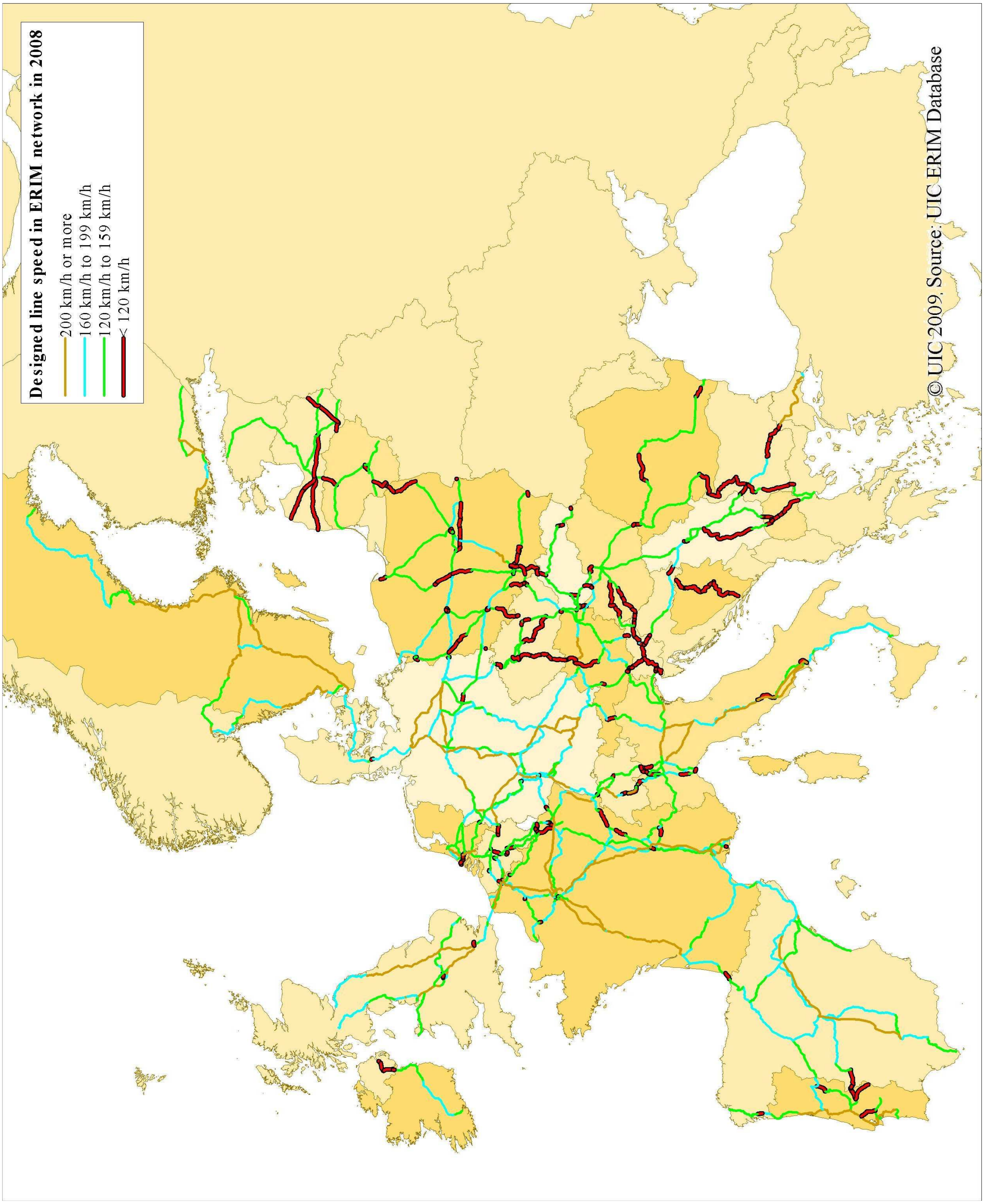
Map 6 – Signalling Systems in 2008



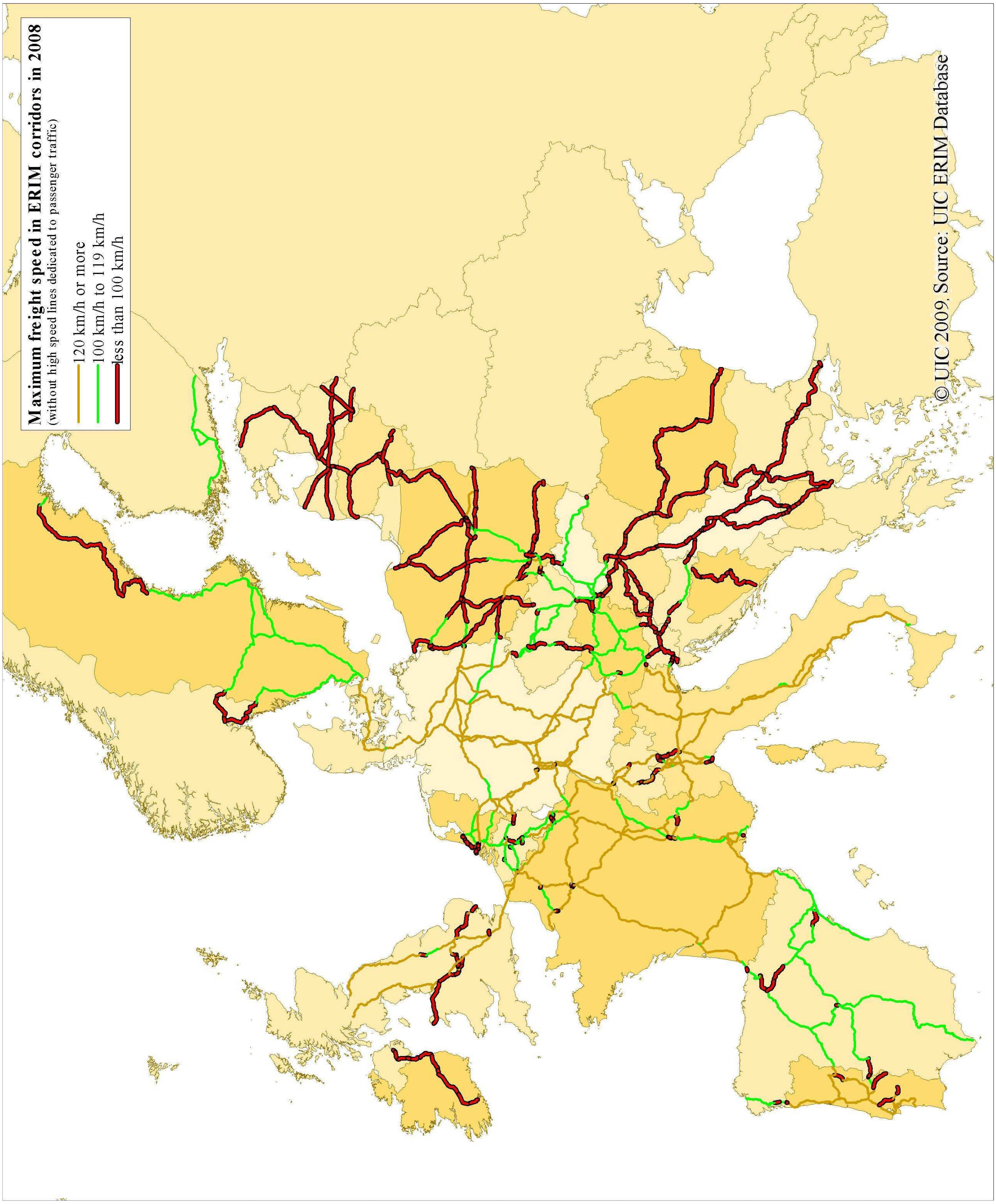
Map 7 – GSM-R in 2008



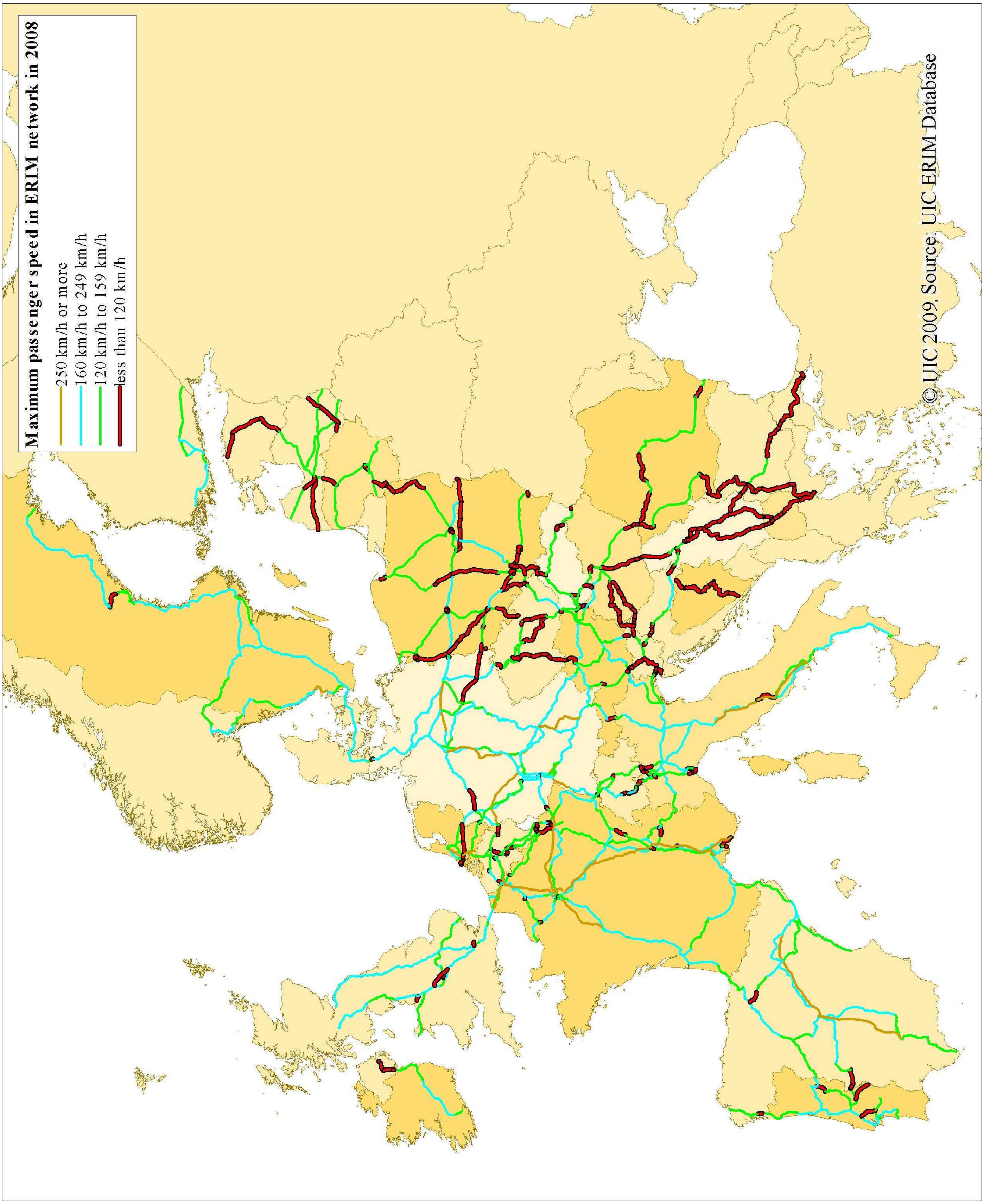
Map 8 – Type of Current in 2008



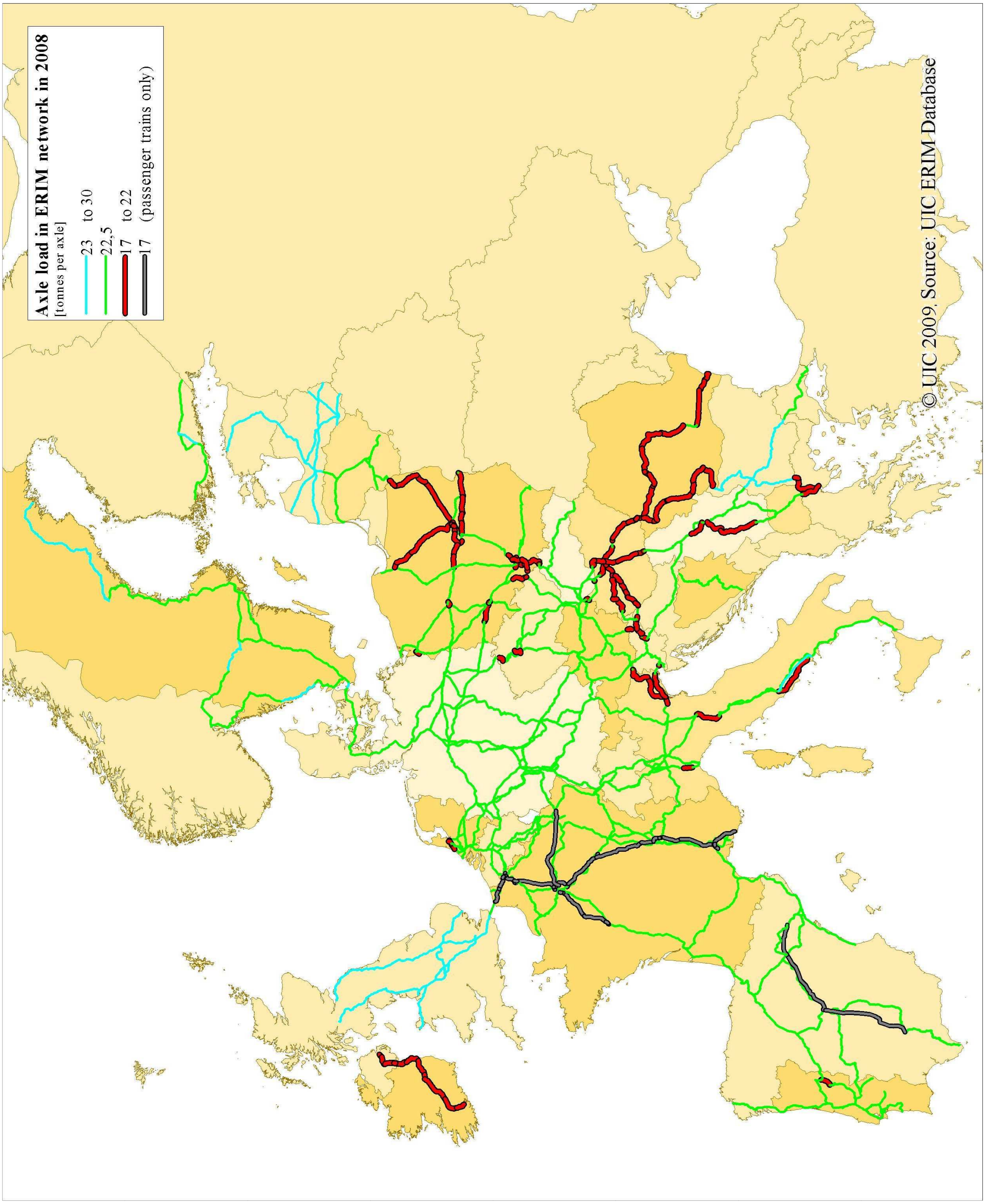
Map 9 – Designed Line Speed in 2008



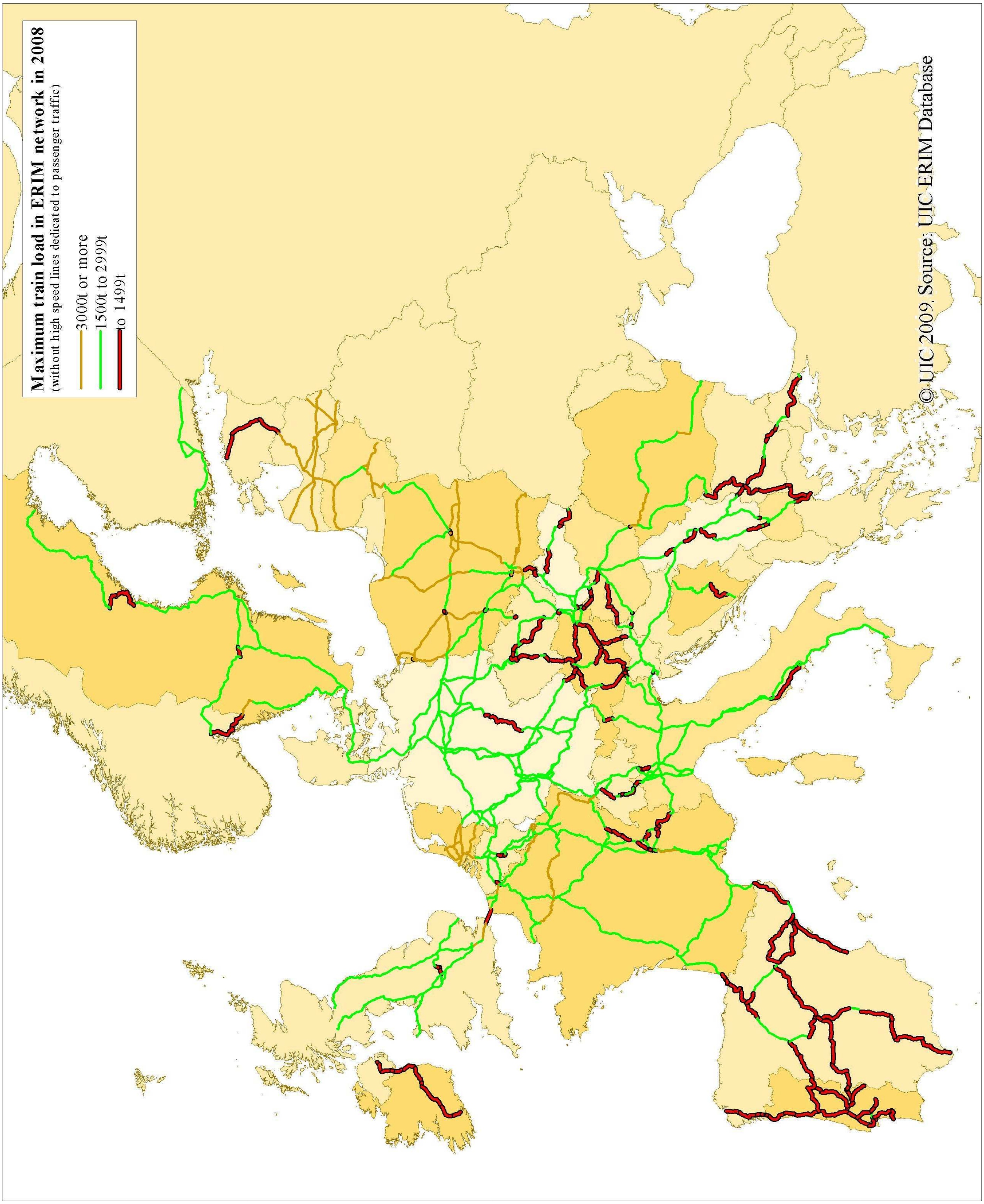
Map 10 – Maximum Freight Speed in 2008



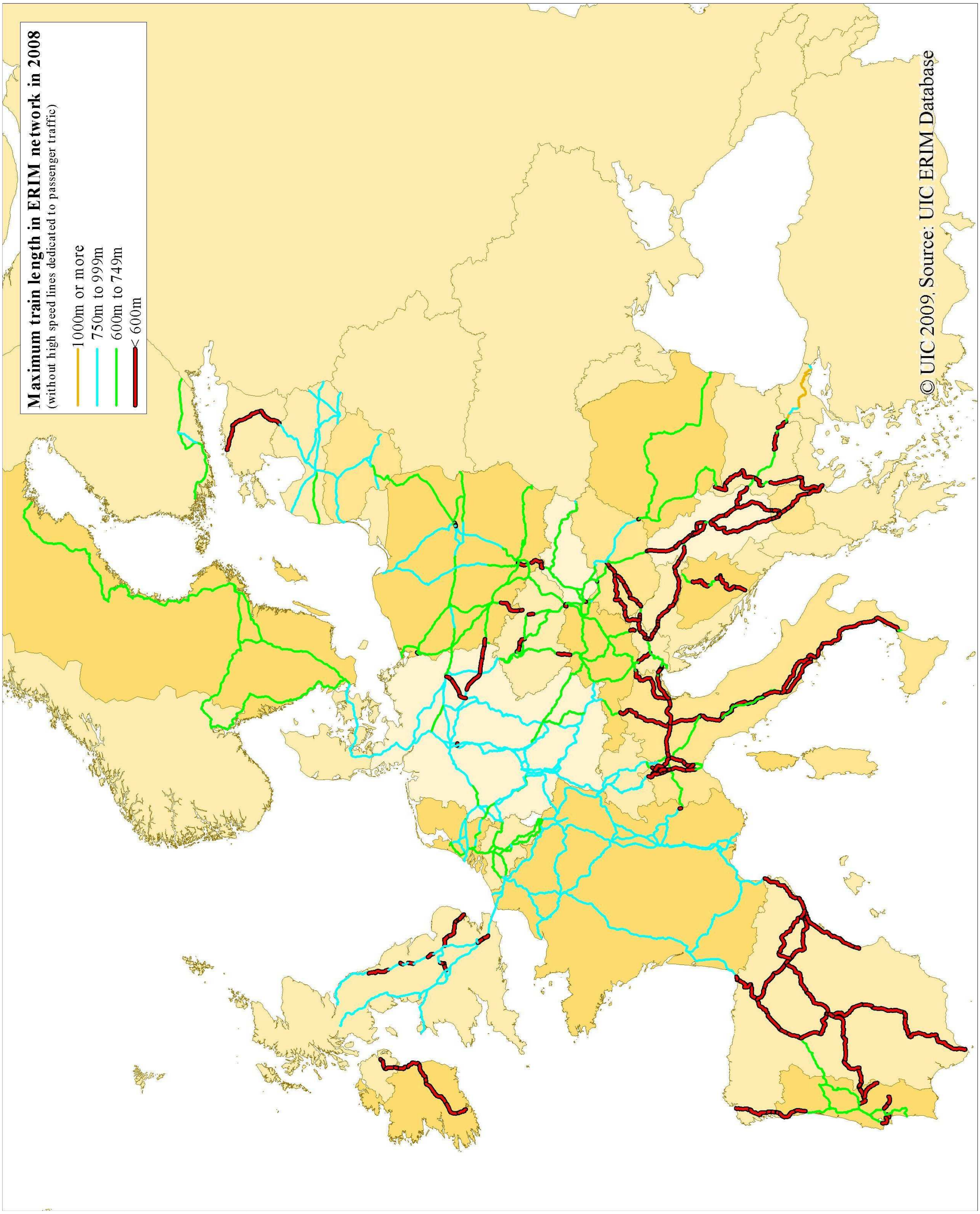
Map 11 – Maximum Passenger Speed in 2008



Map 12 – Axle Load in 2008



Map 13 – Maximum Train Load in 2008



Map 14 – Maximum Train Length in 2008

2 The Projected Infrastructure Details in ERIM Network in 2020

The 2020 infrastructure details are based on the current projections of renewal, upgrading and investment programmes which have been incorporated into the ERIM Infrastructure and Investment questionnaire by the Infrastructure Managers.

2.1 Number of Tracks

The ERIM network is anticipated to increase to 54,392 route km and to 1,213 line sections by 2020. The kilometres can be broken down as follows (see map 15):

- **single track** route 9,653 km (about 18%);
- **double track** route 41,646 km (about 77%);
- **more than double track** route 3,093 km (about 5%).

The histogram in figure 4 shows the changes 2008-2020 of the ERIM network in track configuration. The main new additions to the routes are to be found in Austria, Italy, Slovenia, Spain, Sweden, Switzerland, and The Netherlands.

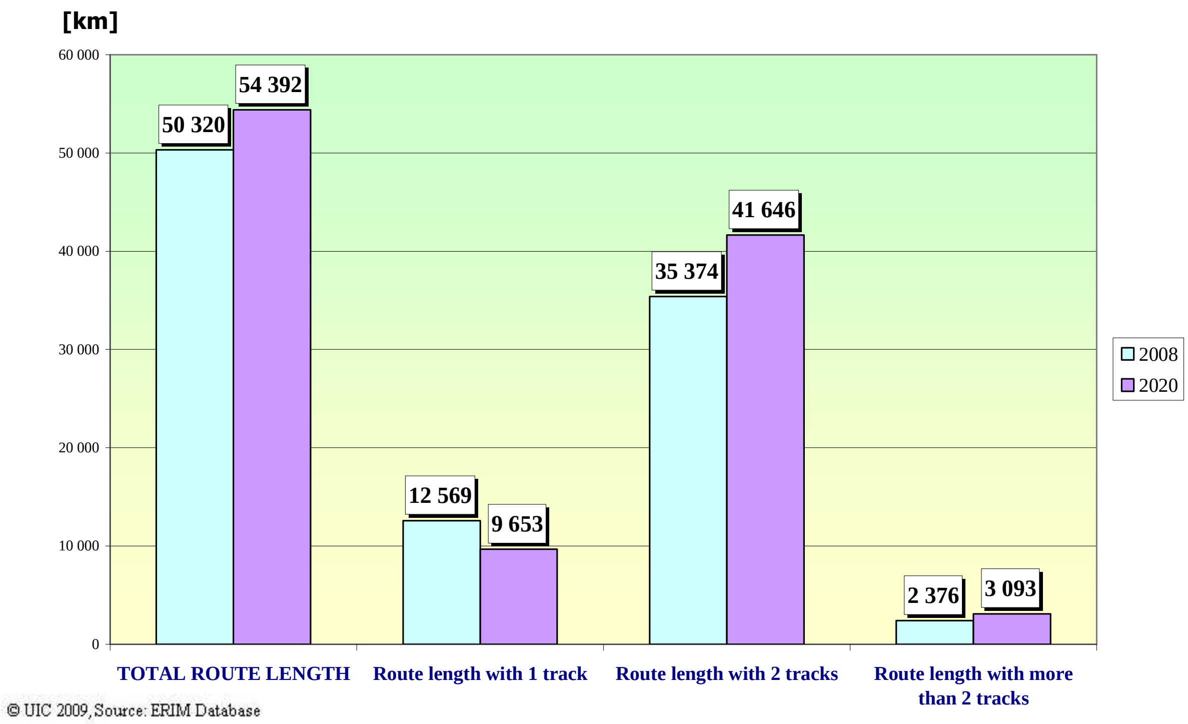


Figure 4 – The Number of Tracks in ERIM Network 2008-2020

2.2 Loading Gauge

The loading gauge picture in 2020 is given in map 16.

While there is a relatively large increase in the areas where GC gauge will be permissible (25% in 2008 to 36% in 2020) the predominant permissible loading gauge is **GB or GB+ (46% of ERIM network in 2020).**

The histogram in figure 5 reports the changes 2008-2020 of the ERIM network in loading gauge.

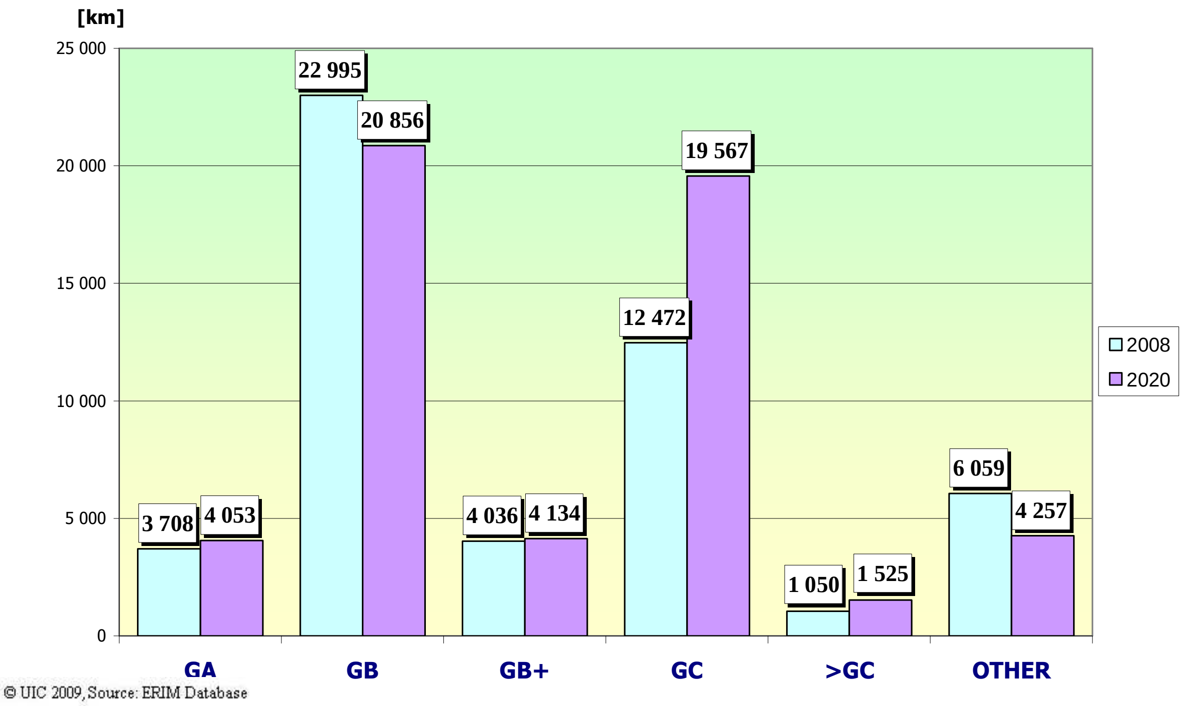


Figure 5 – Loading Gauge 2008-2020

2.3 Signalling Systems and Telecommunications

A significant shift towards ETCS in all areas of the ERIM network has been projected by the Railways (see Map 17). The quantity of **ETCS** is planned to increase to 40,122 km, representing about **74%** of the ERIM network in 2020 (refer to figure 6).These figures need to be seen as aspiration because they are not fully identified in the detailed planning and contracted projects. Therefore they probably are not all included into the investments plans that are referred to in the ERIM investment analysis in the section 5.

The coverage of **GSM-R** in actual service by 2020 is expected to be 53,784 km (about **99%** of ERIM network – see Map 18). GSM-R will be configured to carry both voice and data traffic to support ETCS Level 2 or higher applications over the route-kms where this application will be installed. The UIC ERTMS data on GSM-R has been cross-checked with the ERIM data-base and taken into account for UK, Croatia and Turkey.

Figure 6 shows the changes 2008-2020 of the ERIM network in ETCS and GSM-R coverage.

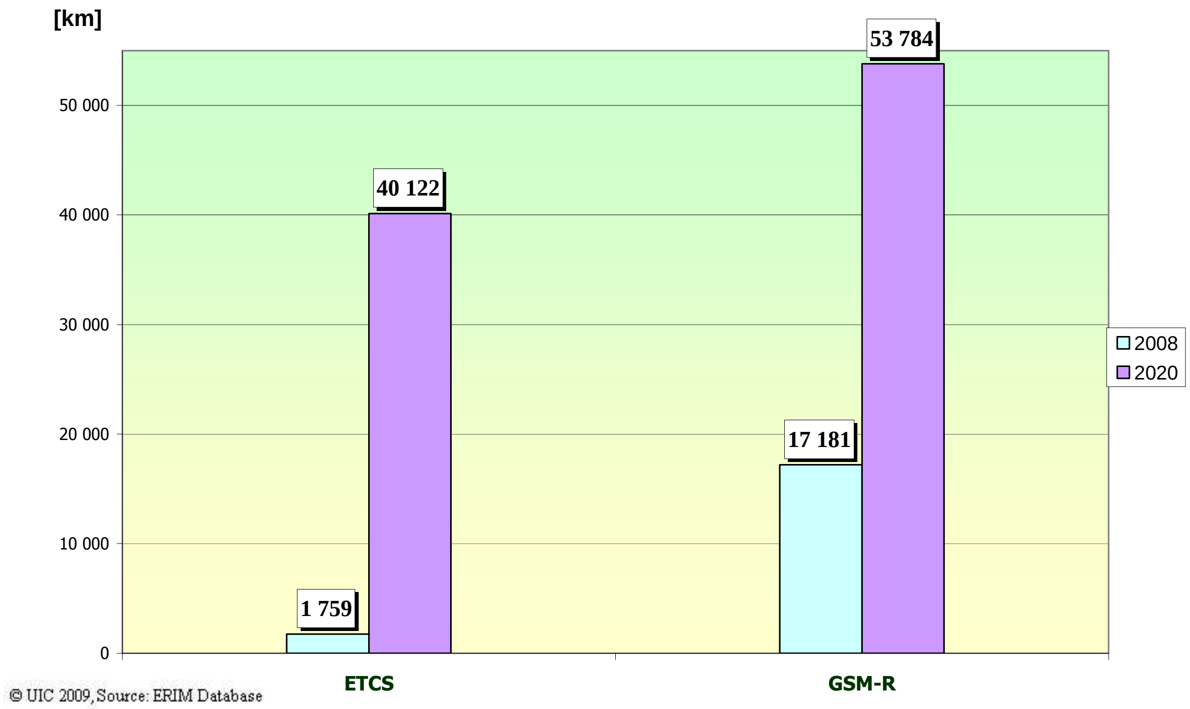


Figure 6 – ETCS and GSM-R 2008-2020

2.4 Type of Current

There is a clear indication of a shift towards AC traction systems, with AC 25kV 50Hz becoming the system of greatest extent. The overall ERIM network displays **AC systems** (25kV, 50Hz and 15kV, 16Hz) totalling about **66%** (35,873 km) of the network and DC systems (1500 DC, 3000 DC) totalling about 29% (15,578 km). The 2,858 km (5%) will not be electrified.

Figure 7 shows the changes 2008-2020 and the future situation is reported in map 19.

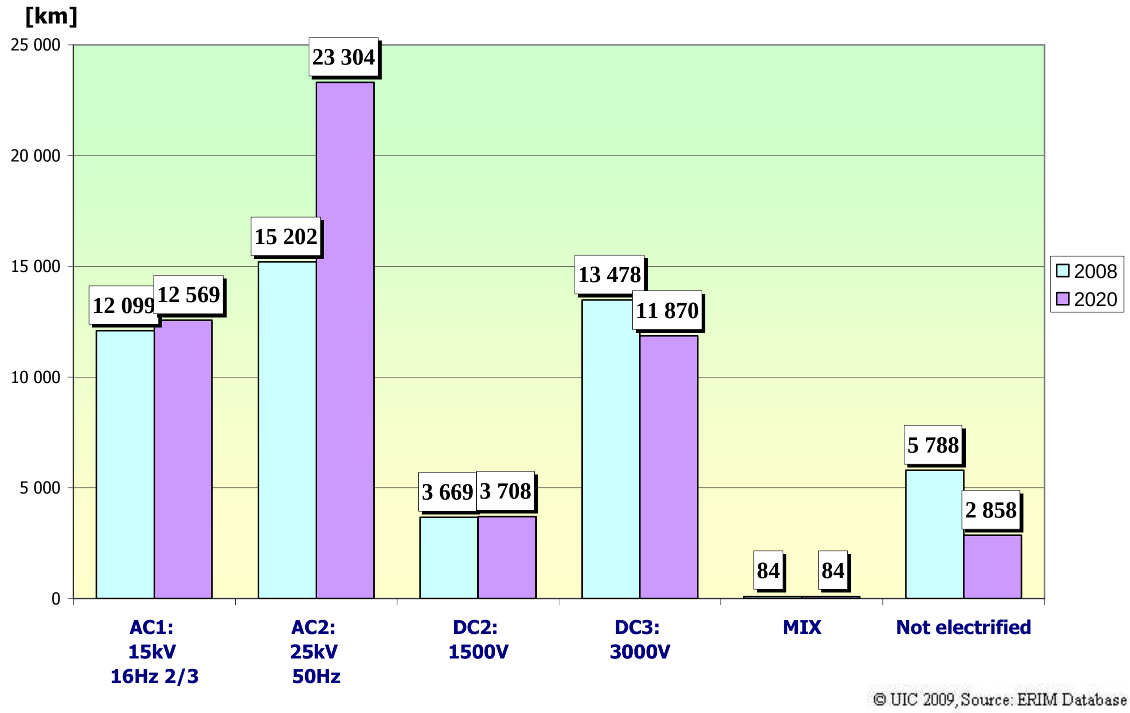


Figure 7 – Type of Current 2008-2020

2.5 Maximum Speed

There is a projected gradual movement in the maximum speeds throughout the ERIM network - refer to the geographical representation reported in maps 20, 21 and 22. The most significant changes will arise in relation to **passenger traffic in the range 160-249 km/h and freight in the range 120 km/h of more.** Figures 8 and 9 show the changes 2008-2020 for passenger and freight line speeds respectively.

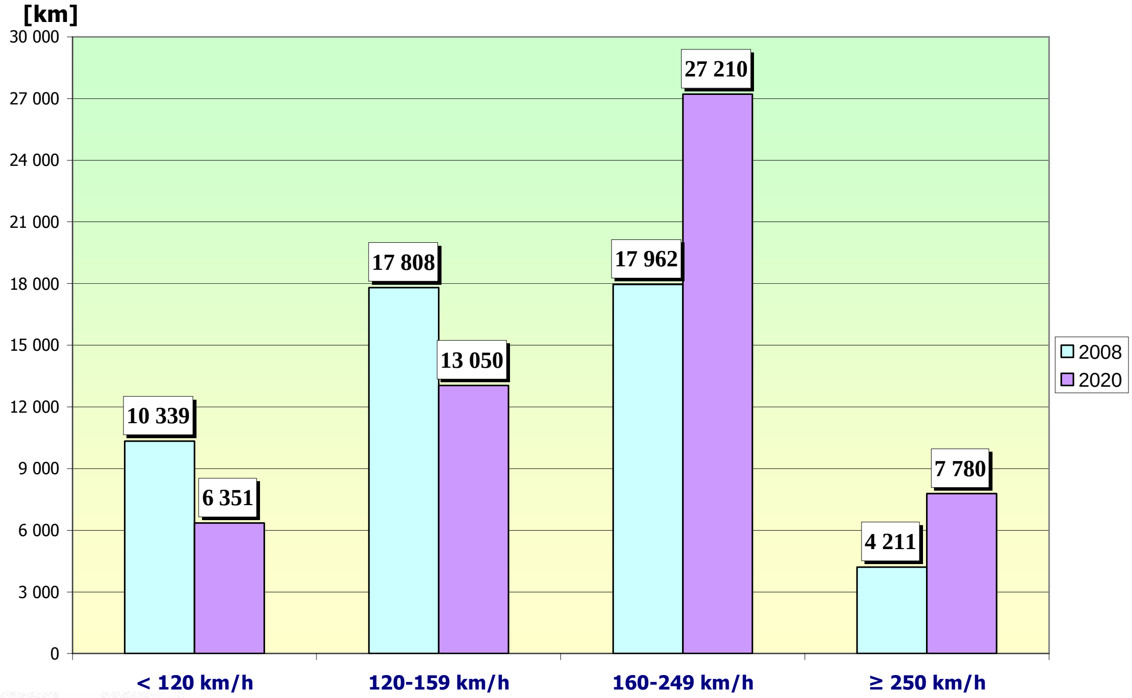


Figure 8 – Maximum Speeds for Passenger Trains 2008-2020

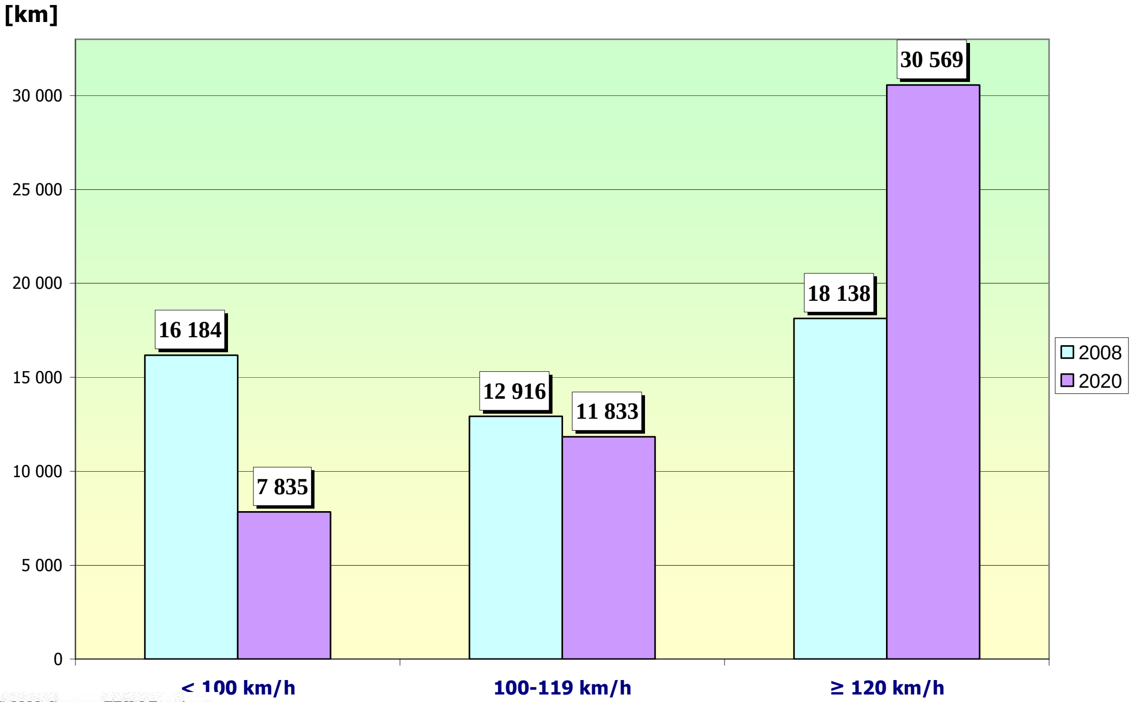


Figure 9 – Maximum Speeds for Freight Trains 2008-2020

2.6 Maximum Axle Load and Line Classification

The majority of the ERIM network will still have a maximum axle load limitation of **22.5 tonnes**. However, the length of routes permitted to carry axle load in the range 23 to 30 tons is expected to increase from 5,554 km (11% of current network) to 10,495 km (19% of the 2020 network).

The following map 23 reports the geographical representation of the maximum axle loads in 2020.
Figure 10 shows the changes 2008-2020 for axle load category.

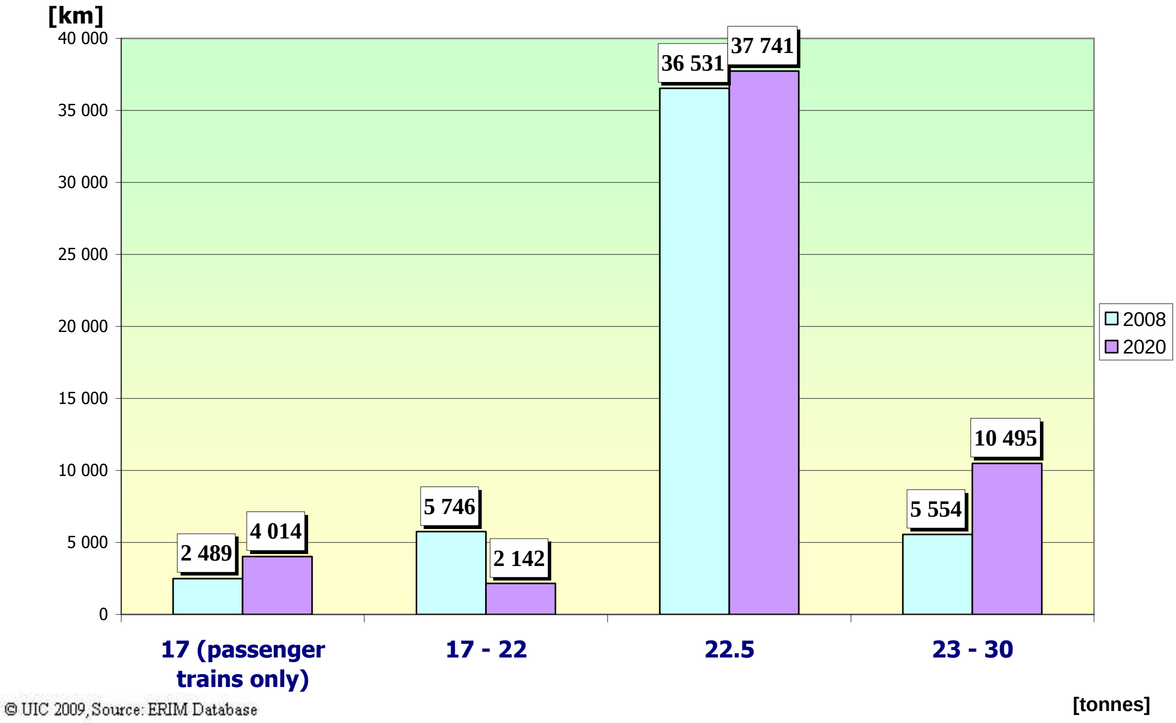


Figure 10 – Axle Load 2008-2020

2.7 Maximum Train Load

There is **no significant overall change** to the limitations on train loads. The changes in the loading ranges are shown in figure 11.

Map 24 shows the geographical representation of the maximum train load over the ERIM network.

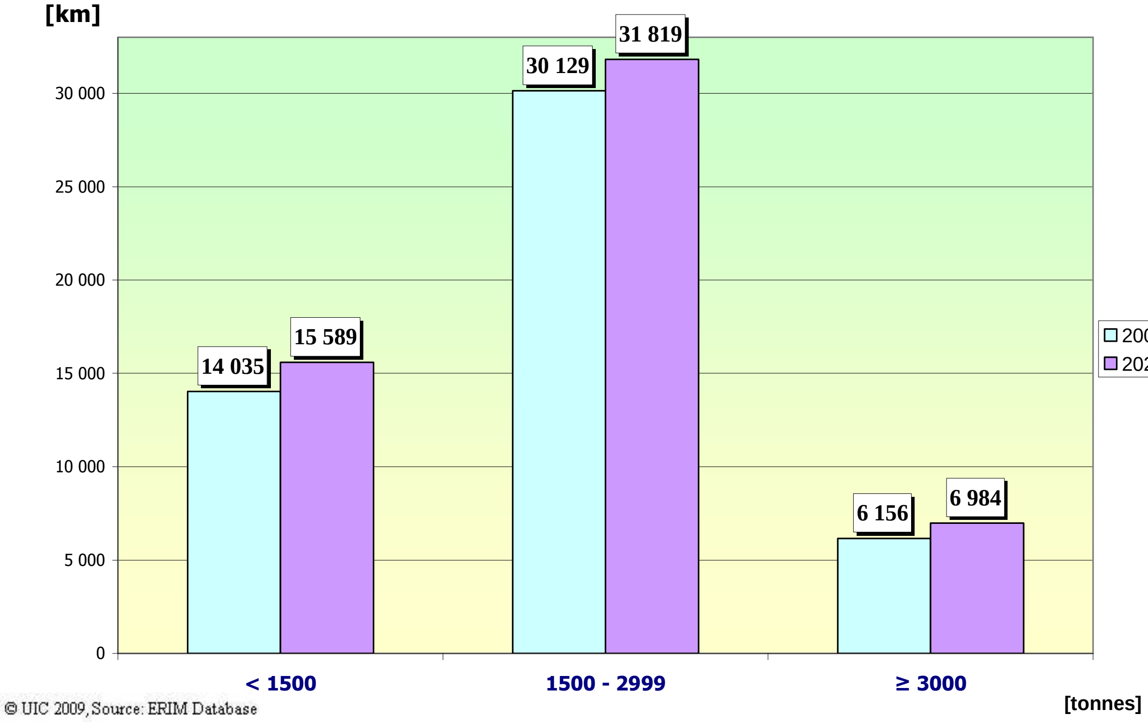


Figure 11 – Maximum Train Loads 2008-2020

2.8 Maximum Train Length

There is some indication of a move towards accommodating longer train lengths in the range of **750-999 metres**. From 39% of the current ERIM network to **55%** of the 2020 network (refer to map 25).

Figure 12 shows the changes 2008-2020 for maximum train length category.

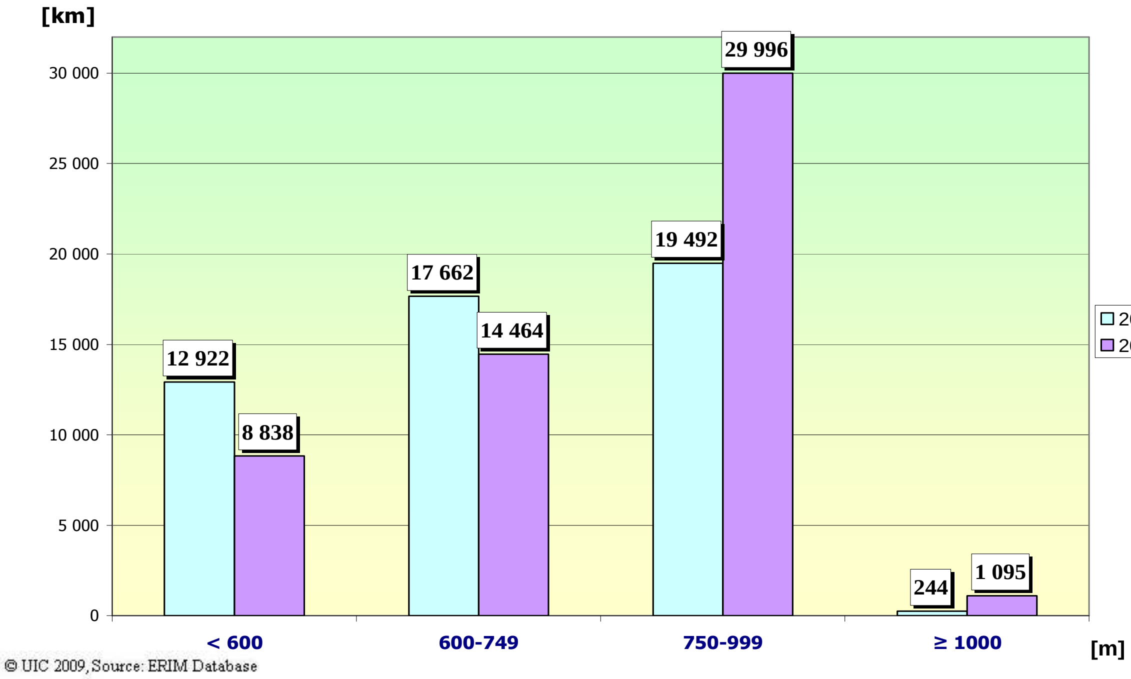
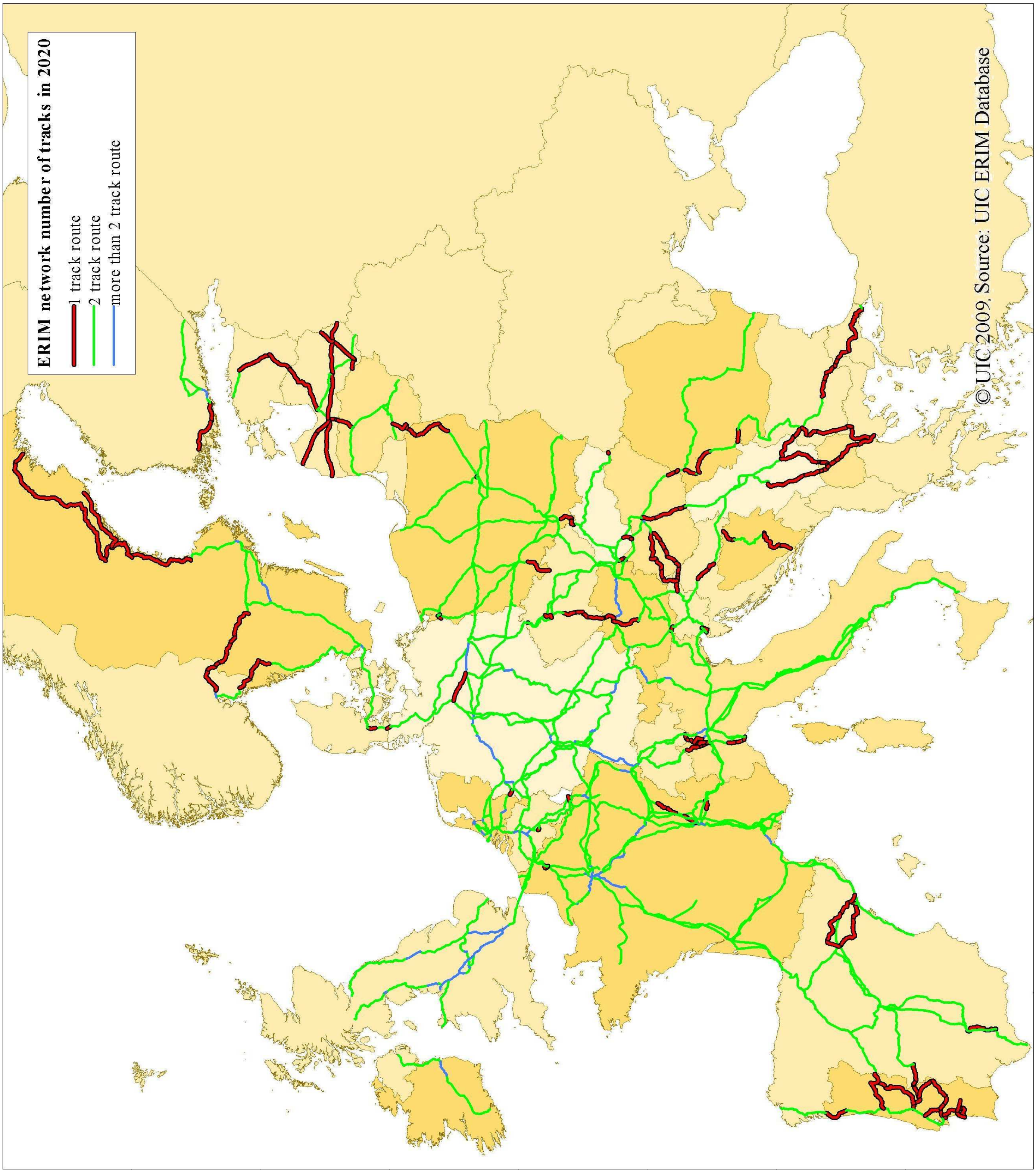
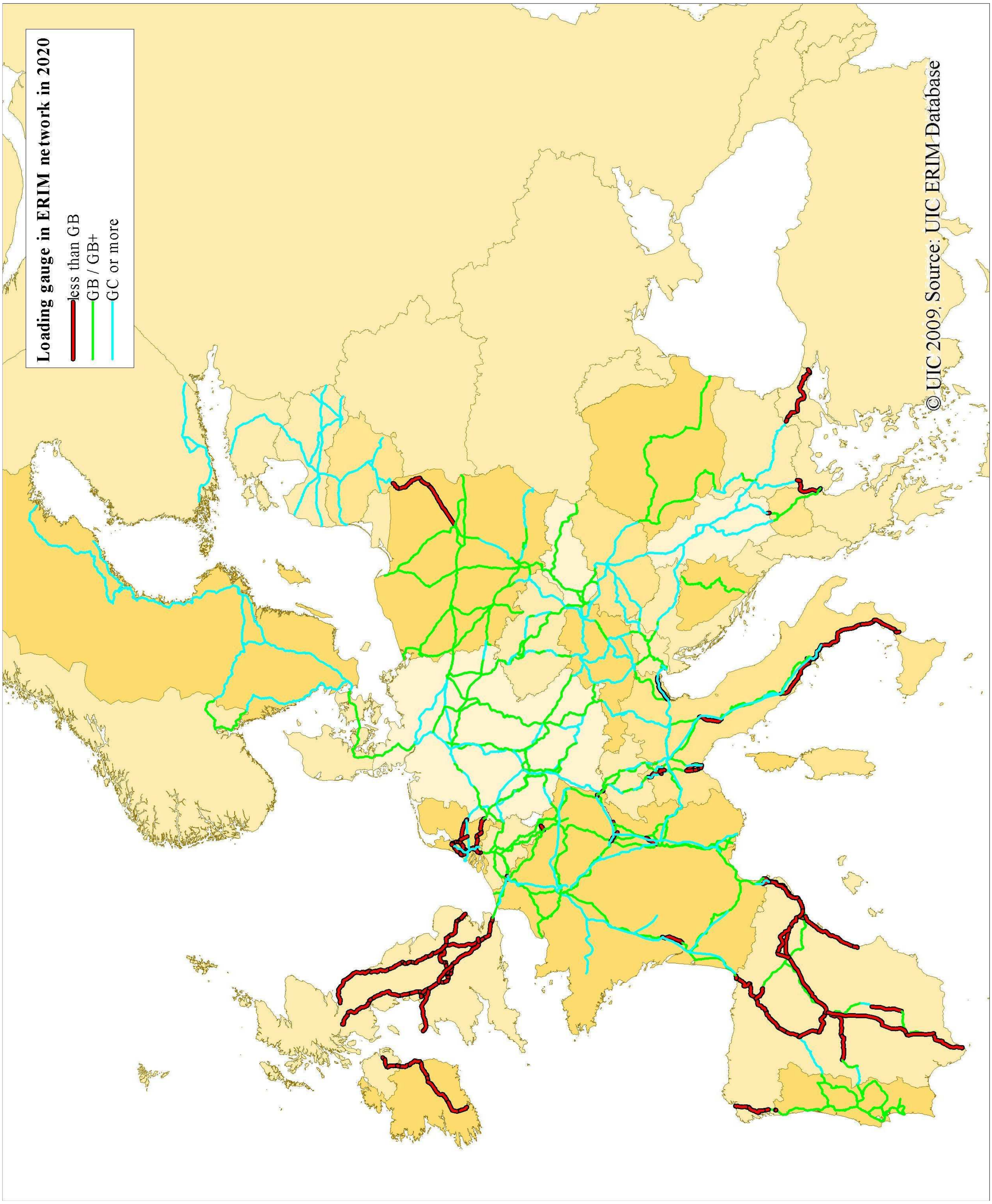


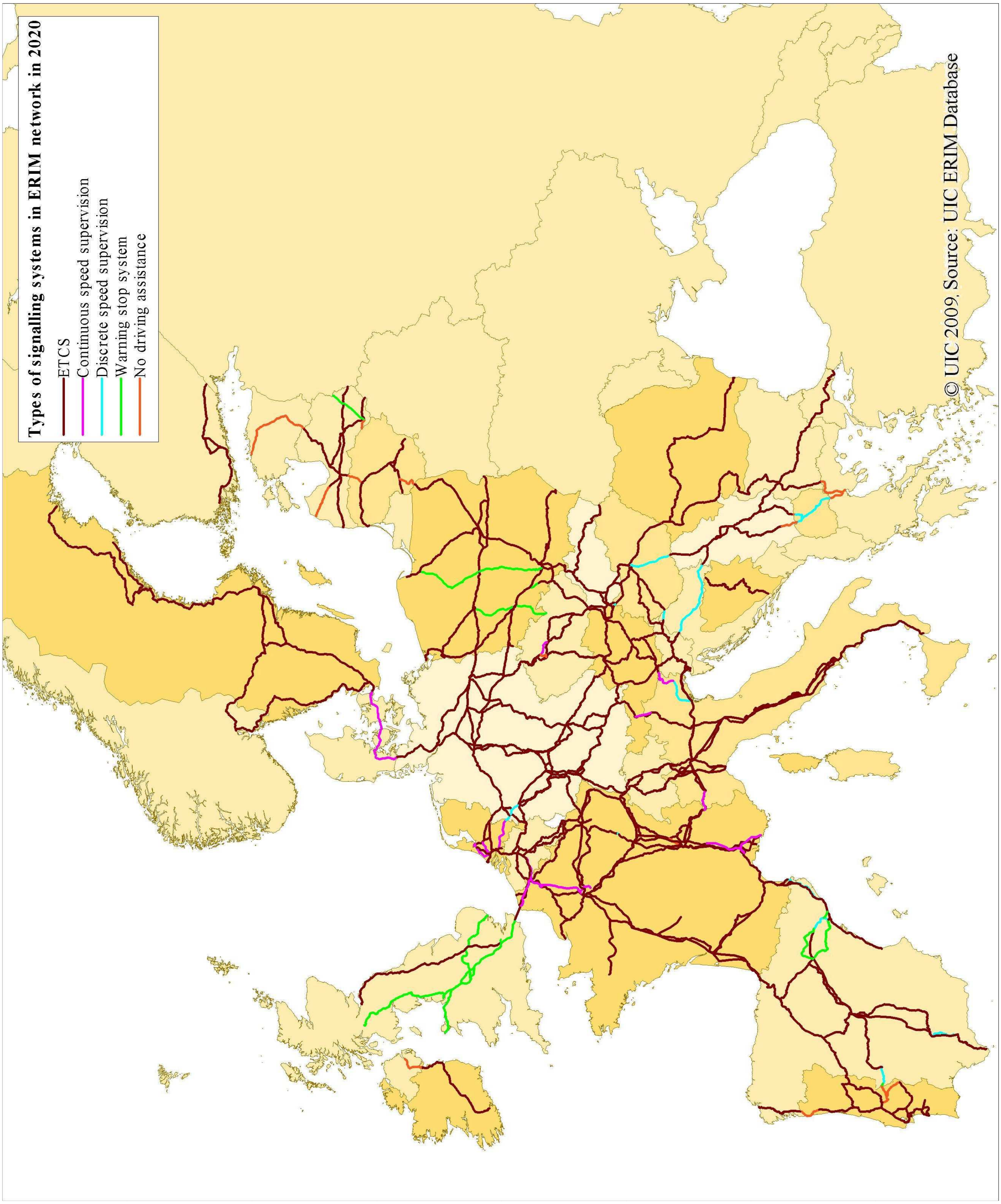
Figure 12 – Maximum Train Length 2008-2020



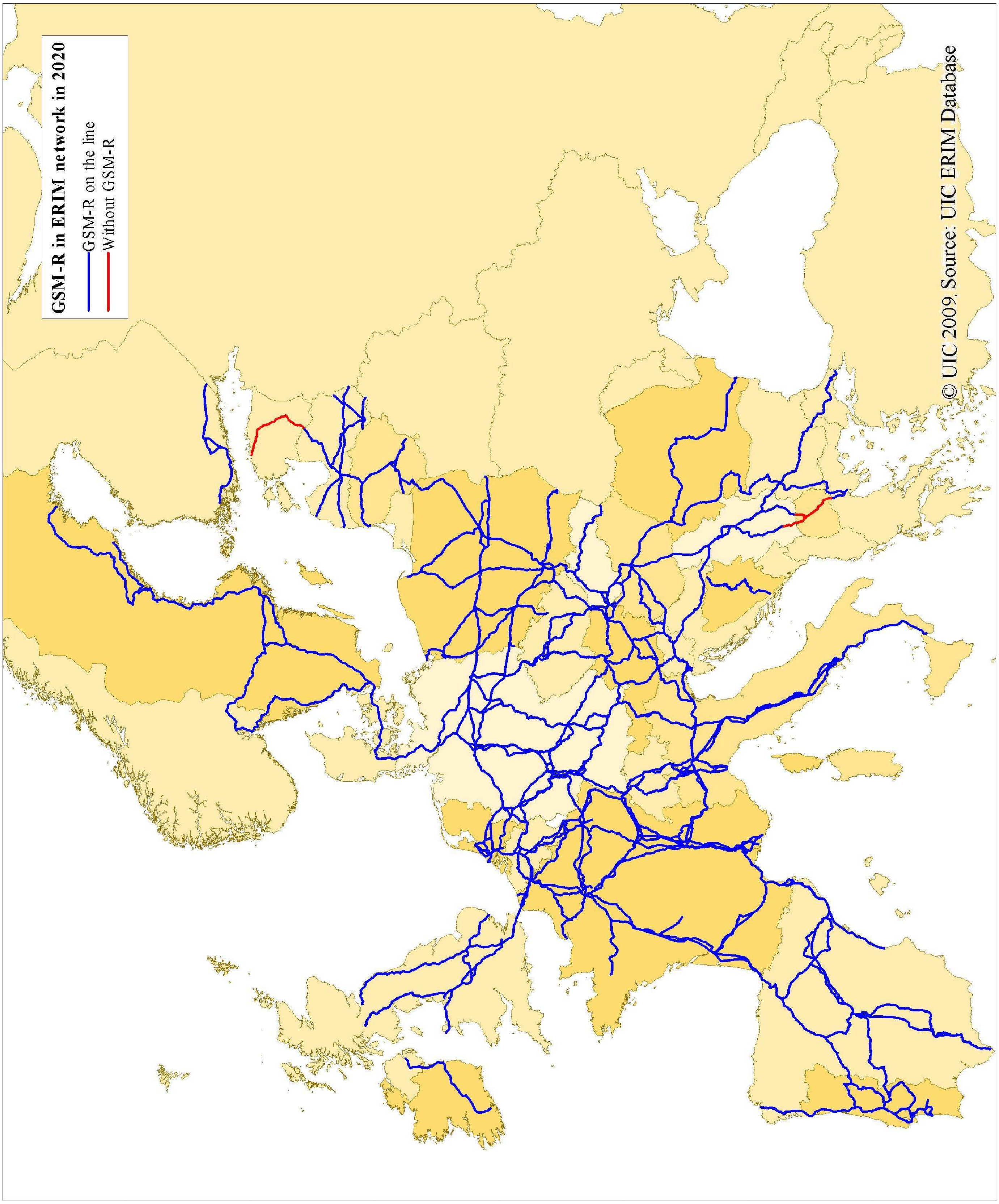
Map 15 – The Number of Tracks in 2020



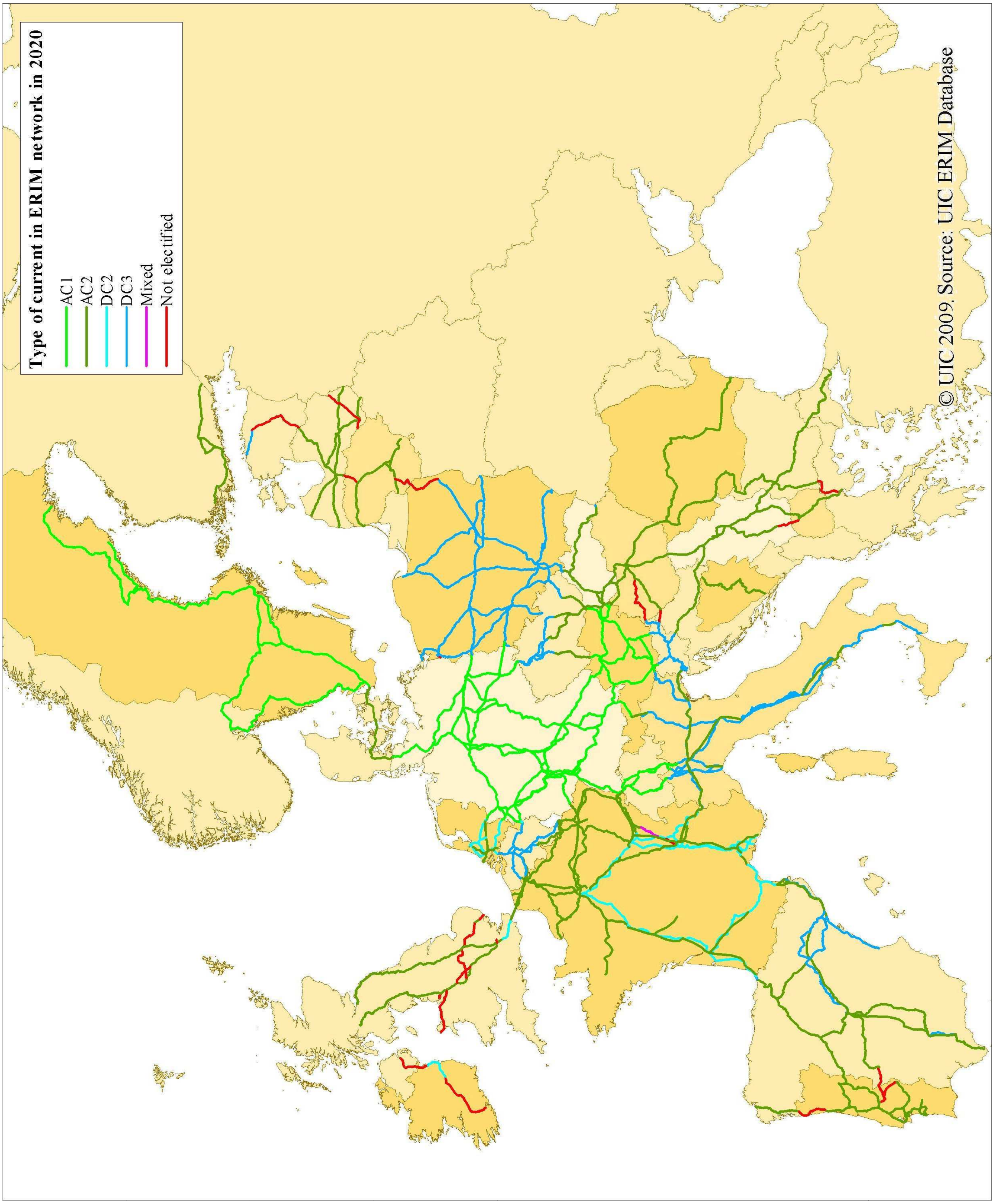
Map 16 – Loading Gauge in 2020



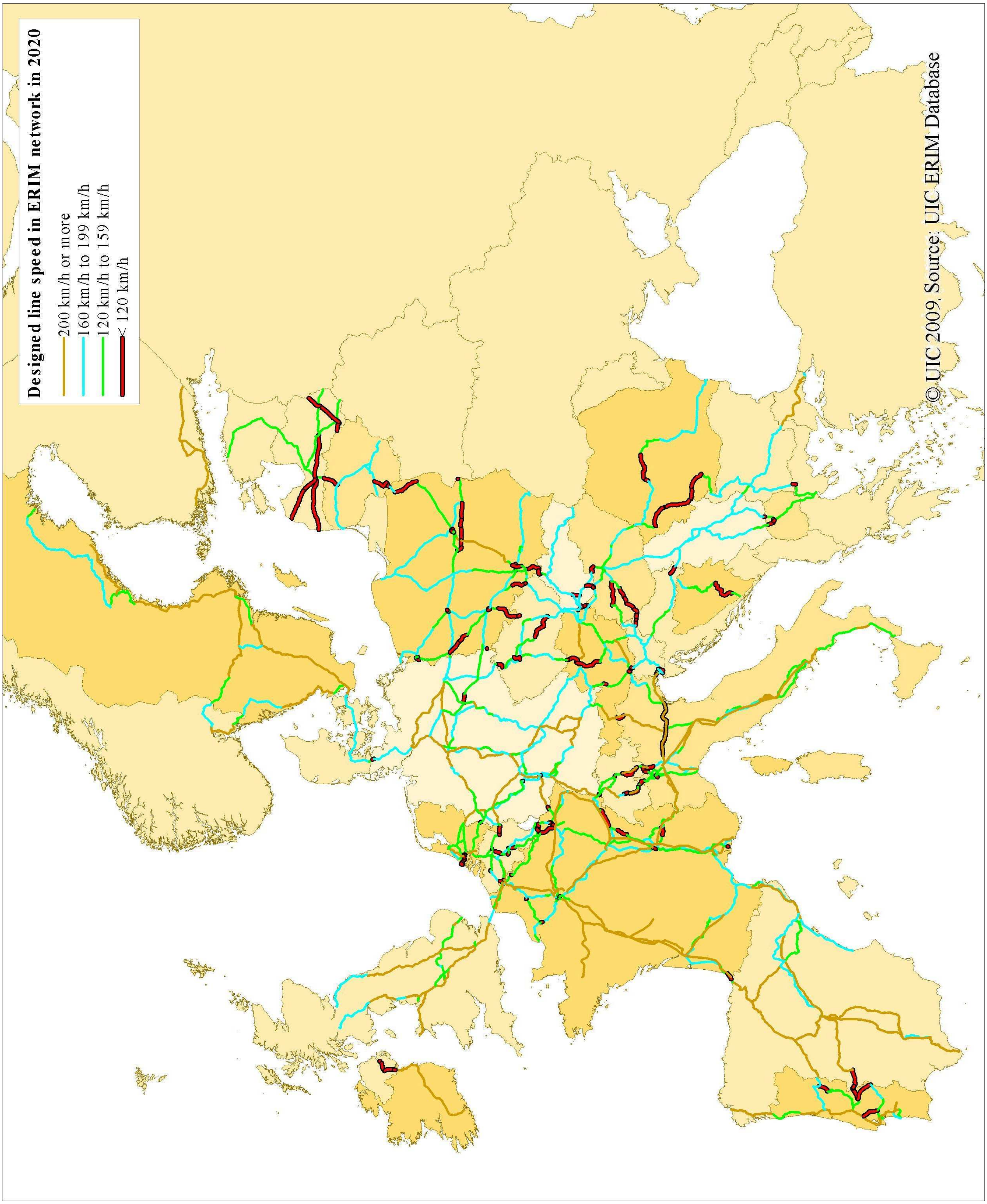
Map 17 – Signalling Systems in 2020



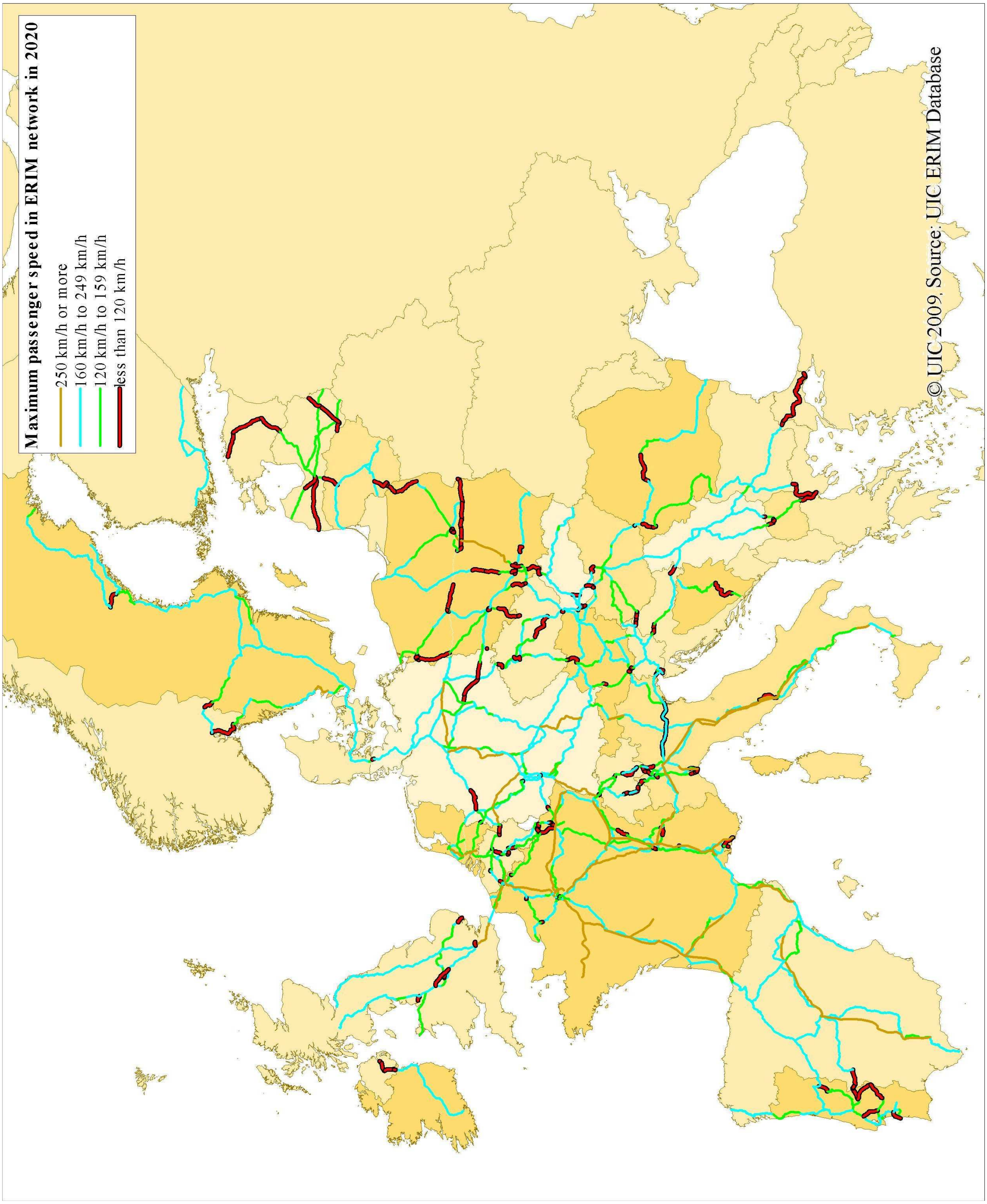
Map 18 – GSM-R in 2020



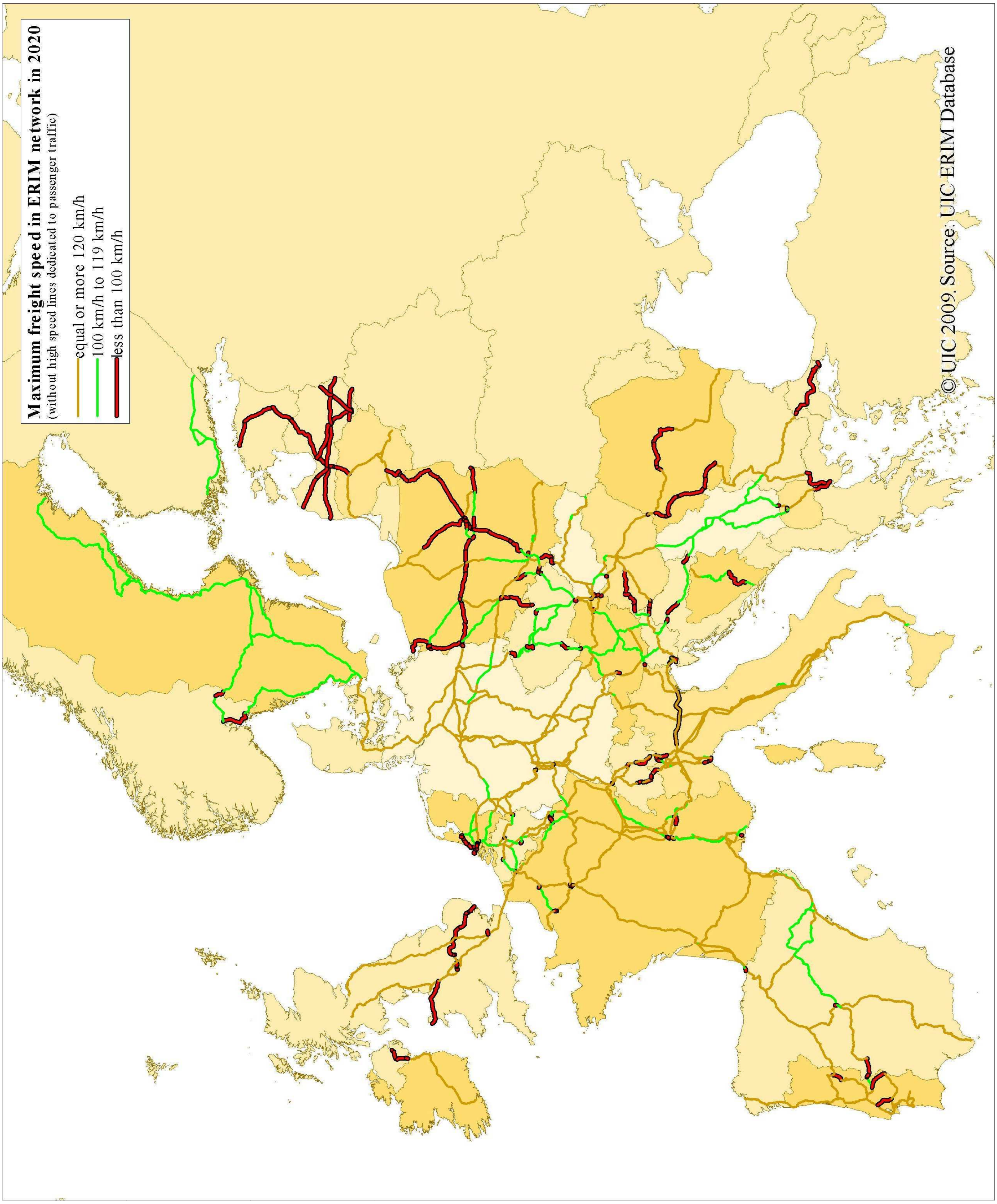
Map 19 – Type of Current in 2020



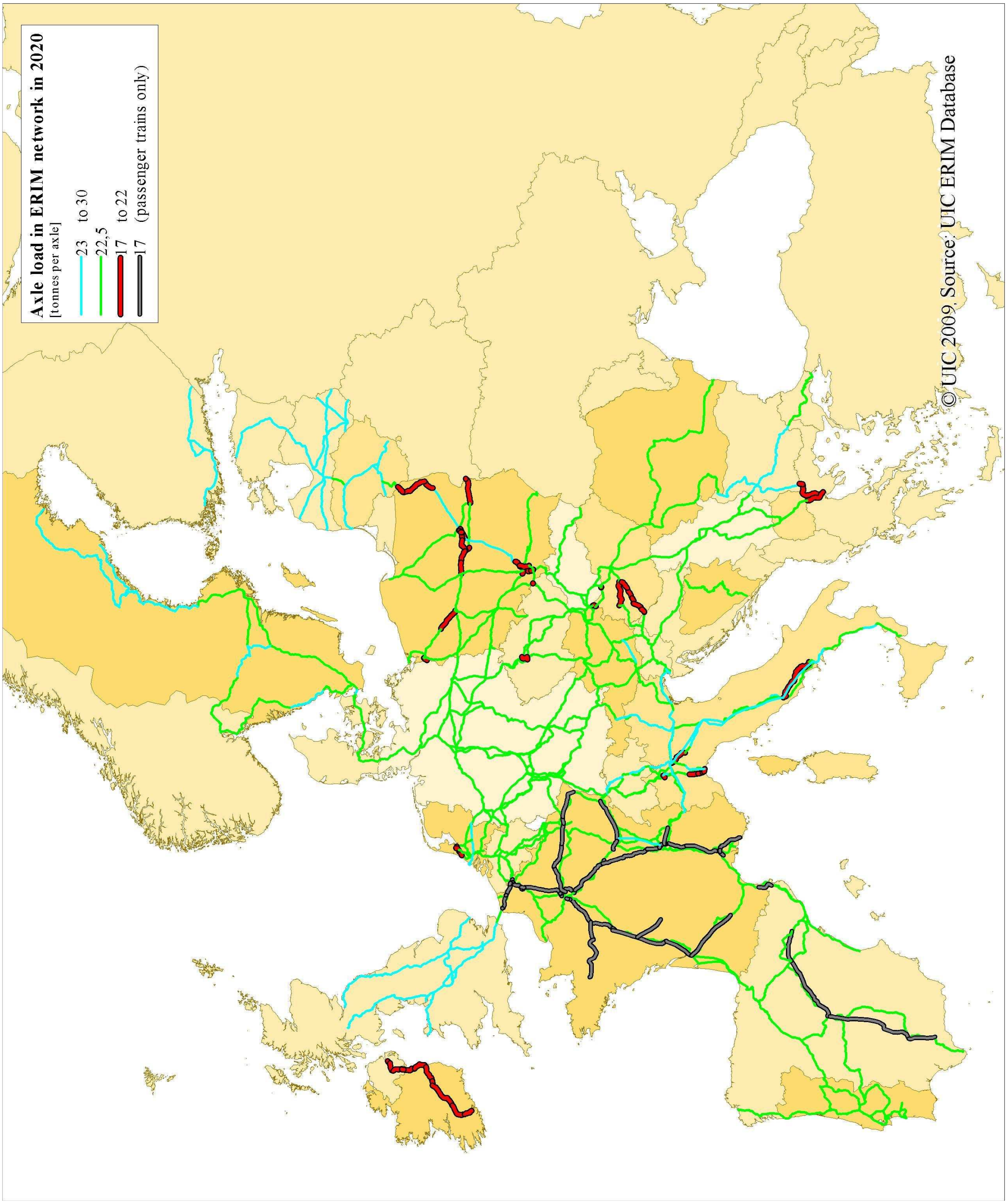
Map 20 – Design Line Speed in 2020



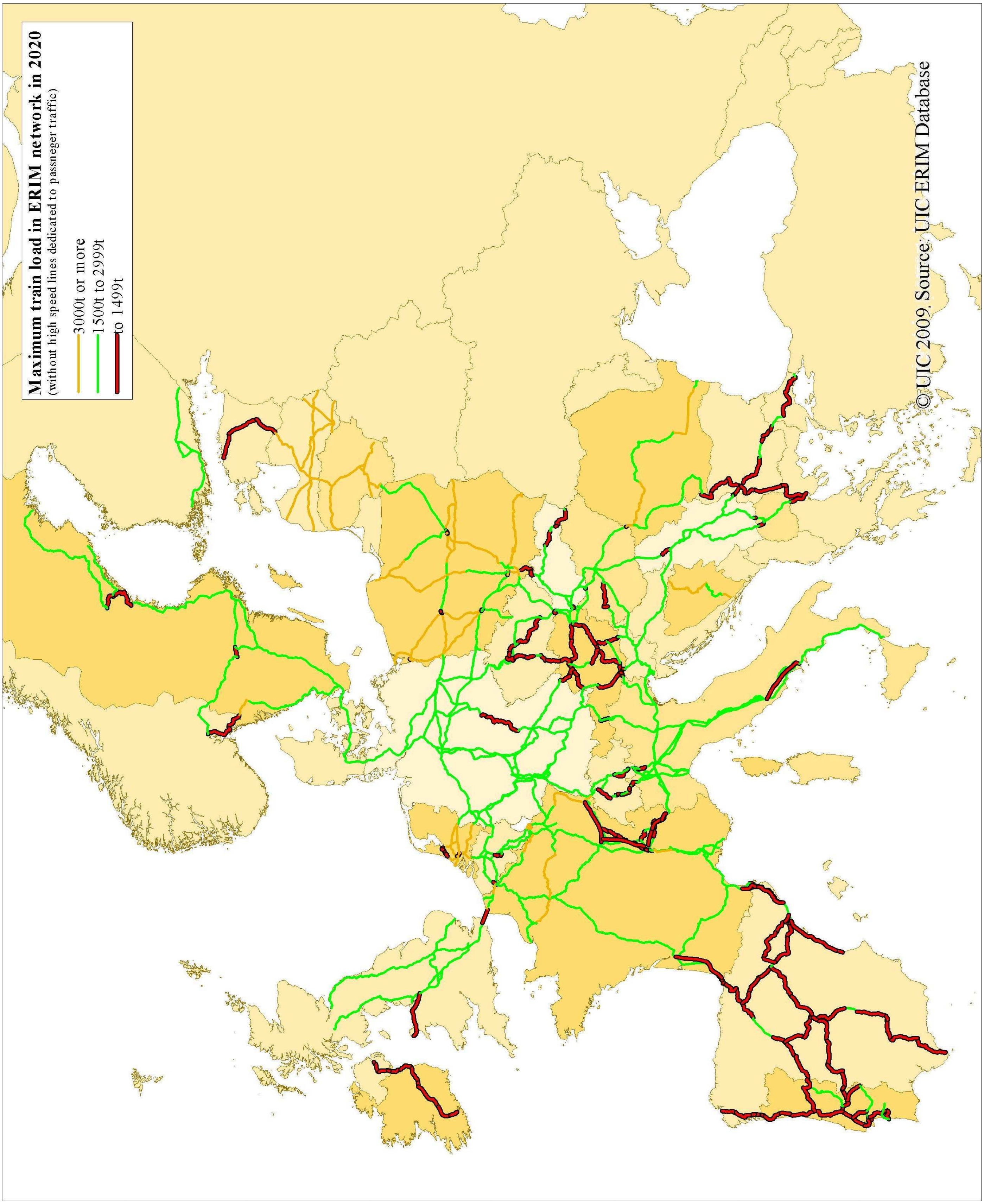
Map 21 – Maximum Passenger Speed in 2020



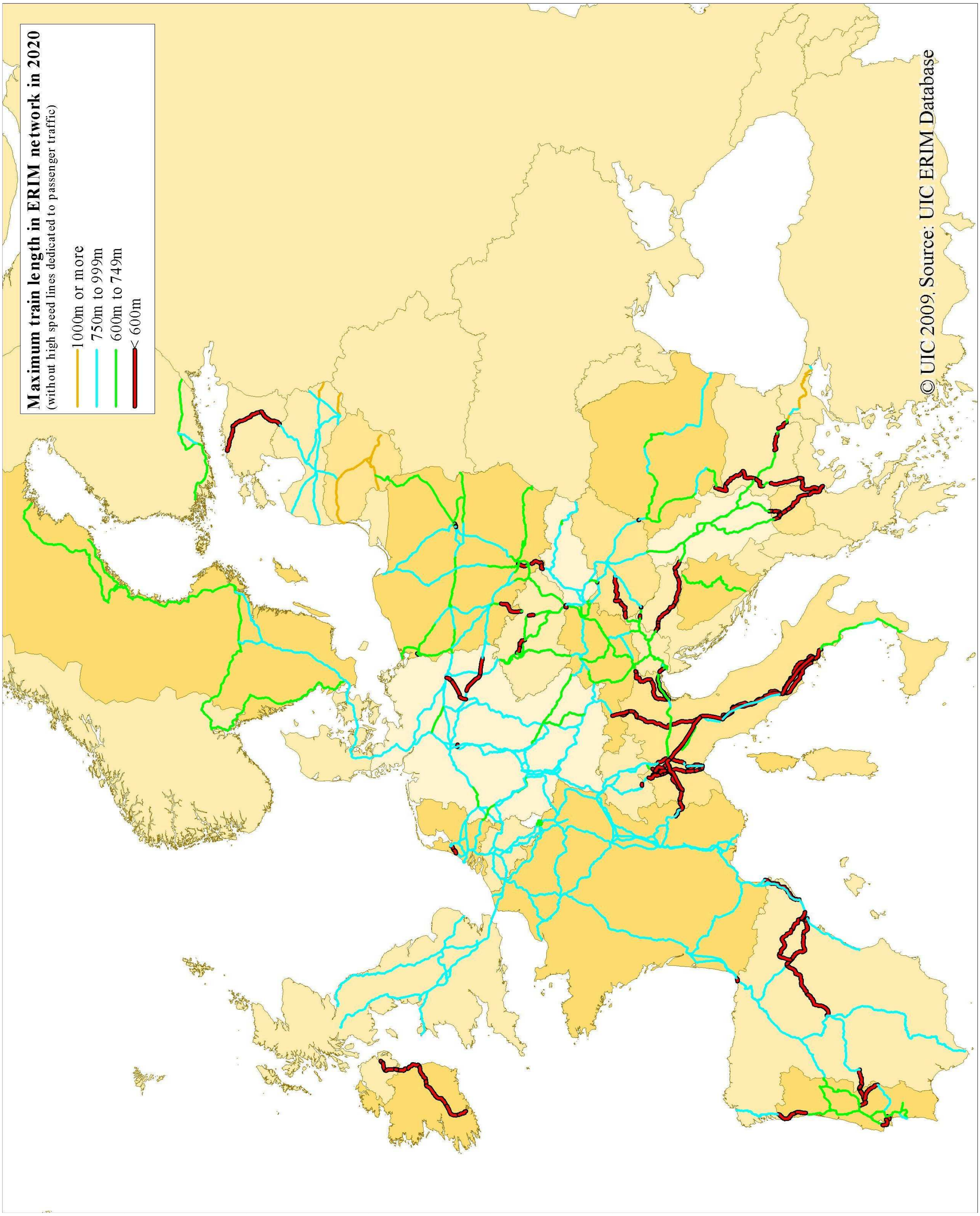
Map 22 – Maximum Freight Speed in 2020



Map 23 – Axle Load in 2020



Map 24 – Maximum Train Load in 2020



Map 25 – Maximum Train Length in 2020

3 Current Traffic Loads and Traffic Forecast for 2020

3.1 Traffic Loads in 2007 in the ERIM Network

A comprehensive picture of the **number of passenger and freight trains** which are currently operating over the ERIM network is available in the ERIM database. It is important to note that in ERIM 2007 report the current traffic figures concerned the year 2005 whereas in this 2008 report they relate to the year 2007. The table 1 indicates the estimated transport units (passenger-km and tonne-km) based on the UIC statistics 2007 in 3 different levels :

1. The transport units per Country.
   As the UIC statistics include only the statistics on UIC members, many new railway undertakings are not integrated. Therefore ERIM has used the UIC statistics on the historical Railway Undertakings (RU) and has applied its market share to obtain the estimated total transport units for each country, for example : If a historical RU carries 100 transport units and has a market share of 98%, the total transport units in the country are estimated to be 100 / 0.98 = 102 transport units.

   The market share has been taken from IBM report on ***Rail Liberation Index 2007. Market Opening: Comparison of the rail markets of the Member States of the European Union, Switzerland and Norway*** (see under Access Index) and has been sent to every ERIM Member Railway for approval or correction.

   Comment : in the previous 2007 report, most of the Railways had provided / used the total traffic figures concerning the whole country and not only the historical RU and thus their figures haven't changed significantly. The big changes concern especially Germany, Sweden and Switzerland.

2. The transport units per historical RU(s)
   Source : UIC statistics 2007.

3. Estimated transport units per ERIM corridors.
   The number of passenger and freight trains running in each line section has been given by the corresponding network or estimated by UIC. Based on this number of trains, UIC has estimated the corresponding transport units (passenger-km and tonne-km) and has asked every network to confirm these estimations or to give their own assessment of their transport units per line section. The estimated percentage of transport units in ERIM corridors compared to the transport units in the Member Network is highlighted in blue.

Country - IM	Route Length	Passengers (p-km millions)			Freight (t-km millions)		
		Total	Domestic	International	Total	Domestic	International
Austria		8 925			17 887		
ÖBB	5 647	8 925	7 244	1 681	17 887	4 227	13 660
ERIM corridors	1 670	5 861	4 757	1 104	15 375	3 633	11 742
% ERIM/ Total	**30%**	**66%**	**66%**	**66%**	**86%**	**86%**	**86%**
Belgium		9 932			8 148		
Infrabel	3 536	9 932	8 546	1 386	8 148	2 010	6 138
ERIM corridors	1 014	4 684	4 030	654	4 711	1 162	3 549
% ERIM/ Total	**29%**	**47%**	**47%**	**47%**	**58%**	**58%**	**58%**
Bosnia & Herzegovina		68			1 148		
ZRS/ZFBH	1 024	68	47	21	1 148	182	966
ERIM corridors	395	34	14	20	428	33	395
% ERIM/ Total	**39%**	**51%**	**30%**	**96%**	**37%**	**18%**	**41%**
Bulgaria		2 389			5 163		
NRIC	4 318	2 389	2 345	44	5 163	3 923	1 240
ERIM corridors	853	1 099	1 079	20	2 464	1 872	592
% ERIM/ Total	**20%**	**46%**	**46%**	**46%**	**48%**	**48%**	**48%**

Table 1 – Domestic and International Passenger and Freight Traffic per Country in 2007

Croatia		1 611			3 574		
HZ	2 726	1 611	1 508	103	3 574	653	2 921
ERIM corridors	357	780	731	50	2 383	435	1 948
% ERIM/ Total	**13%**	**48%**	**48%**	**48%**	**67%**	**67%**	**67%**
Czech Republic		6 855			15 287		
CD	9 499	6 855	6 493	362	15 287	6 522	8 765
ERIM corridors	1 303	1 941	1 838	102	7 839	3 344	4 495
% ERIM/ Total	**14%**	**28%**	**28%**	**28%**	**51%**	**51%**	**51%**
Denmark		5 724			2 030		
DSB	2 047	5 724	5 391	333	2 030	1 530	500
ERIM corridors	350	2 333	2 197	136	1 275	961	314
% ERIM/ Total	**17%**	**41%**	**41%**	**41%**	**63%**	**63%**	**63%**
Estonia		273			8 153		
EVR	967	273	246	27	8 153	416	7 737
ERIM corridors	273	233	210	23	2 096	107	1 989
% ERIM/ Total	**28%**	**85%**	**85%**	**85%**	**26%**	**26%**	**26%**
Finland		3 778			10 433		
VR	5 899	3 778	3 675	103	10 433	7 581	2 852
ERIM corridors	540	1 772	1 723	48	1 107	804	303
% ERIM/ Total	**9%**	**47%**	**47%**	**47%**	**11%**	**11%**	**11%**
France		81 664			40 634		
RFF	29 547	81 664	74 147	7 517	40 634	23 839	16 795
ERIM corridors	7 413	46 351	42 084	4 267	32 148	18 860	13 287
% ERIM/ Total	**25%**	**57%**	**57%**	**57%**	**79%**	**79%**	**79%**
Germany		78 784			110 216		
DB AG	33 896	74 677	71 817	2 860	92 077	40 458	51 619
ERIM corridors	6 708	42 165	40 551	1 615	72 410	31 817	40 594
% ERIM/ Total	**20%**	**56%**	**56%**	**56%**	**79%**	**79%**	**79%**
Greece		1 930			835		
OSE	2 383	1 930	1 853	77	835	193	642
ERIM corridors	176	71	68	3	255	59	196
% ERIM/ Total	**7%**	**4%**	**4%**	**4%**	**31%**	**31%**	**31%**
Hungary		6 033			8 933		
MÁV	7 728	6 033	5 735	297	8 933	1 247	7 685
ERIM corridors	1 143	1 695	1 611	84	4 385	1 014	3 371
% ERIM/ Total	**15%**	**28%**	**28%**	**28%**	**49%**	**81%**	**44%**
Ireland		2 007			129		
CIE	1 919	2 007	2 007	0	129	129	0
ERIM corridors	363	1 361	1 361	0	100	100	0
% ERIM/ Total	**19%**	**68%**	**68%**	**0%**	**78%**	**78%**	**0%**
Italy		45 985			21 197		
FS	16 295	45 985	44 482	1 503	21 197	12 641	8 556
ERIM corridors	3 837	27 568	26 666	901	12 742	7 599	5 143
% ERIM/ Total	**24%**	**60%**	**60%**	**60%**	**60%**	**60%**	**60%**
Latvia		983			18 314		
LDZ	2 236	983	889	94	18 314	375	17 938
ERIM corridors	1 343	661	569	92	17 154	353	16 801
% ERIM/ Total	**60%**	**67%**	**64%**	**98%**	**94%**	**94%**	**94%**
Lithuania		409			14 623		
LG	1 775	409	223	186	14 623	3 010	11 612
ERIM corridors	712	367	196	171	6 857	2 007	4 850
% ERIM/ Total	**40%**	**90%**	**88%**	**92%**	**47%**	**67%**	**42%**
Luxembourg		316			287		
CFL	275	316	232	84	287	69	218
ERIM corridors	84	155	114	41	135	32	103
% ERIM/ Total	**31%**	**49%**	**49%**	**49%**	**47%**	**47%**	**47%**
Macedonia		106			778		
MZ	699	106	102	4	778	25	753
ERIM corridors	252	63	60	3	534	19	515
% ERIM/ Total	**36%**	**60%**	**59%**	**72%**	**69%**	**75%**	**68%**
Netherlands		16 240			7 800		
ProRail	2 806	16 240	15 640	600	7 800	1 200	6 600
ERIM corridors	742	7 149	6 748	401	4 633	681	3 952
% ERIM/ Total	**26%**	**44%**	**43%**	**67%**	**59%**	**57%**	**60%**

Table 1 – Domestic and International Passenger and Freight Traffic **per Country** in 2007 (contd.)

Norway		2 567			2 395		
JBV	4 077	2 567	2 511	56	2 395	1 569	826
ERIM corridors	313	1 101	1 077	24	484	317	167
% ERIM/ Total	**8%**	**43%**	**43%**	**43%**	**20%**	**20%**	**20%**
Poland		19 858			54 253		
PKP PLK	19 429	19 858	19 135	723	54 253	30 208	24 045
ERIM corridors	4 459	9 660	9 308	352	26 307	14 647	11 659
% ERIM/ Total	**23%**	**49%**	**49%**	**49%**	**48%**	**48%**	**48%**
Portugal		3 610			2 586		
REFER	2 839	3 610	3 555	55	2 586	2 311	275
ERIM corridors	1 533	3 183	3 134	48	2 199	1 965	234
% ERIM/ Total	**54%**	**88%**	**88%**	**88%**	**85%**	**85%**	**85%**
Romania		7 417			13 437		
CFR	11 364	7 417	7 271	146	13 437	9 779	3 658
ERIM corridors	1 352	2 464	2 416	49	3 589	2 612	977
% ERIM/ Total	**12%**	**33%**	**33%**	**33%**	**27%**	**27%**	**27%**
Serbia/Montenegro		762			4 551		
ZS	3 819	762	441	321	4 551	577	3 974
ERIM corridors	1 209	704	407	297	3 072	389	2 683
% ERIM/ Total	**32%**	**92%**	**92%**	**92%**	**68%**	**68%**	**68%**
Slovak Republic		2 148			9 423		
ZSR	3 658	2 148	1 953	195	9 423	1 288	8 135
ERIM corridors	922	1 263	1 148	115	6 146	840	5 306
% ERIM/ Total	**25%**	**59%**	**59%**	**59%**	**65%**	**65%**	**65%**
Slovenia		812			3 603		
SZ	1 229	812	690	122	3 603	671	2 932
ERIM corridors	578	559	446	113	2 321	256	2 065
% ERIM/ Total	**47%**	**69%**	**65%**	**93%**	**64%**	**38%**	**70%**
Spain		20 260			11 012		
ADIF	12 837	20 260	19 526	734	11 012	9 125	1 887
ERIM corridors	4 525	13 147	12 413	734	8 738	6 859	1 879
% ERIM/ Total	**35%**	**65%**	**64%**	**100%**	**79%**	**75%**	**100%**
Sweden		14 945			33 785		
BV	9 860	9 642	8 414	1 228	23 300	15 882	7 418
ERIM corridors	2 722	6 509	5 681	829	8 847	6 030	2 817
% ERIM/ Total	**28%**	**68%**	**68%**	**68%**	**38%**	**38%**	**38%**
Switzerland		15 818			17 573		
SBB/BLS	3 328	15 771	15 014	757	16 736	8 528	8 208
ERIM corridors	802	4 100	3 903	197	11 247	5 731	5 516
% ERIM/ Total	**24%**	**26%**	**26%**	**26%**	**67%**	**67%**	**67%**
Turkey		5 553			9 377		
TCDD	8 671	5 553	5 472	81	9 377	8 061	1 316
ERIM corridors	319	230	227	3	314	270	44
% ERIM/ Total	**4%**	**4%**	**4%**	**4%**	**3%**	**3%**	**3%**
United Kingdom		50 027			21 200		
Network Rail	16 116	50 027	48 635	1 392	21 200	20 710	490
ERIM corridors	2 058	12 448	11 876	572	4 608	4 118	490
% ERIM/ Total	**13%**	**25%**	**24%**	**41%**	**22%**	**20%**	**100%**

	Route Length	Passengers			Freight		
		Total	Domestic	International	Total	Domestic	International
OVERALL - COUNTRY		**417 788**			**478 762**		
OVERALL - IM's	232 449	**408 330**	385 239	23 091	**449 301**	218 939	230 362
Overall - ERIM corridors	50 320	**201 711**	188 645	13 066	**266 904**	118 929	147 974
% ERIM/Overal Total	**22%**	**49%**	**49%**	**57%**	**59%**	**54%**	**64%**

Table 1 – Domestic and International Passenger and Freight Traffic per **Country** in 2007 (contd.)

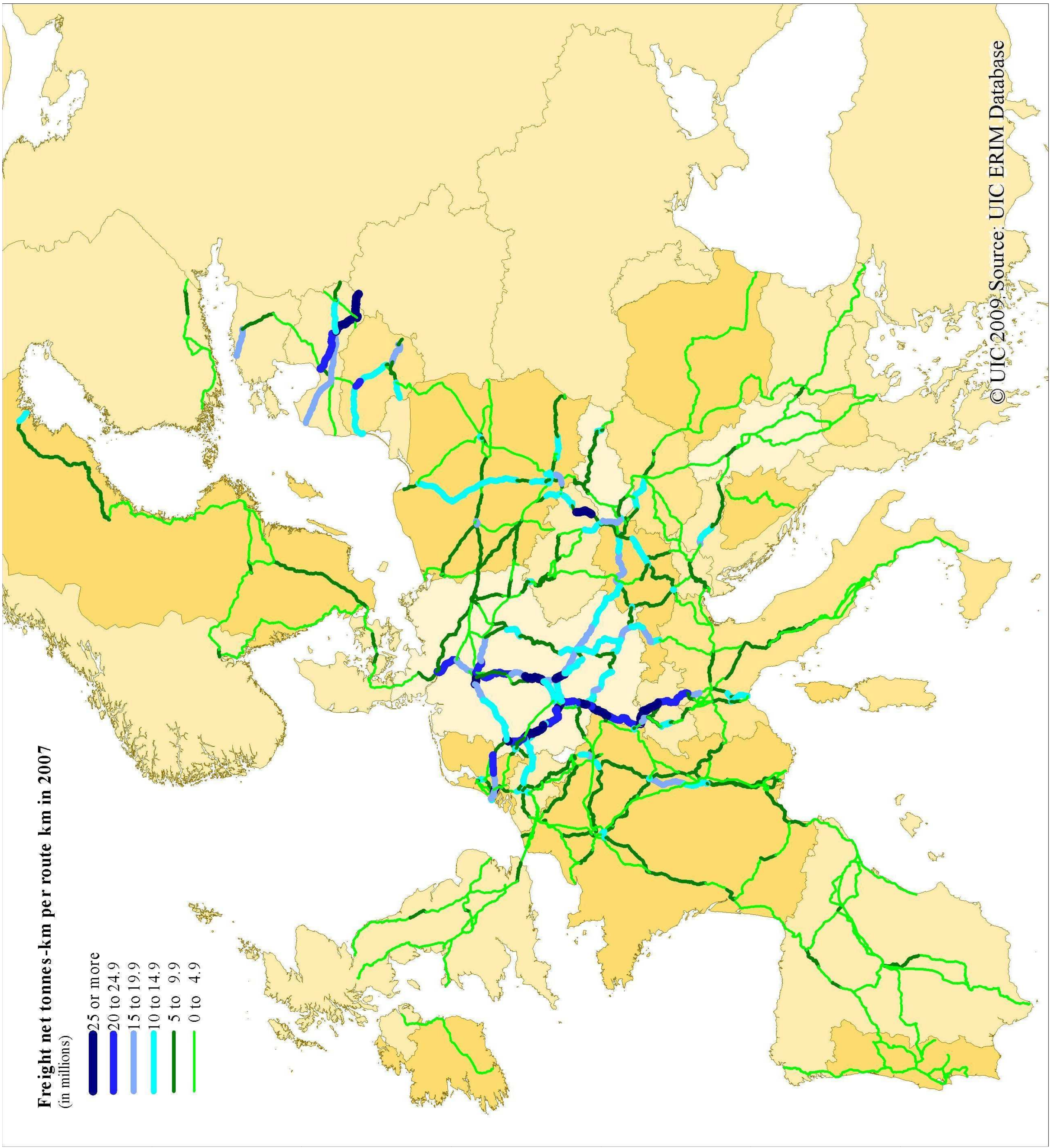
Table 2 shows the breakdown of the ERIM traffic over the six ERTMS Corridors. The volume of traffic on the rest of the network is shown as a residual.

			Estimated passenger-kms per year in 2007			Estimated net tonnes-kms per year in 2007		
Corridor	Country	Route length [km]	Total (Millions)	National (Millions)	International (Millions)	Total (Millions)	National (Millions)	International (Millions)
Corridor A	Germany	1 080	8 287	7 970	317	18 363	8 069	10 295
	Italy	714	3 381	3 271	111	3 042	1 814	1 228
	Netherlands	248	773	749	24	2 607	52	2 555
	Switzerland	797	4 096	3 903	193	11 208	5 725	5 483
Total Corridor A		2 840	16 537	15 892	645	35 221	15 660	19 561
Corridor B	Austria	110	382	268	114	1 637	327	1 310
	Denmark	350	2 333	2 197	136	1 275	961	314
	Germany	1 205	8 080	7 770	309	17 283	7 594	9 689
	Italy	891	4 999	4 835	163	1 047	624	423
	Sweden	909	3 279	2 861	417	3 686	2 512	1 173
Total Corridor B		3 465	19 071	17 932	1 140	24 928	12 019	12 909
Corridor C	Belgium	532	2 198	2 016	182	2 527	623	1 904
	France	1 084	4 394	3 989	404	8 652	5 076	3 576
	Luxembourg	59	113	71	41	45	11	34
	Switzerland	5	4	0	4	39	6	33
Total Corridor C		1 680	6 708	6 076	632	11 264	5 716	5 547
Corridor D	France	877	3 776	3 428	348	5 583	3 275	2 307
	Hungary	283	226	223	3	200	69	131
	Italy	613	4 983	4 821	163	2 017	1 203	814
	Slovenia	412	406	339	66	1 897	218	1 679
	Spain	535	3 580	3 153	427	1 247	556	691
Total Corridor D		2 720	12 971	11 964	1 007	10 944	5 321	5 623
Corridor E	Austria	167	710	580	130	1 321	163	1 158
	Czech Rep.	828	1 336	1 266	71	4 599	1 962	2 637
	Germany	55	218	210	8	474	208	266
	Hungary	502	1 198	1 128	70	2 999	728	2 272
	Romania	865	2 051	2 011	40	2 780	2 084	696
	Slovakia	297	298	255	43	2 431	116	2 315
Total Corridor E		2 714	5 812	5 450	362	14 604	5 261	9 344
Corridor F	Germany	980	4 693	4 513	180	9 963	4 378	5 585
	Poland	954	2 342	2 257	85	4 828	2 688	2 140
Total Corridor F		1 934	7 035	6 770	265	14 791	7 066	7 725
Total ERTMS Corridors		15 353	68 134	64 084	4 050	111 751	51 042	60 709
Total Others		34 967	133 577	124 561	9 015	155 153	67 887	87 265
Overall Total ERIM		**50 320**	**201 711**	**188 645**	**13 066**	**266 904**	**118 929**	**147 974**

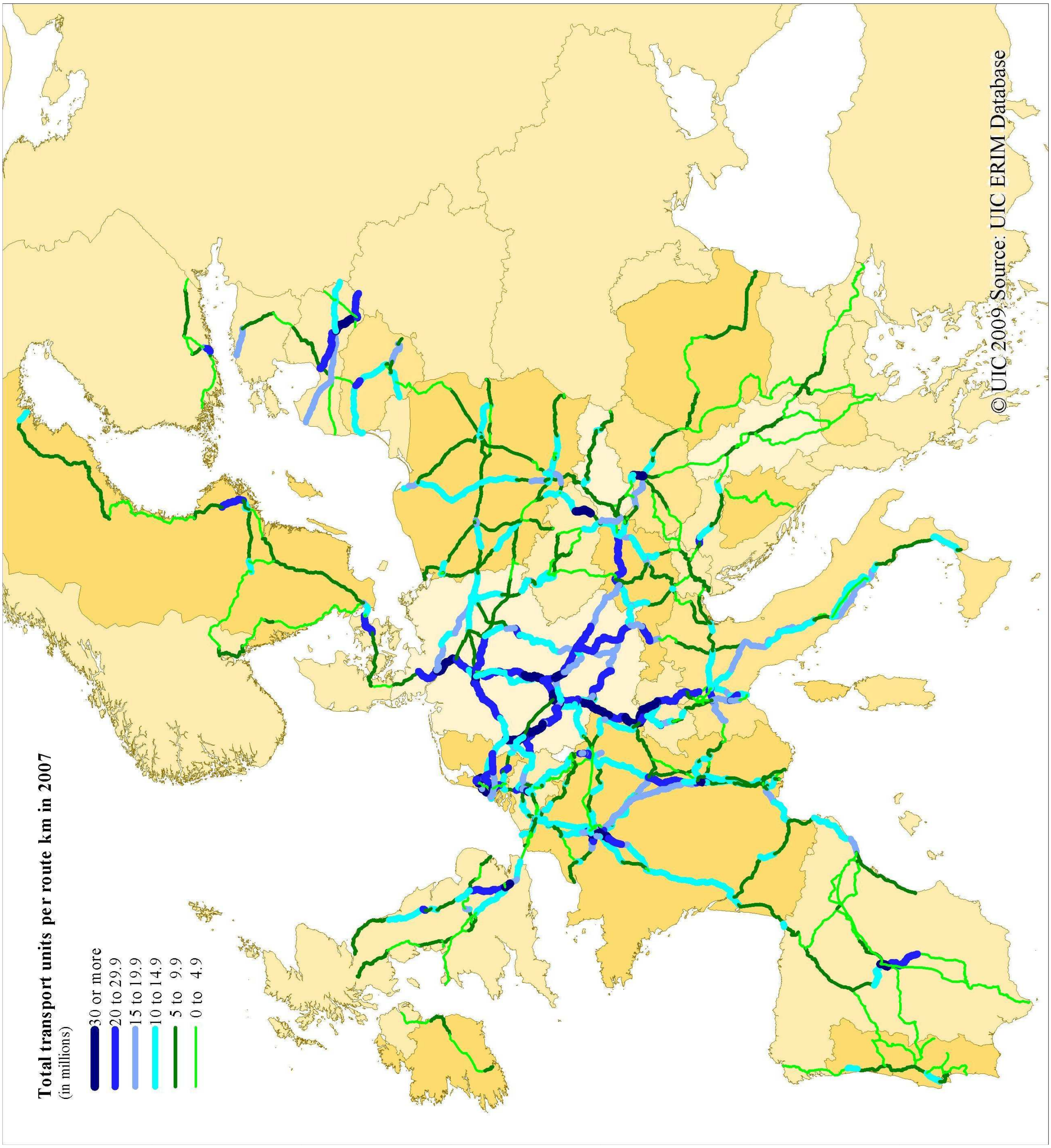
© UIC 2009, Source: ERIM Database

Table 2 – Traffic Load per ERTMS Corridor 2007

The distribution of current freight traffic in tonne-km per route-km within the ERIM network is shown in Map 26. Similar distribution of current transport units (including both tonne-kms and passenger-kms) is shown in the Map 27.



Map 26 – Freight net tonnes-km per route-km in 2007



Map 27 – Total transport units in 2007

3.2 EU 27 Gross Domestic Product

The universal experience seems to be that transport demand grows in some general correlation with the Gross Domestic Product (GDP). In EU 27 from 2000 to 2007, the average annual growth of GDP has been between 2 % and 2,5 % which probably can be considered as a sustainable growth estimation over a longer time period.

Therefore an annual growth of 3 % -3,5 % for the rail freight transport is not an unrealistic average value at long run. According to the current Eurostat estimation (updated in February 2009), the annual GDP growth will be very low in 2009 due to the current economic crises, but should start to recover in 2010 and probably the rail freight will follow the same general pattern.

- 2000 3,9 %
- 2001 2,0 %
- 2002 1,2 %
- 2003 1,3 %
- 2004 : 2,5 %
- 2005 : 2,0 %
- 2006 : 3,1 %
- 2007: 2,9 %
- 2008 : 1,4 % (estimation)
- 2009 : 0,2 % (estimation)
- 2010 1,1 % (estimation)

Source : Eurostat website / last update 13th of February 2009

3.3 EU 27 Annual Freight Growth

The annual average freight traffic growth (in tonne-km) in EU 27 between 1995-2006 has been 2,8 % all modes included. Since 1995, the total freight growth has increased steadily year after year, and the economic downturn in 2002-2003 probably partly due to the “explosion of the internet bubble” didn’t seem to have any effect on the total transport growth. The Road transport has followed the steady annual growth of the total transport, whereas Rail has known more yearly fluctuations. The annual freight growth, all modes included, from 2005 to 2006 (the latest available information) is 3,1% (corresponding exactly the annual growth of the GDP in 2006). The 2006 / 2005 annual freight growth of road traffic has been 4,9 % and for rail traffic 5,2 %, as shown on next page, in table 3.

The same table indicates that the total value of rail traffic was 435 million tonne-kilometres in 2005 which is very close to the total value of 407 million tonne-kilometres presented in the previous ERIM report for the same year.[1] These values provide the **order of magnitude** of the total rail freight business, even if they didn’t measure exactly the same thing : Eurostat measured the total traffic in 27 EU countries and ERIM the traffic of the historical RUs within 32 countries.

Even if the total amount of rail traffic is quite comparable, it is important to note here that the comparison of growth forecasts between the total rail transport and the ERIM corridors can only give an indication. Indeed, ERIM is a selection of the freight oriented corridors and therefore should have higher annual growth estimations than those predicting the overall growth for the total freight market.

The Eurostat have several categories of passenger traffic, and therefore the performance tables are not shown in this ERIM report.

[1] N.B. As explained earlier, ERIM has “skipped” the year 2006 and therefore no comparison can be made for this year. However, the Eurostat figures 2006 and ERIM figures 2007 are in line.

EU-27 Performance by Mode

FREIGHT TRANSPORT

	ROAD	RAIL	INLAND WATER-WAYS	PIPE-LINES	SEA	AIR	TOTAL
						thousand mio tonne-kilometres	
1995	1 289	386	121	115	1 150	2.0	3 062
1996	1 303	392	118	119	1 162	2.1	3 096
1997	1 352	409	126	118	1 205	2.3	3 213
1998	1 414	392	130	125	1 243	2.4	3 307
1999	1 470	383	127	124	1 288	2.5	3 394
2000	1 519	401	133	126	1 348	2.7	3 529
2001	1 556	385	132	132	1 400	2.7	3 607
2002	1 606	382	132	128	1 417	2.6	3 668
2003	1 625	391	123	130	1 445	2.6	3 717
2004	1 747	413	136	131	1 488	2.8	3 918
2005	1 800	413	138	136	1 530	2.9	4 020
2006	1 888	435	138	135	1 545	3.0	4 143
1995-2006	46.5%	12.6%	14.5%	17.2%	34.3%	50.0%	35.3%
per year	3.5%	1.1%	1.2%	1.5%	2.7%	3.8%	2.8%
2005-2006	4.9%	5.2%	0.0%	-0.7%	1.0%	3.4%	3.1%

Table 3 : EU 27 Performance by Mode.
Source : EU Energy and Transport in Figures. Statistical Pocketbook 2007 / 2008.

3.4 EU 27 Modal Split

The rail freight growth forecast should not be related only to the economic growth, but also to the current market share of rail mode. The market share of rail transport has decreased 2% between 1995 and 2006, being today around 10% whereas the road transport has grown 3 % during the same period being today almost 46%. Whilst the other transport modes have roughly maintained their market share, there has been a modal shift from rail to road, see Table 4.

The same phenomenon of modal shift has happened when looking at the land transport where the share of rail transport has decreased from 20% in 1995 to 17% in 2006 whereas the road transport has grown from 68% to 73% during the same period, see Table 5.

If we leave out the other transport modes and consider only the competition between rail and road, we can conclude the following :

- Road + Rail total market is in 2006 : 1 888 + 435 = 2 323 million Tkms.
- Road market share is 81 % (1 888 / 2 323) and Rail market share 19 % (423 / 1 888)
- If Road continued to grow 3,5% per year[2], the total Road traffic would be 3 056 million Tkms in 2020
- If Rail continued to grow 1,1% per year, the total Rail traffic would be 507 million Tkms in 2020.
- Accordingly the total traffic would be 3 563 (3 056 + 507) Tkms, and Road would have 86% and Rail 14% of the market.

[2] Over 14 years

MODAL SPLIT

(%)

	ROAD	RAIL	INLAND WATER-WAYS	PIPE-LINES	SEA	AIR
1995	42.1	12.6	3.9	3.8	37.6	0.1
1996	42.1	12.6	3.8	3.9	37.5	0.1
1997	42.1	12.7	3.9	3.7	37.5	0.1
1998	42.8	11.9	3.9	3.8	37.6	0.1
1999	43.3	11.3	3.7	3.7	37.9	0.1
2000	43.0	11.4	3.8	3.6	38.2	0.1
2001	43.1	10.7	3.6	3.6	38.8	0.1
2002	43.8	10.4	3.6	3.5	38.6	0.1
2003	43.7	10.5	3.3	3.5	38.9	0.1
2004	44.6	10.5	3.5	3.3	38.0	0.1
2005	44.8	10.3	3.4	3.4	38.1	0.1
2006	45.6	10.5	3.3	3.2	37.3	0.1

Notes: Air and Sea: only domestic and intra-EU-27 transport; provisional estimates
Road: national and international haulage by vehicles registered in the EU-27

Source: tables 3.2.4c to 3.2.7, estimates *(in italics)*

Table 4 Modal Split all transport modes
Source : EU Energy and Transport in Figures. Statistical Pocketbook 2007 / 2008.

MODAL SPLIT

(%)

	ROAD	RAIL	INLAND WATERWAYS	PIPELINES
1995	67.5	20.2	6.3	6.0
1996	67.4	20.3	6.1	6.2
1997	67.4	20.4	6.3	5.9
1998	68.6	19.0	6.3	6.1
1999	69.9	18.2	6.0	5.9
2000	69.7	18.4	6.1	5.8
2001	70.6	17.4	6.0	6.0
2002	71.4	17.0	5.9	5.7
2003	71.6	17.2	5.4	5.7
2004	72.0	17.0	5.6	5.4
2005	72.4	16.6	5.5	5.5
2006	72.7	16.7	5.3	5.2

Notes: Road: national and international haulage by vehicles registered in the EU-27

Source: tables 3.2.4c to 3.2.7

Table 5 Modal split inland transport modes
Source : EU Energy and Transport in Figures. Statistical Pocketbook 2007 / 2008.

However, the current relatively low market share of rail transport underlines also a high growth potential if it can regain market share. Indeed, even small modal shift from Road to Rail transport can bring a significant increase to the total rail volumes. Therefore the crucial question for rail transport is probably not (only) the fluctuations in the total transport demand, but what proportion of the total market it can win compared to Road.

3.5 ERIM Forecast for Rail Growth within the ERIM Network

ERIM has estimated a growth factor for each line section of the ERIM network. Unless the Railways have done their own growth projection, this growth factor has been applied to the 2007 traffic figures to derive the 2020 traffic projections.

The cumulative effect of applying ERIM growth factors and using national growth projections results in an estimated overall growth of 58 % of all transport units meaning an annual growth of 3,6% from 2007 to 2020. The growth forecast of **passenger** traffic is **30%** leading to an approximately **2.1%** cumulative annual growth over 13 years. The ERIM 2008 forecast for annual growth for passenger traffic remains thus in line with the ERIM 2007 forecast.

Whereas the growth forecast for passenger traffic is stable, there seems to be significant change in expectations on the freight growth. The expected overall **growth of tonne-kms from 2007 to 2020 is 80%**, i.e. approximately **4.6 %** cumulative annual growth over 13 years (whereas the annual freight growth was estimated to be 3.2% in ERIM 2007 report). The higher growth estimations are mainly due to changed 2020 freight forecasts made by the following railways: DB AG (Germany), MAV (Hungary), ProRail (Netherlands), PKP PLK (Poland), SZ (Slovenia) and BV (Sweden). They illustrate increasing confidence in rail freight traffic, whether it is due to company strategies, sustainability values or political environment. This optimism is also justified by the high annual rail freight traffic growth of 5,2% as indicated in the table 3. However, most of these forecasts were made before the recent economic downturn and therefore the next year's ERIM freight forecast may need to be moderated at lower level. Probably an average annual freight growth of 3,2% up to 2020 (as predicted last year) would be a sustainable and reasonable estimation.

The UIC 2007 **Report on Intermodal Rail / Road Transport in Europe** which has traditionally applied moderate growth projections is likely to maintain their estimation of **7%** average annual growth rate for combined transport, despite some expected annual fluctuations. This suggests that the growth in other freight business may be around 2 % per annum on today's traffic levels. Should such a reconfiguration of traffic take place, it will reposition combined transport from contributing around 15% of total rail net tonnes-kms throughout Europe to-day to close 30% by 2020. The proportion in some countries will be far higher and may be closer to 50%.

Table 6 shows forecast traffic growth from 2007 to 2020 based on the information on the UIC Members in each country. As such they indicate the overall trend, but can exclude additional traffic that potentially will be realised by the non-UIC Members.

Country - IM	Passengers (p-km millions)			Freight (t-km millions)		
	Total	Domestic	International	Total	Domestic	International
Austria ÖBB						
ERIM 2007	5 861	4 757	1 104	15 375	3 633	11 742
ERIM 2020	7 591	6 119	1 472	21 089	4 931	16 158
growth 2020/2007	**30%**	**29%**	**33%**	**37%**	**36%**	**38%**
Belgium Infrabel						
ERIM 2007	4 684	4 030	654	4 711	1 162	3 549
ERIM 2020	6 016	5 176	839	6 855	1 691	5 164
growth 2020/2007	**28%**	**28%**	**28%**	**45%**	**46%**	**45%**
Bosnia & Herzeg. ZRS/ZFBH						
ERIM 2007	34	14	20	428	33	395
ERIM 2020	146	60	86	3 212	247	2 966
growth 2020/2007	**325%**	**325%**	**325%**	**650%**	**650%**	**650%**
Bulgaria NRIC						
ERIM 2007	1 099	1 079	20	2 464	1 872	592
ERIM 2020	1 501	1 474	28	3 045	2 313	731
growth 2020/2007	**37%**	**37%**	**37%**	**24%**	**24%**	**24%**
Croatia HZ						
ERIM 2007	780	731	50	2 383	435	1 948
ERIM 2020	1 002	938	64	5 791	1 058	4 733
growth 2020/2007	**28%**	**28%**	**28%**	**143%**	**143%**	**143%**
Czech Republic CD						
ERIM 2007	1 941	1 838	102	7 839	3 344	4 495
ERIM 2020	2 193	2 077	116	8 858	3 779	5 079
growth 2020/2007	**13%**	**13%**	**13%**	**13%**	**13%**	**13%**
Denmark DSB						
ERIM 2007	2 333	2 197	136	1 275	961	314
ERIM 2020	2 996	2 822	174	2 414	1 820	595
growth 2020/2007	**28%**	**28%**	**28%**	**89%**	**89%**	**89%**
Estonia EVR						
ERIM 2007	233	210	23	2 096	107	1 989
ERIM 2020	299	270	30	2 692	137	2 554
growth 2020/2007	**28%**	**28%**	**28%**	**28%**	**28%**	**28%**
Finland VR						
ERIM 2007	1 772	1 723	48	1 107	804	303
ERIM 2020	2 260	2 199	62	1 408	1 023	385
growth 2020/2007	**28%**	**28%**	**28%**	**27%**	**27%**	**27%**
France RFF						
ERIM 2007	46 351	42 084	4 267	32 148	18 860	13 287
ERIM 2020	59 315	53 855	5 460	47 296	27 747	19 548
growth 2020/2007	**28%**	**28%**	**28%**	**47%**	**47%**	**47%**
Germany DB AG						
ERIM 2007	42 165	40 551	1 615	72 410	31 817	40 594
ERIM 2020	43 359	41 699	1 661	168 337	73 966	94 371
growth 2020/2007	**3%**	**3%**	**3%**	**132%**	**132%**	**132%**
Greece OSE						
ERIM 2007	71	68	3	255	59	196
ERIM 2020	85	81	3	328	76	252
growth 2020/2007	**20%**	**20%**	**20%**	**28%**	**28%**	**28%**
Hungary MÁV						
ERIM 2007	1 695	1 611	84	4 385	1 014	3 371
ERIM 2020	1 980	1 883	97	5 834	1 115	4 719
growth 2020/2007	**17%**	**17%**	**16%**	**33%**	**10%**	**40%**

Table 6 – Domestic and International Passenger and Freight Traffic per Country in 2020

Ireland CIE						
ERIM 2007	1 361	1 361	0	100	100	0
ERIM 2020	2 246	2 246	0	100	100	0
growth 2020/2007	**65%**	**65%**	**0%**	**0%**	**0%**	**0%**
Italy FS						
ERIM 2007	27 568	26 666	901	12 742	7 599	5 143
ERIM 2020	33 373	32 282	1 091	19 192	11 445	7 746
growth 2020/2007	**21%**	**21%**	**21%**	**51%**	**51%**	**51%**
Latvia LDZ						
ERIM 2007	661	569	92	17 154	353	16 801
ERIM 2020	866	746	121	29 054	463	28 591
growth 2020/2007	**31%**	**31%**	**31%**	**69%**	**31%**	**70%**
Lithuania LG						
ERIM 2007	367	196	171	6 857	2 007	4 850
ERIM 2020	457	244	213	8 529	2 496	6 033
growth 2020/2007	**24%**	**24%**	**24%**	**24%**	**24%**	**24%**
Luxembourg CFL						
ERIM 2007	155	114	41	135	32	103
ERIM 2020	155	114	41	135	32	103
growth 2020/2007	**0%**	**0%**	**0%**	**0%**	**0%**	**0%**
Macedonia MZ						
ERIM 2007	63	60	3	534	19	515
ERIM 2020	119	113	5	1 142	41	1 101
growth 2020/2007	**88%**	**88%**	**88%**	**114%**	**114%**	**114%**
Netherlands ProRail						
ERIM 2007	7 149	6 748	401	4 633	681	3 952
ERIM 2020	10 238	9 558	680	10 345	930	9 416
growth 2020/2007	**43%**	**42%**	**69%**	**123%**	**36%**	**138%**
Norway JBV						
ERIM 2007	1 101	1 077	24	484	317	167
ERIM 2020	1 244	1 217	27	547	358	189
growth 2020/2007	**13%**	**13%**	**13%**	**13%**	**13%**	**13%**
Poland PKP PLK						
ERIM 2007	9 660	9 308	352	26 307	14 647	11 659
ERIM 2020	15 871	15 293	578	43 222	24 066	19 157
growth 2020/2007	**64%**	**64%**	**64%**	**64%**	**64%**	**64%**
Portugal REFER						
ERIM 2007	3 183	3 134	48	2 199	1 965	234
ERIM 2020	3 596	3 542	54	3 628	3 242	386
growth 2020/2007	**13%**	**13%**	**13%**	**65%**	**65%**	**65%**
Romania CFR						
ERIM 2007	2 464	2 416	49	3 589	2 612	977
ERIM 2020	2 825	2 769	56	4 114	2 994	1 120
growth 2020/2007	**15%**	**15%**	**15%**	**15%**	**15%**	**15%**
Serbia/Montenegro ZS						
ERIM 2007	704	407	297	3 072	389	2 683
ERIM 2020	1 596	924	672	8 389	1 064	7 325
growth 2020/2007	**127%**	**127%**	**127%**	**173%**	**173%**	**173%**
Slovak Republic ZSR						
ERIM 2007	1 263	1 148	115	6 146	840	5 306
ERIM 2020	1 735	1 577	157	6 246	853	5 392
growth 2020/2007	**37%**	**37%**	**37%**	**2%**	**2%**	**2%**

Table 6 – Domestic and International Passenger and Freight Traffic per Country in 2020 (Contd.).

Slovenia SZ						
ERIM 2007	559	446	113	2 321	256	2 065
ERIM 2020	857	643	215	4 424	531	3 893
growth 2020/2007	**53%**	**44%**	**90%**	**91%**	**107%**	**89%**
Spain ADIF						
ERIM 2007	13 147	12 413	734	8 738	6 859	1 879
ERIM 2020	24 636	22 982	1 654	16 182	12 338	3 844
growth 2020/2007	**87%**	**85%**	**125%**	**85%**	**80%**	**105%**
Sweden BV						
ERIM 2007	6 509	5 681	829	8 847	6 030	2 817
ERIM 2020	10 487	9 152	1 335	13 102	8 931	4 172
growth 2020/2007	**61%**	**61%**	**61%**	**48%**	**48%**	**48%**
Switzerland SBB/BLS						
ERIM 2007	4 100	3 903	197	11 247	5 731	5 516
ERIM 2020	6 931	6 598	333	25 778	13 135	12 642
growth 2020/2007	**69%**	**69%**	**69%**	**129%**	**129%**	**129%**
Turkey TCDD						
ERIM 2007	230	227	3	314	270	44
ERIM 2020	277	273	4	403	346	57
growth 2020/2007	**20%**	**20%**	**20%**	**28%**	**28%**	**28%**
United Kingdom Network Rail						
ERIM 2007	12 448	11 876	572	4 608	4 118	490
ERIM 2020	15 988	15 253	734	7 603	6 794	809
growth 2020/2007	**28%**	**28%**	**28%**	**65%**	**65%**	**65%**

	Passengers			**Freight**		
	Total	**Domestic**	**International**	**Total**	**Domestic**	**International**
Overall Total ERIM 2007	**201 711**	188 645	13 066	**266 904**	118 929	147 974
Overall Total ERIM 2020	**262 240**	244 178	18 061	**479 293**	210 063	269 229
growth 2020/2007	**30%**	**29%**	**38%**	**80%**	**77%**	**82%**

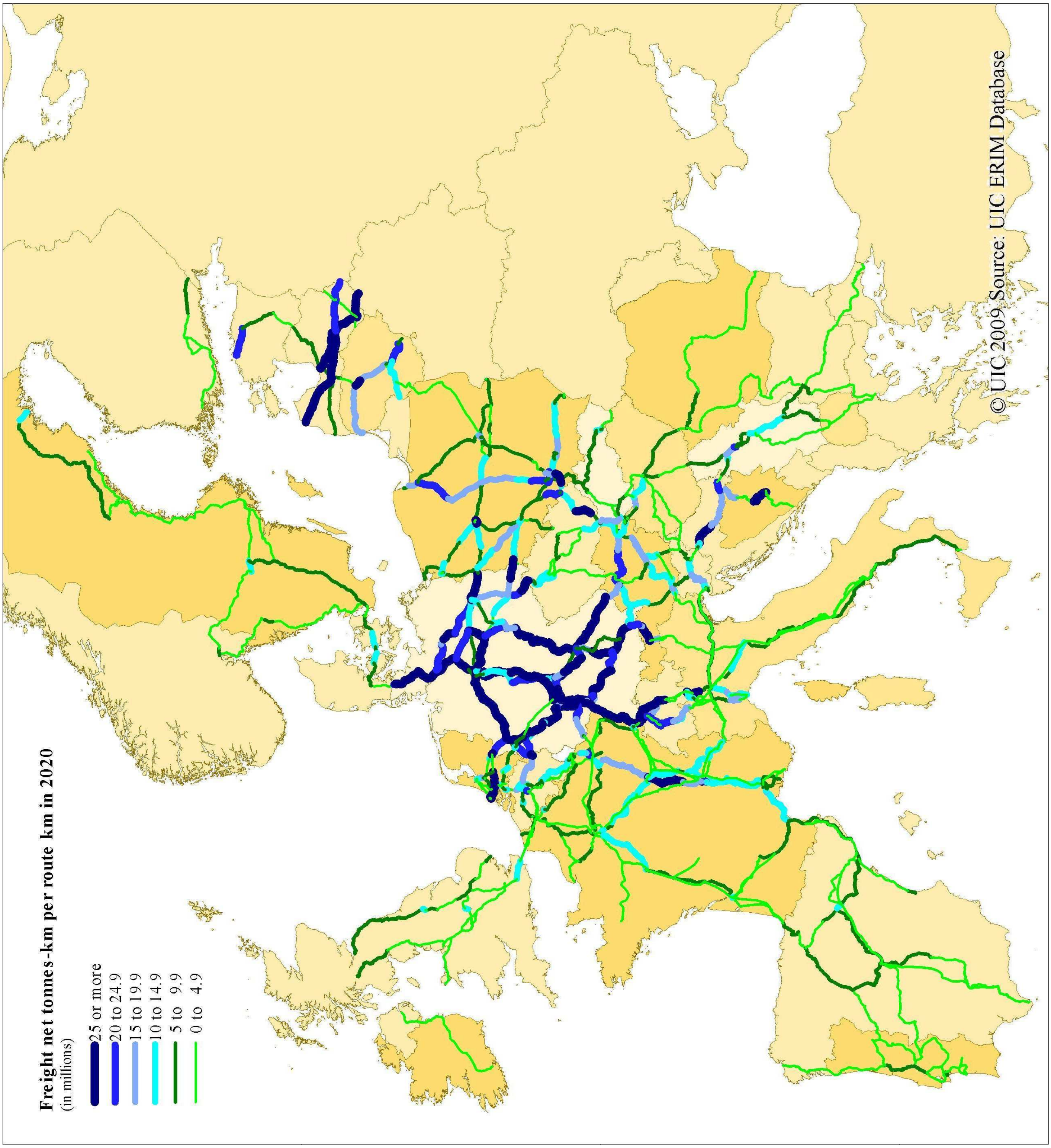
Table 6 – Domestic and International Passenger and Freight Traffic per Country in 2020 (Contd.).

The Table 7 shows forecast traffic growth from 2007 to 2020 based on the information on the UIC Members per each ERTMS Corridors. As such they indicate the overall trend, but can exclude additional traffic that potentially will be realised by the non-UIC Members.

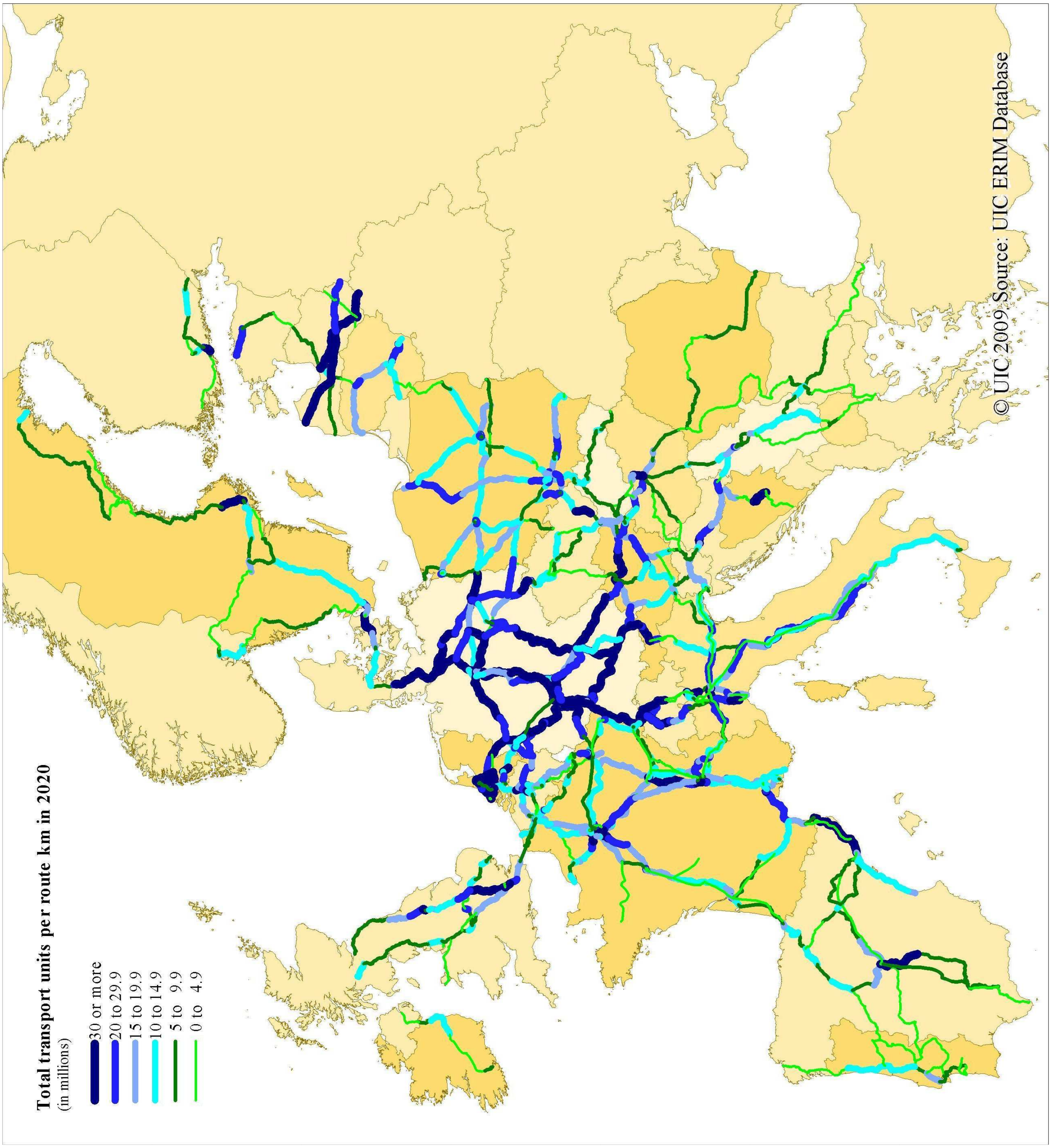
			Estimated passenger-kms per year in 2020			Estimated net tonnes-kms per year in 2020		
Corridor	Country	Route length [km]	Total (Millions)	National (Millions)	International (Millions)	Total (Millions)	National (Millions)	International (Millions)
Corridor A	Germany	1 080	9 836	9 459	377	36 362	15 977	20 385
	Italy	734	4 041	3 909	132	5 020	2 994	2 026
	Netherlands	229	1 223	1 166	58	5 969	249	5 719
	Switzerland	874	6 924	6 598	326	25 688	13 122	12 567
Total Corridor A		2 918	22 024	21 132	892	73 038	32 341	40 697
Corridor B	Austria	110	493	347	147	2 515	503	2 013
	Denmark	350	2 996	2 822	174	2 414	1 820	595
	Germany	1 205	7 561	7 272	290	34 860	15 317	19 543
	Italy	903	5 542	5 361	181	1 513	902	611
	Sweden	909	4 584	4 000	584	4 874	3 322	1 552
Total Corridor B		3 477	21 176	19 801	1 376	46 177	21 864	24 313
Corridor C	Belgium	532	2 823	2 589	234	3 677	907	2 770
	France	1 084	5 970	5 420	550	13 765	8 075	5 689
	Luxembourg	59	113	71	41	45	11	34
	Switzerland	5	7	0	7	89	14	76
Total Corridor C		1 680	8 912	8 080	831	17 576	9 007	8 569
Corridor D	France	877	5 593	5 078	515	9 596	5 630	3 966
	Hungary	283	245	242	4	259	76	184
	Italy	628	7 737	7 484	253	3 000	1 789	1 211
	Slovenia	447	621	498	122	3 546	452	3 094
	Spain	535	8 364	7 142	1 222	2 856	1 052	1 803
Total Corridor D		2 770	22 559	20 443	2 116	19 257	8 999	10 258
Corridor E	Austria	167	1 056	862	194	1 803	222	1 581
	Czech Rep.	828	1 510	1 430	80	5 196	2 217	2 979
	Germany	55	324	311	12	1 834	806	1 028
	Hungary	502	1 442	1 360	82	3 981	800	3 180
	Romania	865	2 351	2 305	46	3 187	2 389	798
	Slovakia	297	410	351	59	2 471	118	2 353
Total Corridor E		2 714	7 093	6 620	473	18 471	6 551	11 920
Corridor F	Germany	980	4 715	4 535	181	24 593	10 806	13 787
	Poland	954	3 849	3 708	140	7 932	4 417	3 516
Total Corridor F		1 934	8 564	8 243	321	32 525	15 223	17 303
Total ERTMS Corridors 2020		15 492	90 329	84 319	6 010	207 044	93 985	113 059
Total ERTMS Corridors 2007		15 353	68 134	64 084	4 050	111 751	51 042	60 709
growth ERTMS 2020/2007		1%	33%	32%	48%	85%	84%	86%
Total Others		38 900	171 911	159 859	12 052	272 248	116 078	156 170
Overall Total ERIM 2020		**54 392**	**262 240**	**244 178**	**18 061**	**479 293**	**210 063**	**269 229**
Overall Total ERIM 2007		50 320	201 711	188 645	13 066	266 904	118 929	147 974
growth ERIM 2020/2007		8%	30%	29%	38%	80%	77%	82%

Table 7 – Traffic Load per ERTMS Corridor in 2020

The distribution of 2020 freight traffic in tonne-km per route-km within the ERIM network is shown in Map 28. Similar distribution of current transport units (including both tonne-kms and passenger-kms) is shown in the Map 29.



Map 28 – Freight net tonnes-km per route-km in 2020



Map 29 – Total transport units in 2020

4 Capacity Analysis Today and in 2020

4.1 Concept of Theoretical Line Capacity and Capacity Constraint

In arriving at a satisfactory response to the issue of capacity utilisation and residual reserve on any line, one has to consider many factors such as the following:

1. the **physical parameters** of the section e.g. number of tracks, type of signalling and number of block sections, number of passing loops etc.;
2. the mix, **homogeneity** and **stopping patterns** of traffic (passenger and freight, fast and slow trains);
3. the market demand and related timetable loading throughout the day (**peak and off peak load**);
4. the degree of automation of the **traffic control systems**.
5. the balance struck between providing a **stable timetable with good recovery margins** (adequate running time supplements and buffers between following trains) and maximising the number of useable train paths by a tighter compression of the timetable, with the consequential potential for greater disturbance of services during degraded conditions.

It is clear from the above that **no one single figure can be given for the capacity** of double track or single track lines. The physical parameters of a line section (point 1. above) as embodied in the concept design will, of course, impose a upper limit on train throughput but the actual constraints listed in points 2 - 5 will, in turn, place practical limitations on capacity availability.

UIC leaflet 406 sets out the different factors that influence capacity and provides a general guideline on how to take them into consideration when assessing the capacity of a line section. The methodology necessitates detailed knowledge of the section characteristics and the operating schedules of each train, together with an understanding of the added time supplements and buffers between trains. It is quite clear that such a **rigorous analysis of the capacity of the European network has always been beyond the scope of the ERIM project**.

The ERIM Project has, therefore, applied a **pragmatic** approach by asking Member Railways to first supply the current number of passenger and freight trains operating in each line section, as well as the corresponding theoretical capacity in terms of the maximum number of train paths, based on their particular knowledge of the line sections and their practical experience in real operational conditions. This approach has permitted a distinction to be made between the **"less utilised"** line sections and **"heavier utilised"** sections. A **70% capacity utilisation,** (calculated as the percentage of the average daily trains to theoretical daily train capacity) has been taken as an indicative threshold to highlight areas of potential capacity constraint. It is likely that the figure of 70% daily infrastructure utilisation will equate with a higher utilisation rate of 80% or more in peak hours. The UIC project, **CapMan**, on capacity management established that, in general, an infrastructure occupation of 80% during the peak hour periods represents the operational threshold to maintain stability in punctuality.

The sections with an utilisation rate of 70 % or greater have been extracted from the database. It should be clear that **the calculated percentages on capacity utilisation cannot be taken as an absolute** and compared with each other in different sections of the ERIM network. They represent a relative indication of amount of capacity taken up by the current trains in any particular section when compared with the maximum theoretical capacity of the same line section, as advised by each Infrastructure Manager.

Consequently, the following general remarks can only be made:

1. the line sections below **70%** utilisation factors may not be heavily congested at present, certainly not over the 24hrs period;

2. the line sections between **70%-85%** may have some flexibility to carry extra traffic at certain periods of the day, particularly if accompanied by ‘soft’ measures such as attention to operation aspects, optimised running patterns of trains and small investments such as IT improvements etc.

3. the line sections between **85%-100%** are likely to be operating at optimum operational efficiency, in terms of train throughput, based on the current configuration of the infrastructure and train patterns.

4.2 Average Line Capacities in ERIM Network

Bearing in mind that the theoretical capacity for different line sections can vary greatly due to the points 1-5 listed in the previous section, the ERIM database can offer useful benchmarks as to the average theoretical capacity of double and single track sections, based on the statistical averages of the information supplied by Infrastructure Managers throughout the ERIM network.

Double Track

The ERIM data suggests that the **average theoretical capacity of double track lines** (bearing in mind the different national approaches in defining theoretical capacity) in Europe is around **260 trains per days** including both directions. If one takes the 70% - 80% utilisation threshold, **a general utilisation of around 100 trains per direction** (per track) and per day can be taken as a good indicator of the capacity of an ‘average’ double track section, having regard to maintaining a stable timetable.

Best example of double track utilisation shows average theoretical values in the range of 400 – 450 trains per day. Based on these examples and considering the European rail system in general, it may be useful to observe that, in setting out to design new sections of lines or upgrade existing sections, a **theoretical capacity of 400 trains** can be taken as an indication of a reasonable maximum design capacity of a double track conventional line. Using this figure, and applying a 70%- 80% quality utilisation threshold, would result in a planned use for **140 -160 trains per direction and per day.**

Single Track

The ERIM database shows that the average theoretical capacity of single lines (bearing in mind the different national approaches in defining theoretical capacity) is about **80 -100 trains per day**. If one takes the 70% - 80% utilisation threshold, **a general utilisation of around 60-80 trains per day** (both directions) can be taken as a good indicator of the capacity of the ‘average’ single track section**.** There are examples in the ERIM database where theoretical capacity of **150 trains per day** are provided for.

4.3 Capacity Utilisation in ERIM Network in 2020

The previous section distinguished between capacity utilisation values below 70% which may be broadly defined as un-congested and those above 70% and 85% (with the consequential likely utilisation rate of 80% or higher in peak hours). As one moves progressively towards the 100% theoretical capacity limit, the prospect of instability in the timetable may arise to a greater degree. In some sections this can be mitigated by greater attention to operational aspects (e.g. strict imposition of dwell times at stations, rigorous pre-examination of rolling stock prior to voyage commencement, hot standby of personnel, etc) and /or infrastructure redundancy or fall-back provisions.

In the previous ERIM 2007 report, the current capacity utilisation was estimated (with the method described on page 64 of this present report). According to this estimation, 14% of ERIM network (6 500 Km) have a capacity utilisation between 70% - 84% and 10% of ERIM network (5 000 Km) have a capacity utilisation equal or higher than 85%.

This ERIM Atlas provides a high level overview of the future capacity utilisation of the entire ERIM network. The predicted traffic growth rates for each corridor, as explained in Section 3.5 are applied to the current train numbers to arrive at a possible number of trains in 2020, before productivity benefits are taken into account. **Productivity benefits of 20%** in loading factors are assumed on passenger and freight trains (for those line sections, which are expected to grow by more than 20% by 2020) to arrive at the adjusted number of predicted trains in 2020. In this way anticipated technological progress and improved operational efficiency are factored into the analysis.

This productivity benefit of 20% appears reasonable for the passenger business since some of the growth could be expected to be accommodated on existing trains and it has also been taken as a target for the **Combined Transport** Group to increase the loading of existing trains from 66% to 80% (20% increase). The increase of the load factors for bulk commodity and single wagon trains may be more difficult to predict but since the underlying growth assumption for these traffics is smaller, a different productivity increase is unlikely to affect greatly the overall picture.

Many of the contributors to the ERIM questionnaire have not been in a position to provide specific details of the likely number of trains and capacity utilisation in 2020 and accordingly ERIM has utilised a reasonable approximation to assess what the **likely picture might be by 2020** as follows:

- Where updated figures for theoretical capacity have been supplied for 2020 they are utilised. Otherwise, it is assumed that the current theoretical line capacity figures do not change unless new lines are installed, in which case the theoretical capacity of the route is increased pro-rata to the existing line sections. Where new high speed passenger lines are added it is assumed that preference will be given to the freight on the existing parallel routes with the transfer of the passenger traffic to the new line to release capacity, if needed.

- Finally the adjusted number of predicted trains in 2020 is compared with the updated theoretical capacity figures to arrive at the map of **potentially constrained line sections by 2020.**

The above working hypothesis has been applied to the entire ERIM network suggesting that **32% (16 000 route kms) of the ERIM network will potentially be capacity constrained in 2020,** even taken account the expected productivity gains and the currently planned infrastructure investments increasing theoretical capacity. The results of this approach are shown in the Table 8 and on the following Map 30.

Degree of utilisation (u)	%	km
u<70%	68	35 330
70% ≤ u < 85%	14	7 089
u ≥ 85%	18	9 254

Table 8 – Capacity Utilisation in ERIM Corridors in 2020, before investments

Based on these results, an additional working hypothesis to estimate the amount of capacity constrained line sections has been applied in the ERIM Investment Analysis on page 77. This additional analysis having a very positive assumptions indicate that total route-length of the capacity constrained line sections would be as low as 3 000 Kms. Probably the plausible projection of the capacity constrained line sections is somewhere between these two scenarios.

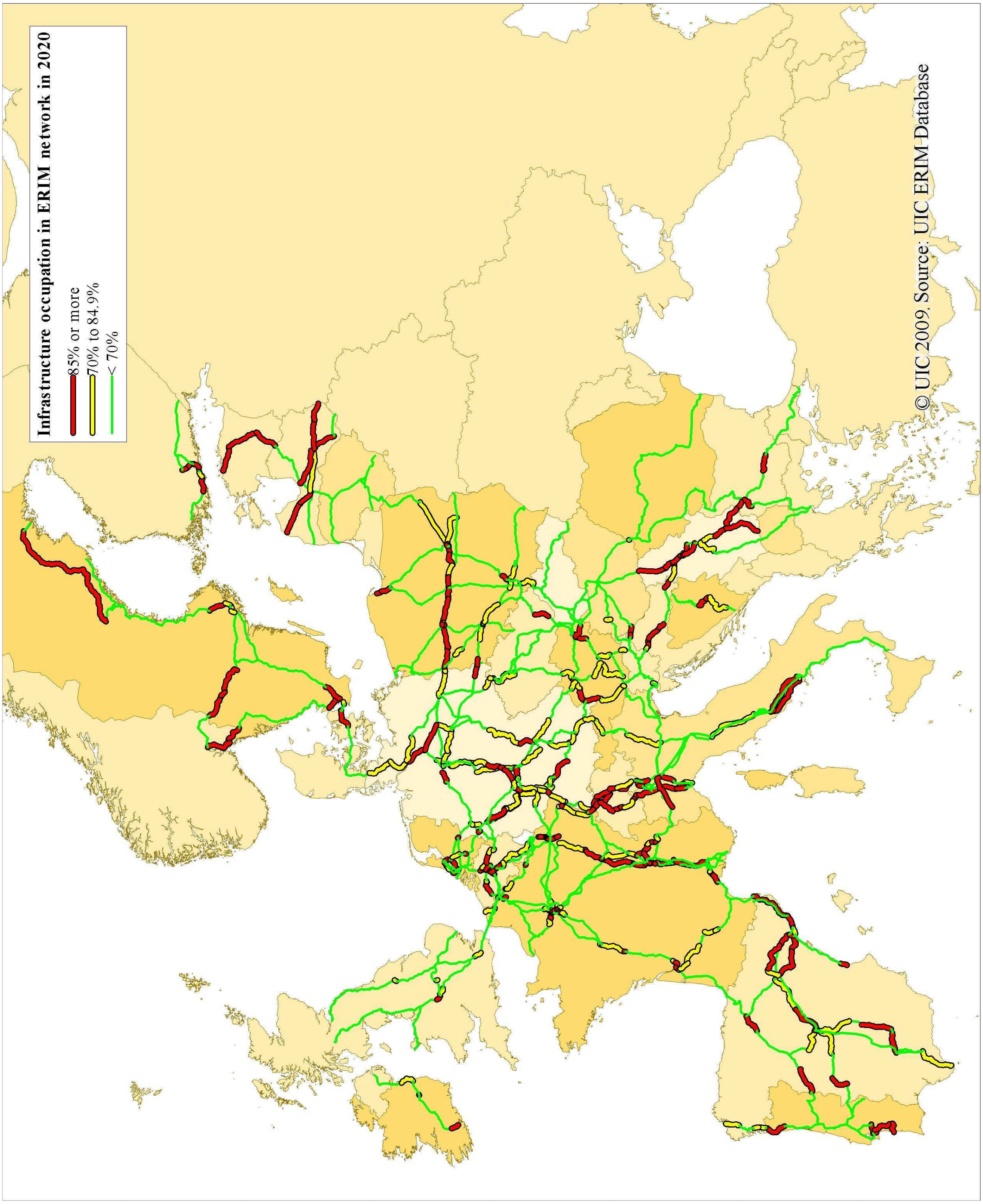
4.4 Capacity shortages within Combined Transport Terminals

In connection with the UIC ERIM and DIOMIS projects, UIC carried out in 2007-2008 the TEMA study to analyse the infrastructure capacity on nodes and on the so-called last mile (the link connecting the CT terminals to the main line). TEMA studied 53 combined traffic terminals at sea ports and 67 inland combined transport terminals which were subsequently regrouped into transport areas. The TEMA CT terminal selection covers approximately 80% of the total European combined traffic by rail. Like ERIM, TEMA estimated the current and future 2020 traffic and assessed the current and future capacity needs. TEMA postulated that, in the intermodal chain, the most significant capacity constraints don't usually appear in the last mile infrastructure, but in connection with the handling operations inside the terminal. In case the latter is congested however, also the last mile infrastructure might become critical as trains have to wait longer before entering into the terminal, so increasing the occupation of arrival / departure tracks.

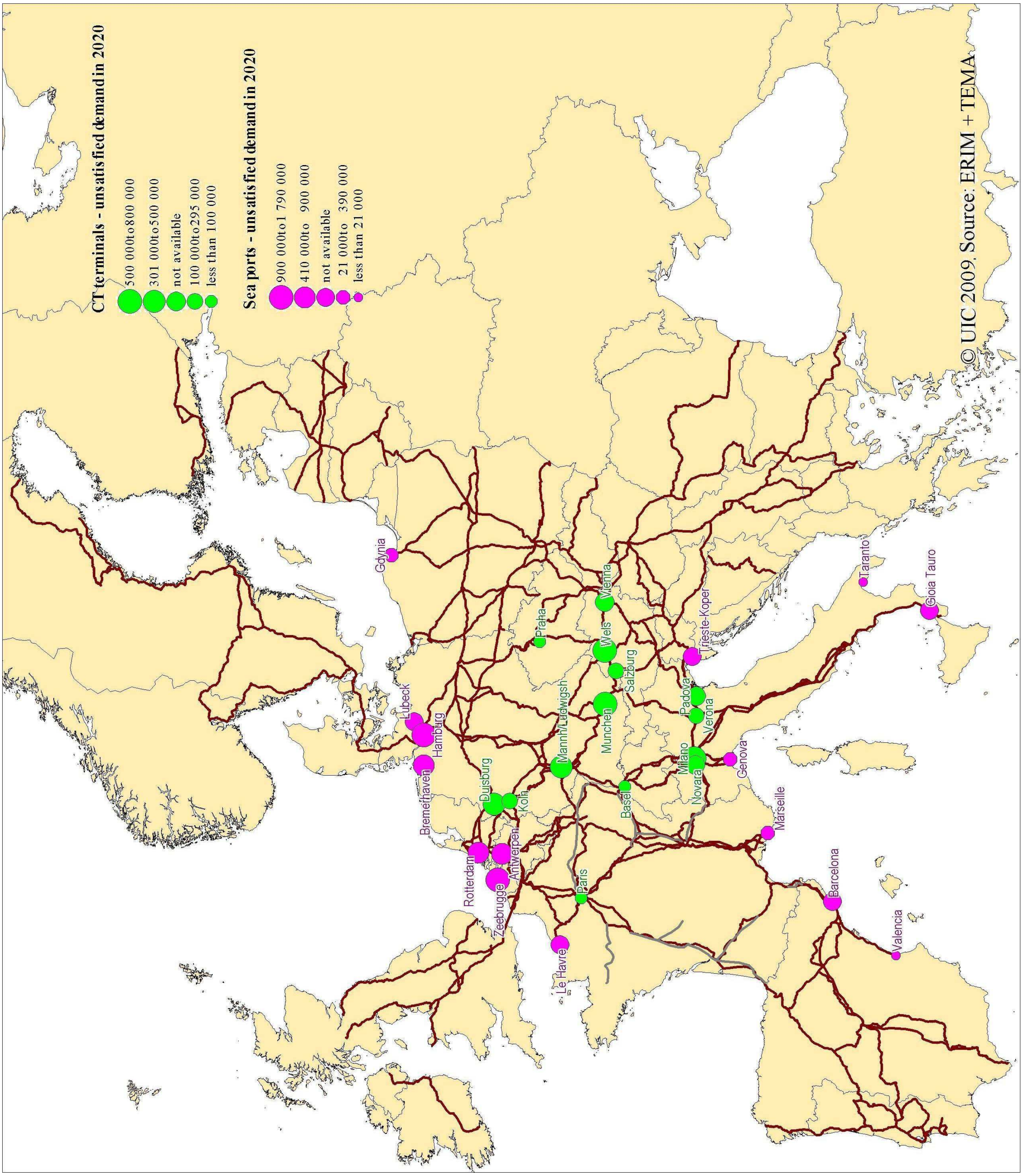
For the seaport terminals TEMA has estimated that 5,6 million loading units (LU) corresponding to 46% of the forecast container traffic in 2020 could be unsatisfied due to the insufficient transhipment capacity, especially in Hambourg, Zeebrugge, Rotterdam and Bremerhaven. This unbalance is partly due to the relatively short terminal investment planning horizon of 3-5 years and therefore the investment plans from 2011-2013 up to 2020 are not decided yet.

For the inland combined transport terminals, TEMA estimated the unsatisfied demand to be around 5,3 million LU, which can still be covered by later investments. However, the conclusion remains the same, the future investment need in combined transport terminals for rail is roughly equivalent to 10 million LU and can have an effect on rail volumes, if not integrated into the rail overall strategies.

The Map 31 shows the unsatisfied demand by 2020 in the seaport and inland terminals for the Combined Transport for rail.



Map 30 – Infrastructure utilisation in 2020



Map 31 – Capacity shortages in major seaport and inland CT terminals

5 Results of the ERIM Investment Analysis

5.1 Introduction

During the course of 2008, UIC have combined the ERIM Infrastructure questionnaire and the ERIM Investments questionnaire creating one questionnaire called **ERIM Infrastructure & Investments**. The first part of the questionnaire is dedicated to the current status of the infrastructure and second part to the national investment plans up to 2020 and what is projected status of the infrastructure in 2020.

In the investment part of the questionnaire, the railways were asked to describe their planned investments within the ERIM corridors in general and respond to questions on infrastructure upgrading and bottleneck relief in particular:

a) Concerning the infrastructure upgrading

ERIM has proposed the upgrading of the five major technical and operational key parameters to a minimum harmonisation level for the existing infrastructure, (higher targets were proposed for new installations). These minimum target were defined by using a **70% threshold of compliance** in the ERIM database, meaning that the remaining 30% (or less) of the infrastructure being below the target level was proposed to be upgraded, whenever feasible. However, during the discussion and in connection with other works, it was considered that the train length is relatively feasible and important lever for capacity efficiency and therefore the minimum target level for train length has been modified up to 750 m (having 39% compliance in the 2008 database). The key parameters and the proposed minimum upgrading targets are the following:

- Loading gauge : GB
- Train length : 750 m
- Axle load : 22,5 t / axle
- Train load : 1 500 t
- Freight Speed 100 Km /h

Each railway was asked whether it has plans to upgrade the aforementioned infrastructure parameters to the ERIM minimum or higher **upgrading** target levels and what would be the approximate upgrading cost. If the upgrading measure is part of a bigger infrastructure project (like they often are), the railway was asked to report the total sum of the infrastructure project.

In case no current upgrading plans was designated, the railway was asked to indicate whether the upgrading would be technically (=financially) feasible and what would be the estimated upgrading cost.

b) Concerning the capacity relief:

As explained earlier in section 4.1, a **70% capacity utilisation** (calculated as the percentage of the average daily trains to theoretical daily train capacity) has been taken as an indicative threshold to highlight areas of potential capacity constraints.

Each railway was also asked to report its investment plans and costs in general and those coinciding with line sections having a capacity utilisation above 70% in particular. When there was no investment plans for a line section having more than 70% of capacity utilisation, the railway was asked whether it considered that the line section was an existing or potential bottleneck. When the answer was affirmative, the railway was asked to indicate a possible measure to enhance capacity / remove the bottleneck and what would be the estimated investment cost. As important infrastructure projects can include measures both for upgrading and for capacity relief, the railways were asked not to double count.

While keeping in mind that investment plans are sometimes modified and thus need to be updated regularly, the ERIM Infrastructure and Investment questionnaire can provide a relatively reliable overview on the **planned investment measures** and their total **costs** within each country and within the ERIM network in total.

The questionnaire also allows to estimate the minimum **investment gap**, when no investment measures is planned to relieve existing or potential bottlenecks or when there is no plans to upgrade the key parameters to the minimum harmonisation level. When no information was given on the estimated investment costs to fulfil the aforementioned investment gaps, ERIM have used **average figures**. It is clear that the costs for upgrading and capacity enhancement can vary considerably, but the averages figures used previously in ERIM and in CER McKinsey study were considered to be acceptable enough as working hypotheses for a high level analysis at European level.

The questionnaire sought to establish also to which extent the planned investment measures have a **secured financing** and therefore the railways were ask to associate each investment measure with a corresponding budget planning status which are :

1. Planned and financing approved
2. Planned but financing not approved or only partially approved
3. Proposed for another planning period or lacking a firm decision.

In case, the investment measure was not planned, but suggested by the ERIM questionnaire in relation to the infrastructure upgrading or bottleneck relief, the following status was used:

4. New idea, not yet processed in planning

And finally the ERIM Infrastructure and Investment questionnaire sought to establish **timing** of investment measures by asking the "Starting Year of Operation", in other words when investment measure is planned be ready for use.

Excepting the last point on timing, the next chapter will provide some aggregated information on investment plans and needs from the ERIM database in the form of tables and maps.

To put the investment amounts presented in the next section into perspective, it is roughly estimated that the Infrastructure Managers of the railways in the EU Members States spend together about **40 billion Euros** annually between **maintenance, renewals, operations and investments**. While the proportion of expenditure in each category fluctuates dramatically from each country, globally, throughout Europe, one can say that it averages about **10 billion Euros in each category** with a potential variation of 1 to 2 billion Euros, up or down, (i.e. 8-12 billion per category) depending on priority expenditure issues in any particular year.

5.2 Results of 2008 Investment Analysis

This new ERIM Infrastructure & Investments questionnaire has been sent for update to the Infrastructure Managers in the 32 ERIM countries. The following 22 countries **maintained or updated** their investment plans from previous year: Austria, Belgium, Bulgaria, Denmark, Finland, France, Germany, Latvia, Luxembourg, Macedonia, Netherlands, Norway, Poland, Portugal, Romania, Serbia/Montenegro, Slovak Republic, Slovenia, Spain, Sweden, Switzerland and UK.

Czech Republic, Hungary, Italy, Ireland, Lithuania provided **their investment plans for the first time**, whereas Bosnia / Herzegovina, Croatia, Estonia, Greece and Turkey **have not responded**. The information for these later countries has been 'in-filled' by using ERIM average unit costs from 2007. This has ensured that a reasonably complete picture can be shown for the entire ERIM network.

1) Summary of questionnaires from 27 countries – given data

Total route-length in the **27 countries** having responded to ERIM questionnaire equals **52 866 km** which accounts for **97%** of total ERIM network. Due to updated investment plans and the 5 new respondent countries, especially Italy, the sum of the planned investments has increased by 41% from 122 475 M€ in 2007 to **173 130 M€** in 2008[3]. The following table 9 gives the investment plans per country. It is important to note that all investment measures which were not specifically referenced to the upgrading of the key parameters are recorded as capacity relief.

	Planned investments in 27 countries						TOTAL costs of investments (Millions €)
Country - IM	Gauge	Axle load	Freight speed	Train length	Train load	Capacity relief	
Austria **ÖBB**	0	0	0	90	0	21 064	21 154
Belgium **Infrabel**	0	0	0	20	0	2 626	2 646
Bulgaria **NRIC**	0	0	1 082	0	0	954	2 036
Czech Republic **SZDC**	0	0	0	0	0	3 044	3 044
Denmark **DSB**	0	0	0	0	0	1 643	1 643
Ireland **CIE**	363	0	0	0	0	0	363
Finland **VR**	0	62	0	20	0	898	980
France **RFF**	220	0	0	0	0	30 119	30 339
Germany **DB AG**	0	0	0	50	0	17 942	17 992
Hungary **MAV**	0	453	905	128	222	0	1 708
Italy **RFI**	0	0	0	0	0	33 557	33 557
Latvia **LDZ**	0	496	0	79	0	1 926	2 501
Lithuania **LG**	46	0	0	4	20	1 060	1 130
Luxembourg **CFL**	0	0	0	0	0	831	831
Macedonia **MZ**	0	0	438	0	0	6	444
Netherlands **ProRail**	0	0	0	0	0	3 730	3 730
Norway **JBV**	0	0	0	0	0	2 275	2 275
Poland **PKP PLK**	0	0	0	0	0	9 869	9 869
Portugal **REFER**	19	0	259	19	14	1 588	1 898
Romania **CFR**	0	1 632	1 626	628	0	402	4 289
Serbia/Montenegro **ZS**	581	807	1 981	1 060	1 278	3 423	9 131
Slovak Republic **ZSR**	0	0	0	0	0	5 158	5 158
Slovenia **SZ**	0	0	0	0	0	802	802
Spain **ADIF**	0	0	0	0	0	1 420	1 420
Sweden **BV**	0	0	0	0	0	6 533	6 533
Switzerland **SBB/BLS**	1	0	0	0	0	4 356	4 357
United Kingdom **Network Rail**	3 300	0	0	0	0	0	3 300
TOTAL	**4 529**	**3 450**	**6 291**	**2 098**	**1 534**	**155 227**	**173 130**

© UIC, Source: ERIM Database 2008

Table 9 – Planned investments in 27 countries given in ERIM Investment Questionnaire

[3] However, the stock of investment plans should go down every year as the remaining time up to 2020 gets shorter.

The ERIM questionnaire sought to establish also at which extend the financing of the infrastructure investments was ensured. Only 28% of the planned investment has an approved financing, which is partly explained by the relatively long time span of 13 years up to 2020.

Planned investments per budget planning stage	Costs of investments in the parameters upgrades (Millions €)						TOTAL costs of investments (Millions €)
	Gauge	Axle load	Freight speed	Train length	Train load	Capacity	
0-Budget planning stage not indicated	19	0	1 181	647	14	43 679	**45 539**
1-Planned and financing approved	220	644	741	114	20	46 113	**47 852**
2-Planned but financing not approved or only partially approved	626	1 453	2 625	1 092	1 278	26 624	**33 699**
3-Proposed for another planning period or lacking a firm decision	3 100	404	840	0	0	23 896	**28 240**
4-New idea, not yet processed in planning	564	948	905	245	222	14 914	**17 799**
TOTAL	**4 529**	**3 450**	**6 291**	**2 098**	**1 534**	**155 227**	**173 130**

© UIC, Source: ERIM Database 2008

Table 10 – Planned investments in 27 countries per budget planning stage

2) Summary of questionnaires from all 32 countries – additional estimations

Upgrading of key parameters

In addition to the missing data from 5 railways, the ERIM detected incomplete investment information for a number of line sections where existing infrastructure parameters are **below the ERIM minimum target level** and indicated by the Railway as 'feasible' for upgrading. To estimate the investment cost to upgrade these infrastructure parameters to the minimum target level, the following average unit costs have been used as ERIM working hypotheses when no estimation was given by the Railway itself. They have been applied to the entire length of each line section being below the upgrading target level.

- Upgrade Gauge to GB – **1.5 M€** per route –km
- Upgrade Train Length to 750m – **0.2 M€** per route –km
- Upgrade Axle load to 22.5 tonnes – **0.5 M€** per route –km
- Upgrade Train load to 1500t – **1.0 M€** per route –km
- Upgrade Freight speed to 100km/h – **1.0 M€** per route –km

When applying these unit costs to all those line sections being below the target level but feasible for upgrading and where no investment plans were indicated by the railway, an estimated additional investment need of 14 989 million Euros is obtained.

Gauge GB	Train length 750m	Axle load 22.5	Train load 1500t	Freight speed 100km/h	**TOTAL**
4 827 M€	1 528 M€	0,588 M€	5 018 M€	3 028 M€	14 989 M€

Bottleneck removal and capacity relief

To estimate the investment cost to relieve capacity bottlenecks the average unit cost from the ERIM 2007 Report have been used : **5.12 million Euros** per route–km. ERIM detected from the 2008 questionnaires a total of **2,307 km** of routes where bottlenecks were confirmed and investment measures planned by the corresponding railways, but no investment costs were indicated. In addition, ERIM detected a total of 481 km of routes including potential bottlenecks for which no information was given by the railways. Consequently ERIM has applied the average unit cost of 5,12 million Euros to the 2,788 Km of routes obtaining the estimated additional investment need of 14 288 million Euros to relieve capacity and to remove the remaining bottlenecks.

This amount don't include :

- Those line sections that had a capacity utilisation above 70% but were confirmed by the railways of not being a bottleneck ,

- Those line sections for which a key parameter upgrade has been estimated as explained on the previous page (it is assumed that the upgrade of the key parameter will remove the capacity constraint).

3) Summary for 32 countries – plans and estimations (in millions of Euro)

A total investment budget of **202 407 million Euros** has been identified for the 32 counties participating in the ERIM study. This amount covers, within the ERIM network, all the infrastructure investments planned by the railways, the upgrading of the key infrastructure parameters to minimum target level and the treatment of the capacity constrained sections. This figure excludes investment in terminals and large nodes which have not formed part of this study.

Planned investments in 27 countries (reported by each Railway)	173 130
Estimated additional investments to upgrade the **key parameters** in 32 countries	14 989
Estimated additional investments to **relieve capacity** in 32 countries	14 288
ALL TOTAL	**202 407**

Table11 shows the spread of this investment budget per country and the Table 12 per ERTMS corridor.

	Planned and estimated investments in 32 countries						TOTAL costs of investments (Millions €)
Country - IM	Gauge	Axle load	Freight speed	Train length	Train load	Capacity relief	
Austria **ÖBB**	0	0	0	215	213	21 889	22 317
Belgium **Infrabel**	0	0	0	20	0	2 729	2 749
Bulgaria **NRIC**	0	0	1 082	0	0	954	2 036
Bosnia&Herzegovina **ZRS/ZFBH**	0	0	124	80	0	0	204
Croatia **HZ**	0	0	146	71	0	0	217
Czech Republic **SZDC**	0	0	0	14	72	3 044	3 130
Denmark **DSB**	0	0	0	0	0	1 643	1 643
Ireland **CIE**	363	182	363	0	363	0	1 271
Estonia **EVR**	0	0	273	55	273	0	601
Finland **VR**	0	62	0	28	0	1 045	1 135
France **RFF**	706	0	167	0	2 496	31 528	34 897
Germany **DB AG**	0	0	0	155	0	18 654	18 809
Greece **OSE**	149	88	0	35	176	0	448
Hungary **MAV**	0	545	1 024	151	252	0	1 972
Italy **RFI**	680	81	275	390	0	33 557	34 983
Latvia **LDZ**	0	496	4	79	0	1 926	2 505
Lithuania **LG**	46	0	0	15	20	1 060	1 141
Luxembourg **CFL**	0	0	0	0	0	831	831
Macedonia **MZ**	0	0	438	0	0	6	444
Netherlands **ProRail**	404	18	66	26	147	3 776	4 436
Norway **JBV**	0	0	0	0	0	2 275	2 275
Poland **PKP PLK**	0	93	546	189	58	9 869	10 755
Portugal **REFER**	19	0	328	19	674	1 696	2 736
Romania **CFR**	0	1 632	1 626	628	0	705	4 591
Serbia/Montenegro **ZS**	581	807	1 981	1 060	1 278	3 423	9 131
Slovak Republic **ZSR**	0	0	41	8	20	5 158	5 227
Slovenia **SZ**	188	0	0	157	97	5 989	6 430
Spain **ADIF**	11	0	0	1	7	1 420	1 439
Sweden **BV**	0	0	0	224	84	6 923	7 231
Switzerland **SBB/BLS**	1	0	0	5	99	5 104	5 209
Turkey **TCDD**	479	0	319	0	223	0	1 021
United Kingdom **Network Rail**	5 733	35	516	0	0	4 310	10 594
TOTAL	**9 356**	**4 037**	**9 319**	**3 626**	**6 553**	**169 515**	**202 407**

© UIC, Source: ERIM Database 2008

Table 11 – Planned and estimated investments in 32 countries

Corridor	Planned investments in ERTMS corridors: Gauge	Axle load	Freight speed	Train length	Train load	Capacity relief	TOTAL cost of investments (Millions €)
ERTMS corridor A	0	0	0	0	0	10 937	10 937
ERTMS corridor B	0	0	0	0	0	25 179	25 179
ERTMS corridor C	1	0	0	12	0	2 438	2 452
ERTMS corridor D	693	783	2 032	1 051	1 283	4 730	10 572
ERTMS corridor E	0	1 187	1 316	505	0	2 622	5 630
ERTMS corridor F	0	0	0	48	0	2 361	2 409
Total ERTMS corridors	**694**	**1 971**	**3 348**	**1 616**	**1 283**	**48 268**	**57 179**
Total others	3 836	1 479	2 943	482	251	106 959	115 951
TOTAL ERIM PLANNED	**4 529**	**3 450**	**6 291**	**2 098**	**1 534**	**155 227**	**173 130**

Corridor	Estimated additional investments in ERTMS corridors: Gauge	Axle load	Freight speed	Train length	Train load	Capacity relief	TOTAL cost of investments (Millions €)
ERTMS corridor A	395	42	35	157	200	748	1 577
ERTMS corridor B	152	0	0	111	0	390	652
ERTMS corridor C	41	0	34	0	0	0	75
ERTMS corridor D	153	0	370	100	154	0	777
ERTMS corridor E	0	10	32	38	78	302	460
ERTMS corridor F	0	10	202	58	29	313	612
Total ERTMS corridors	**740**	**62**	**673**	**463**	**461**	**1 753**	**4 152**
Total others	4 087	526	2 355	1 065	4 557	12 535	25 125
TOTAL ERIM ESTIMATED	**4 827**	**588**	**3 028**	**1 528**	**5 018**	**14 288**	**29 277**
TOTAL ERIM plan+estimation	**9 356**	**4 037**	**9 319**	**3 626**	**6 553**	**169 515**	**202 407**

Table 12 – Planned and estimated investments per ERTMS corridors in 32 countries

The planned and estimated investments to upgrade the key parameters and to relieve capacity are shown on the following Maps from 32 to 37. As explained earlier the upgrading of the key parameters can be part of bigger infrastructure projects which have often been recorded by the Railways as measures to relieve capacity. Therefore, in Maps 32-36, some line sections appear as “below the target value -no investments planned” since the planned upgrading is included in the Map 37 illustrating the investments to improve the capacity.

Not used

As explained in paragraph 5.2, this ERIM 2008 report has used the same average costs as those used in the ERIM 2007 report and which were aligned with CER McKinsey study. The average upgrading costs that have been calculated now from the ERIM 2008 database are higher than last year, probably because of additional data input and inflation. They have been calculated by using information given by railways according to the Table 9. One should remain prudent with these figures as the data sample is small and the respondent railways may not be representative of European average (e.g. the average cost to upgrade the loading gauge is high due to the data from United Kingdom). These average costs obtained from the ERIM 2008 database have only an indicative value and can be used solely for a broad benchmarking. They have not been used in any other tables.

The table underneath highlights that the ERIM 2008 estimation of total investment budget of **202 407 M€ may be underestimated** if the actual average unit costs were higher than those used “officially” in this report. By applying the average costs below, the total investment budget would rise to 215 624 as indicated below.

- Upgrade Gauge to GB – **2.8 M€** per route –km
- Upgrade Train Length to 750 m – **0.6 M€** per route –km
- Upgrade Axle load to 22.5 tonnes – **0.9 M€** per route –km
- Upgrade Train load to 1 500 t – **1.2 M€** per route –km
- Upgrade Freight speed to 100 km/h – **1.8 M€** per route –km
- Capacity relief **5,9 M€** per route - Km

Planned investments in 27 countries (reported by each Railway)	173 130
Estimated additional investments to upgrade the **key parameters** in 32 countries	26 059
Estimated additional investments to **relieve capacity** in 32 countries	16 435
ALL TOTAL	**215 624**

5.3 Capacity Utilisation in ERIM Network in 2020 (including planned investments)

In the previous section 4 on Capacity Analysis Today and in 2020, the capacity shortages have been estimated by comparing the estimated 2020 traffic loads with the 2020 theoretical capacity. In this analysis the planned investments improving the theoretical 2020 capacity have been taken into account every time a railway declared an improved theoretical capacity for 2020. This declared capacity increase is often due to very tangible improvements, such as transformation of single track to double track line or construction of high speed line releasing capacity on the conventional line, whereas the more "general" upgrading of the line, for instance due to ERTMS, has usually not been factored into the 2020 theoretical capacity declared by the railways.

Knowing that it is difficult to assess how much the "general" upgrading improves the theoretical capacity of each line section, ERIM has made a simulation with the extreme positive working hypotheses which are the following:

- All planned investments will be done by 2020, regardless whether their **financing** have been secured today or not.
- The bottlenecks (which were confirmed by railways as being bottlenecks) would be removed completely if any investments, **regardless what type of investment they are**, have been planned for these line sections.

Even applying such an optimistic approach, the ERIM analysis shows that probably more than 3 000 km, representing 6% of the ERIM network may face capacity shortages in 2020 (see Table 13).

Degree of utilisation (u)	%	km
u<70%	94%	51 360
70% ≤ u < 85%	2%	1 026
u ≥ 85%	4%	2 007

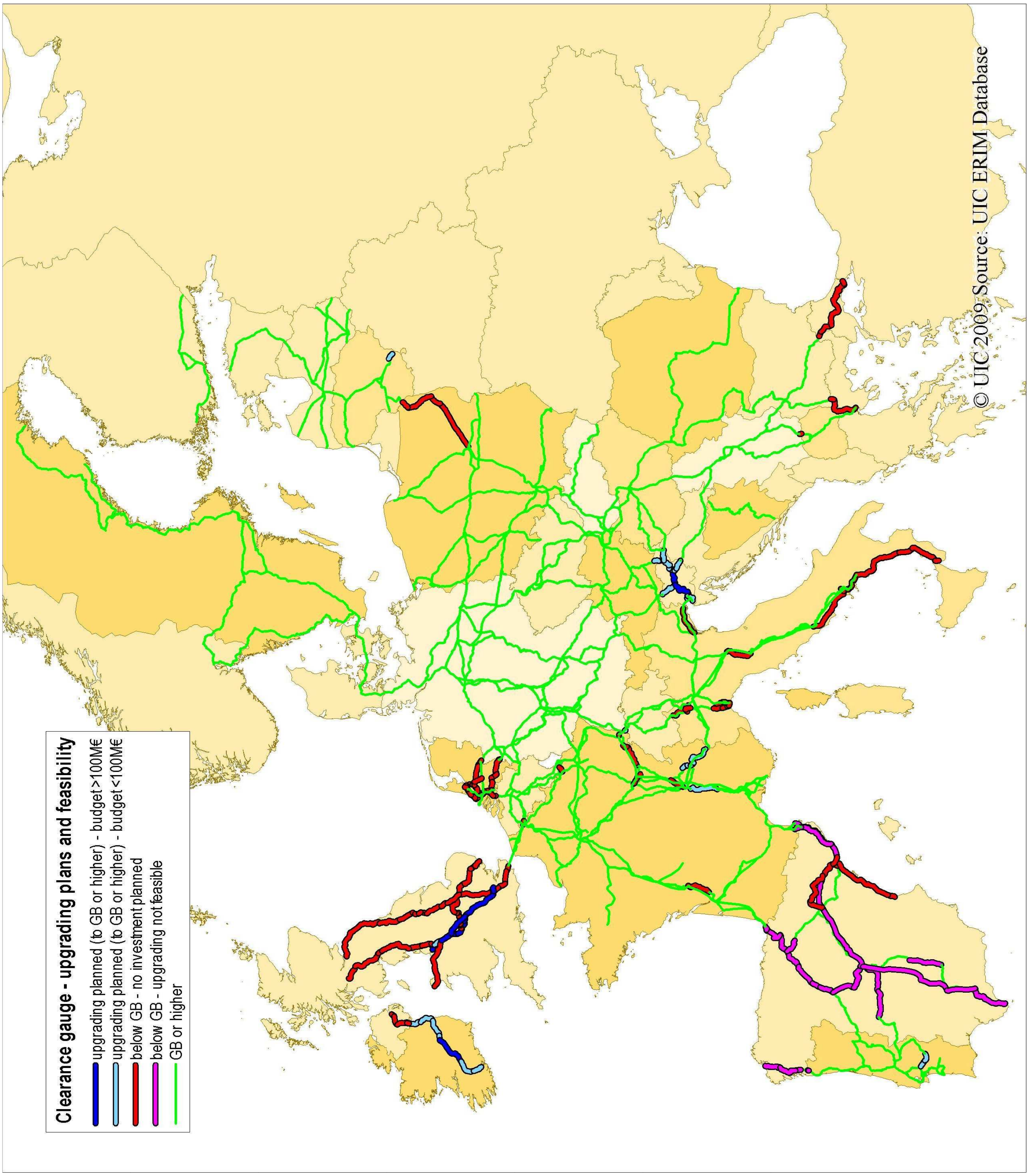
Table 13 – Capacity Utilisation in ERIM Corridors in 2020, after planned investments

Another analysis to estimate the amount of capacity constrained line sections has been done in the ERIM Capacity Analysis on page 66. This analysis indicate that total route-length of the capacity constrained line sections would be as high as 16 000 Kms.

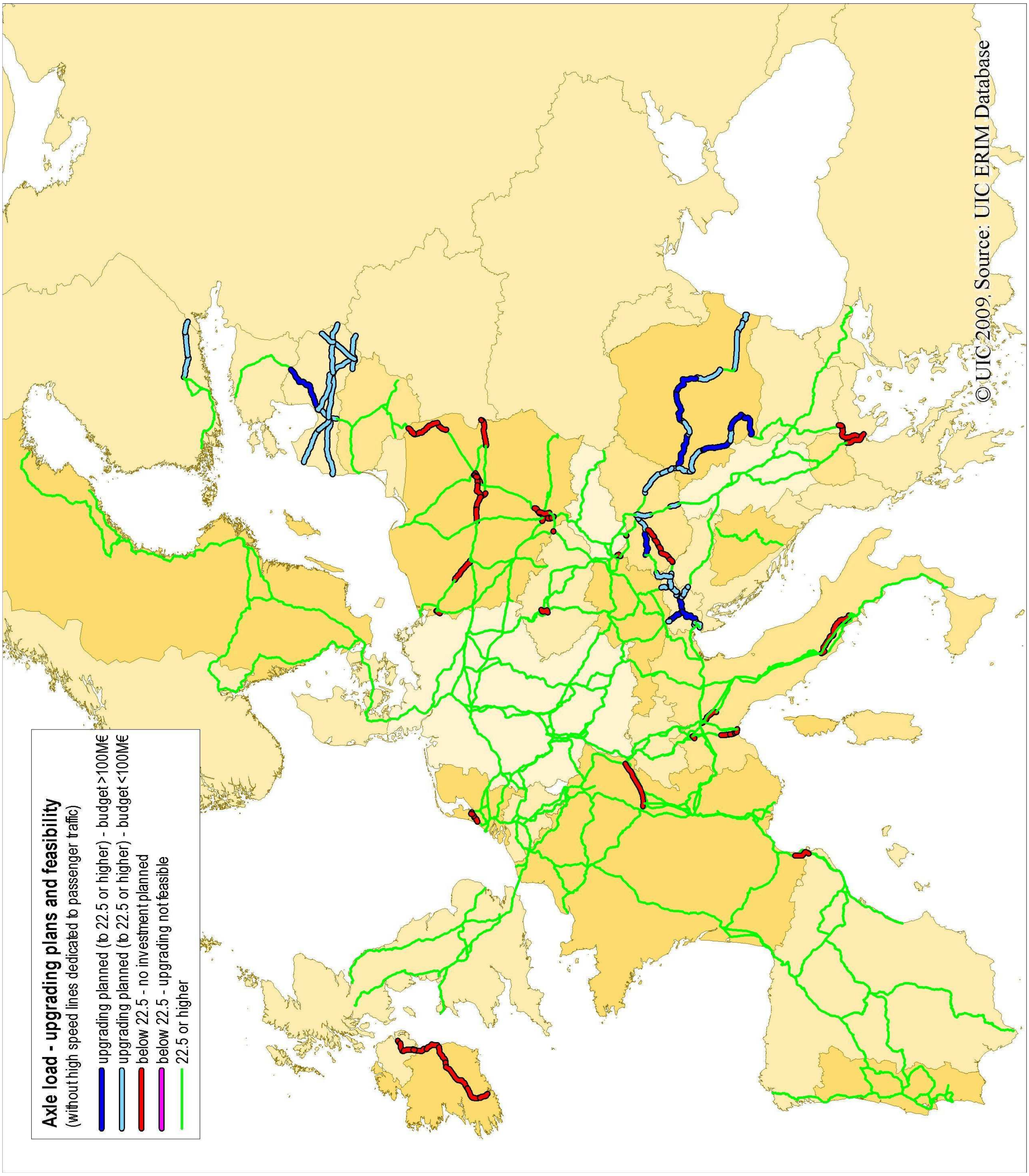
Probably the plausible projection of the capacity constrained line sections is somewhere between 3 000 – 16 000 km. **Whatever is the actual amount of capacity constrained line sections, it is important to remind that the bottlenecks don't affect only the corresponding line sections, but can often reduce the usable capacity along the entire corridor or train path.**

For the moment, the ERIM database doesn't allow technically any other scenarios than the ones postulated in this report. ERIM intends to reduce the gap between the two scenarios, in collaboration with its member railways, in its 2009 analysis.

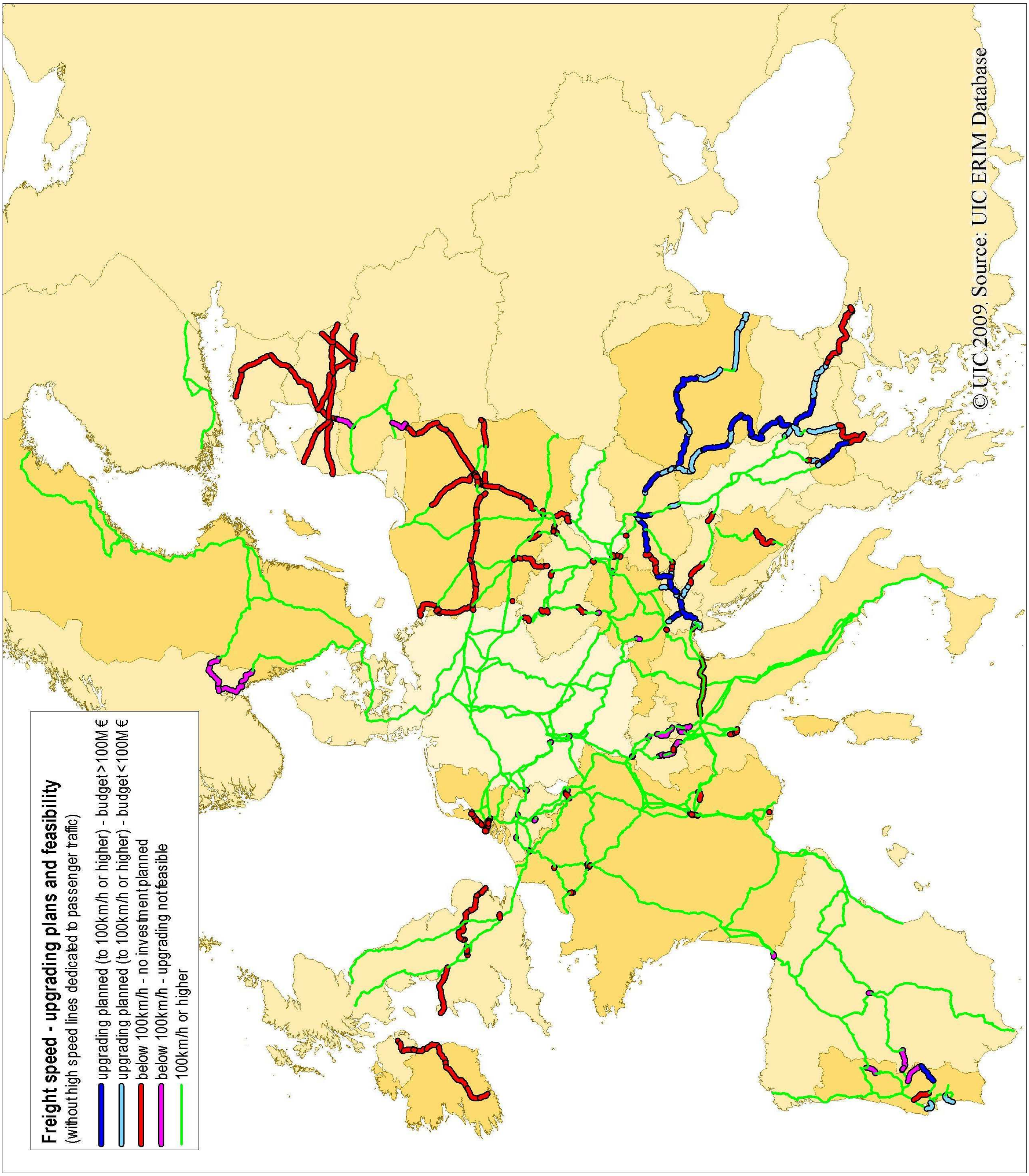
The Map 39 shows the line sections with potential capacity shortages in 2020 assuming that any planned investment will remove completely the potential bottleneck.



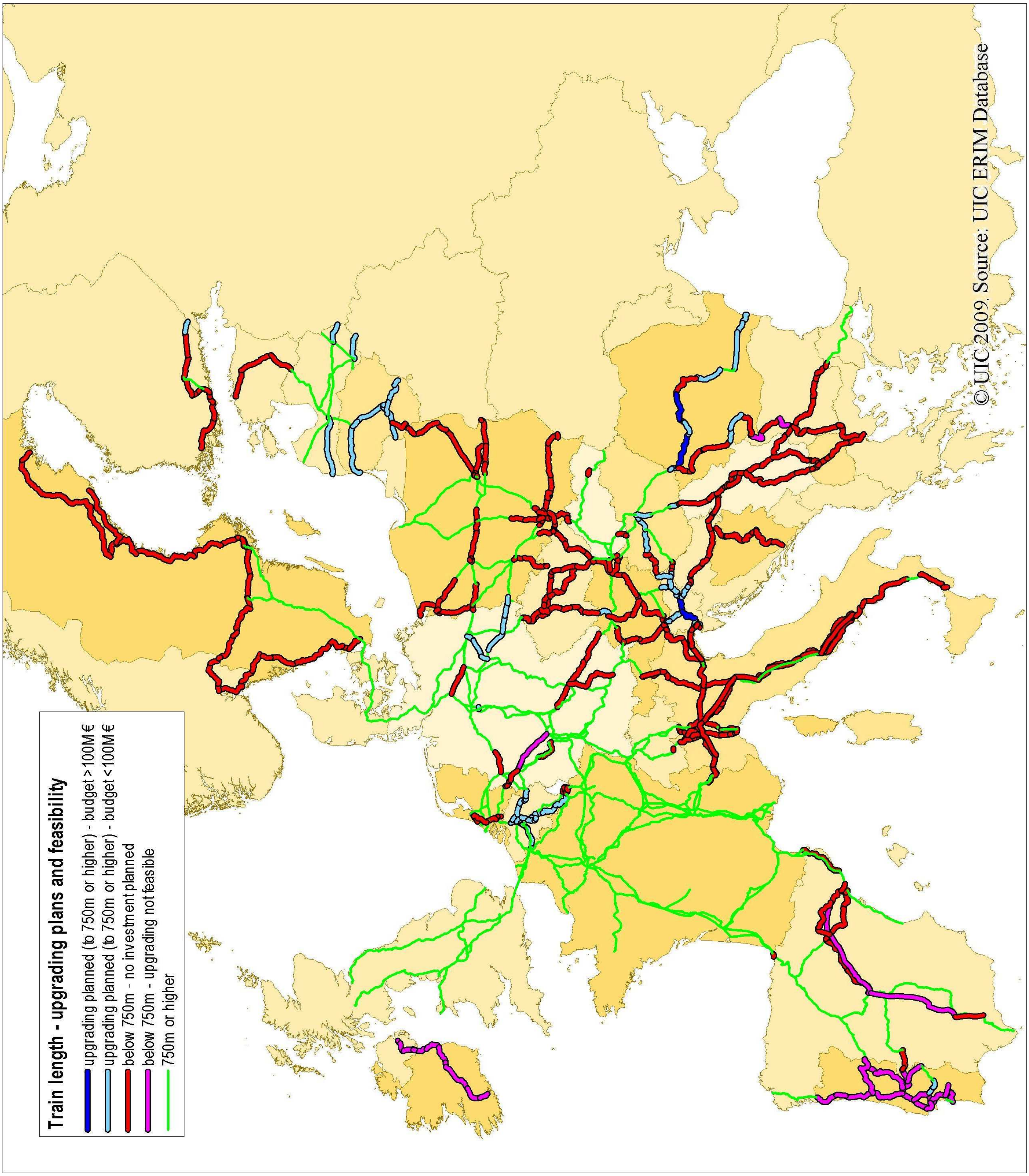
Map 32 – Investments to upgrade the clearance gauge



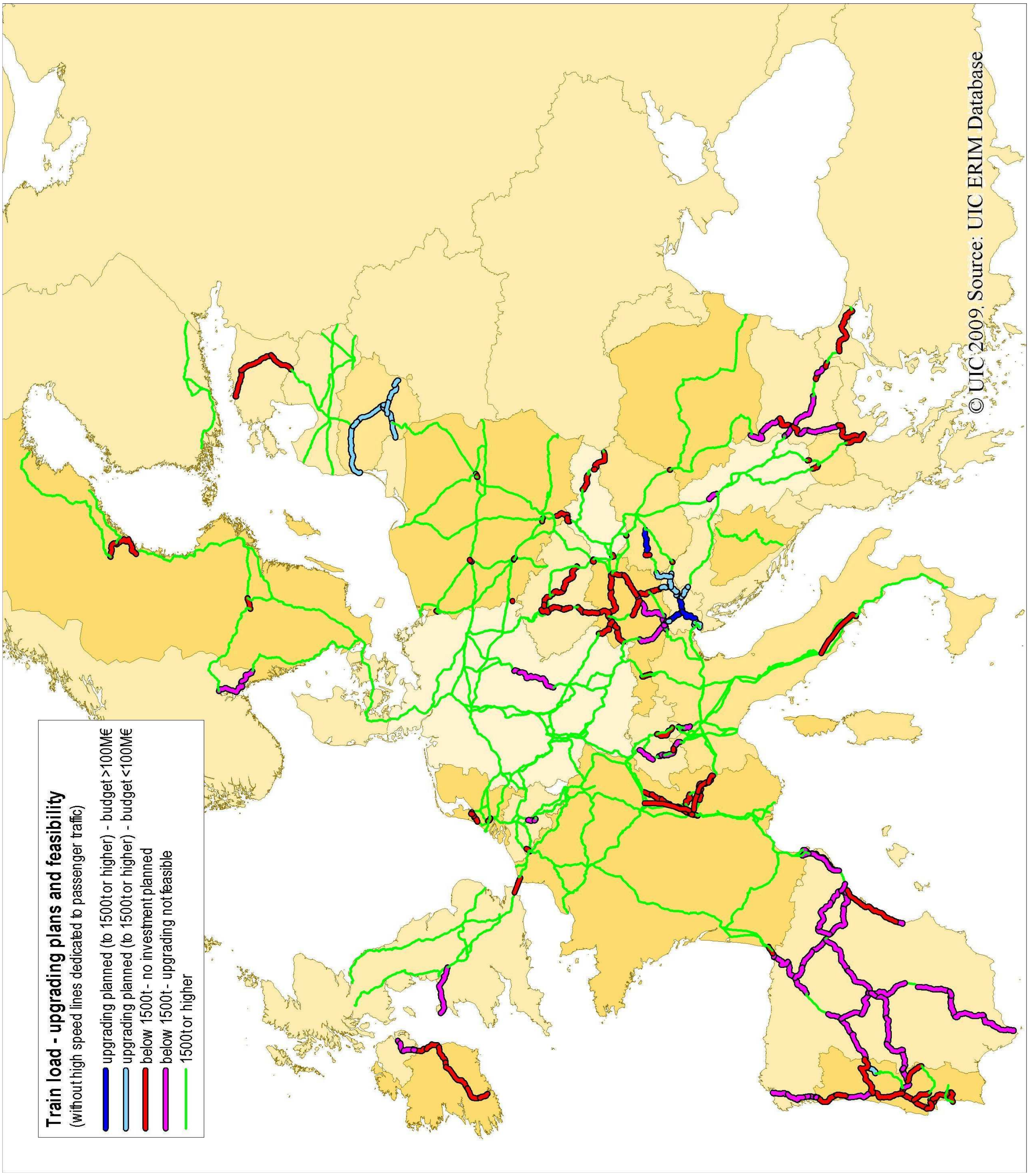
Map 33 – Investments to upgrade the axle load



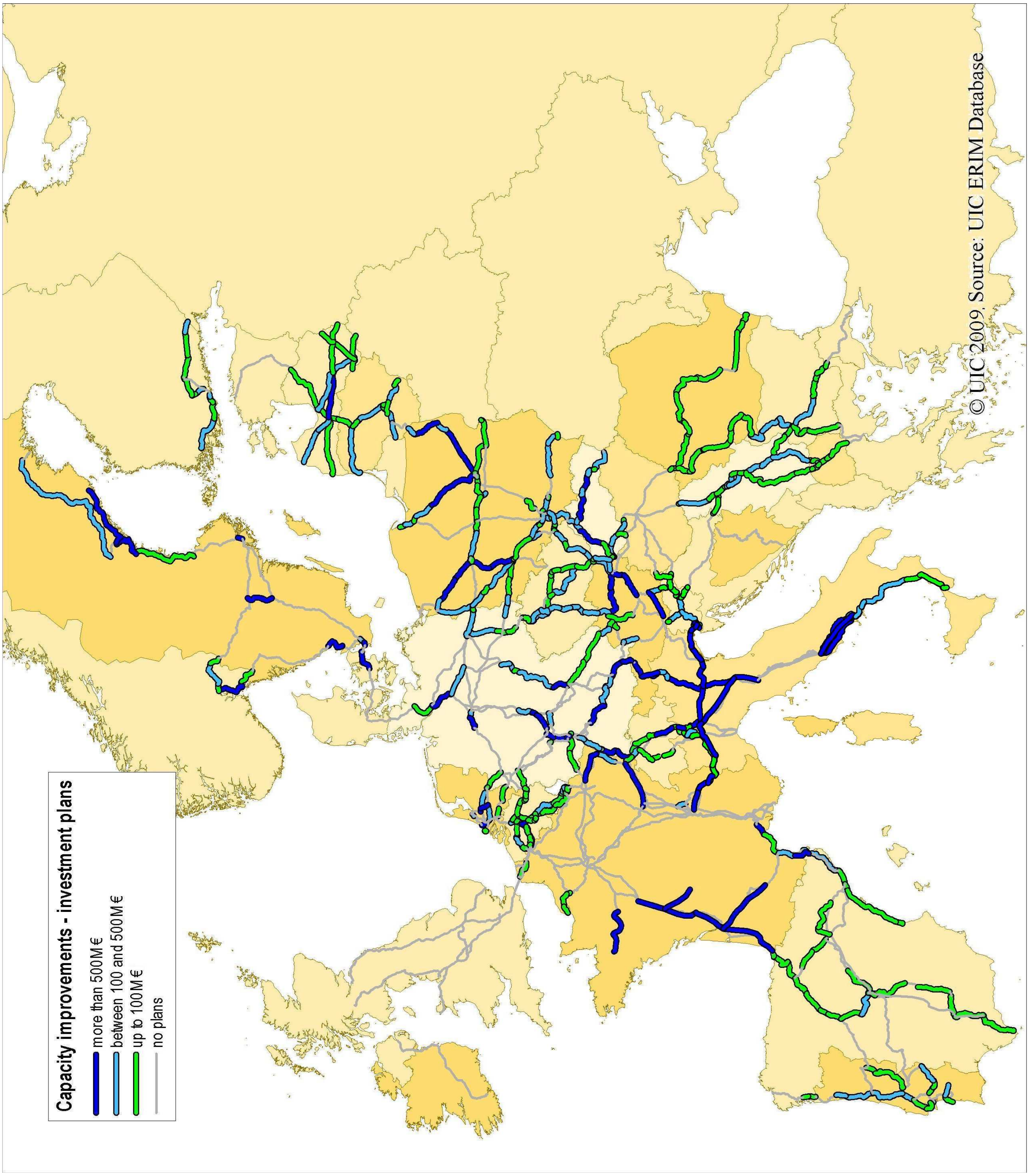
Map 34 – Investments to upgrade the maximum freight speed



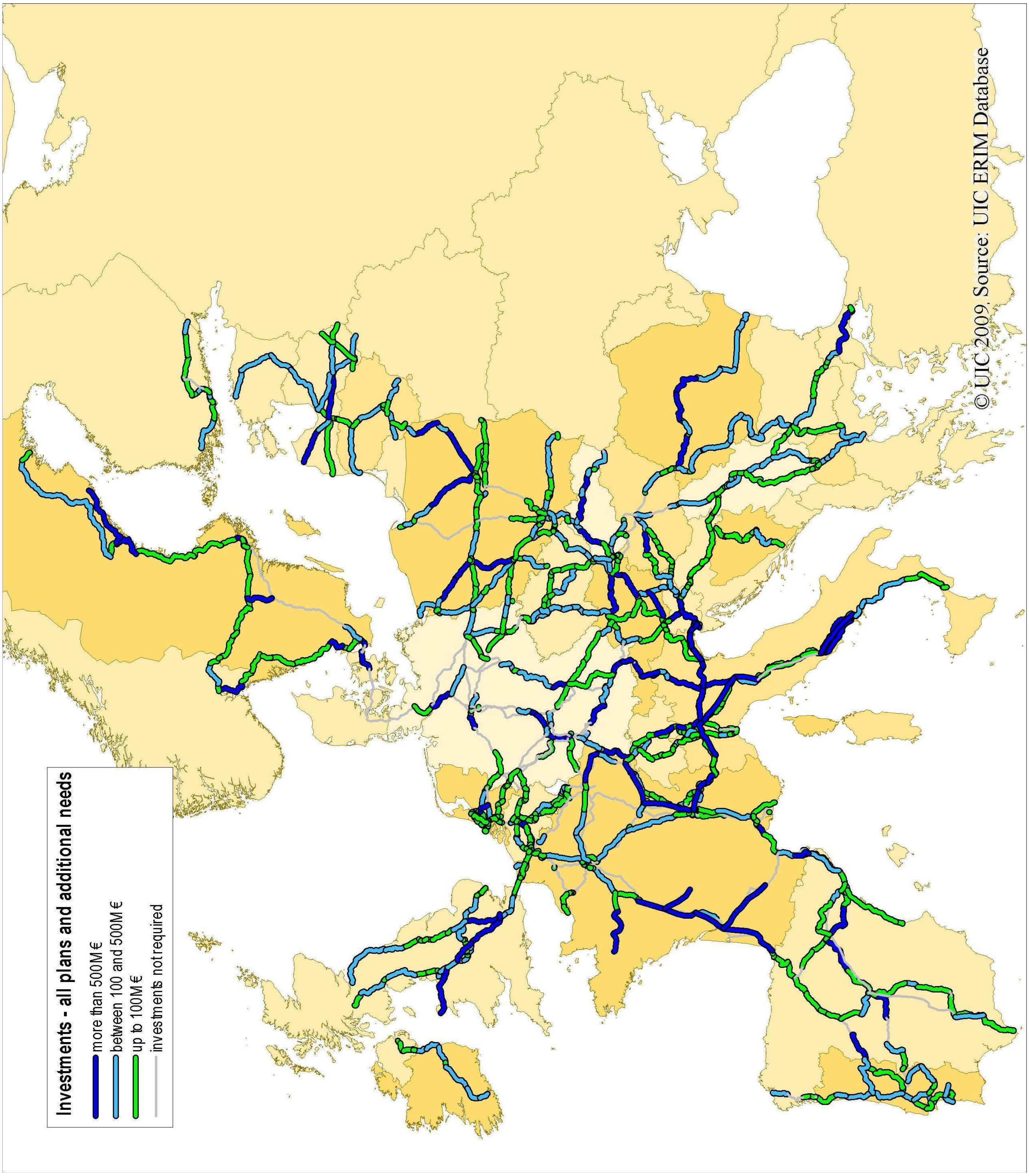
Map 35 – Investments to upgrade the maximum train length



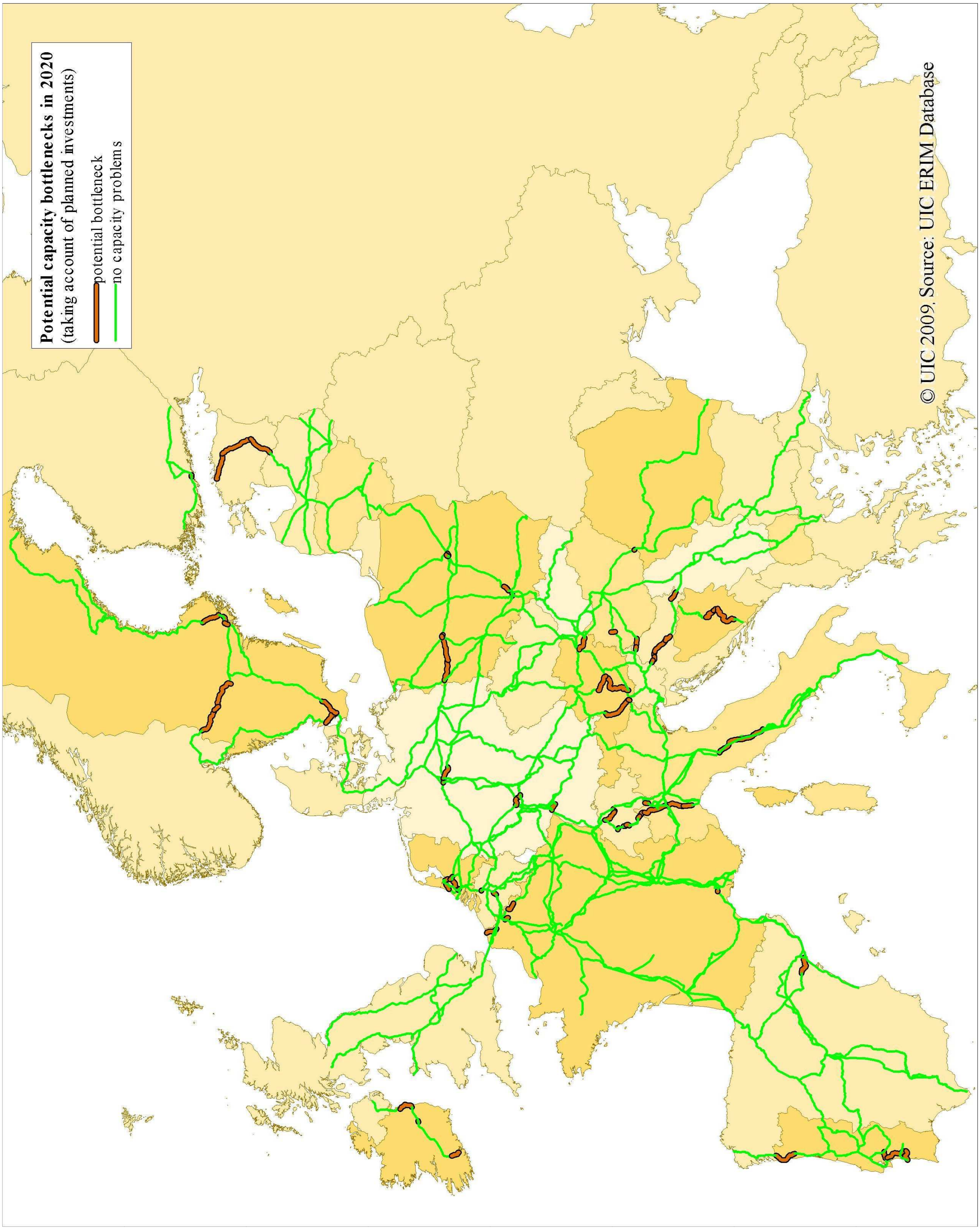
Map 36 – Investments to upgrade the maximum train load



Map 37 – Investments to improve the capacity



Map 38 – All planned and needed investments



Map 39 – Potential capacity bottlenecks in 2020 (planned investments removing all bottlenecks)

Appendices

Different Corridor Configurations

defined to describe the European Rail Space

Appendix 1: **ERTMS Corridors**

Appendix 2 : **Central European Railway Area with Adjoining Regional Links**

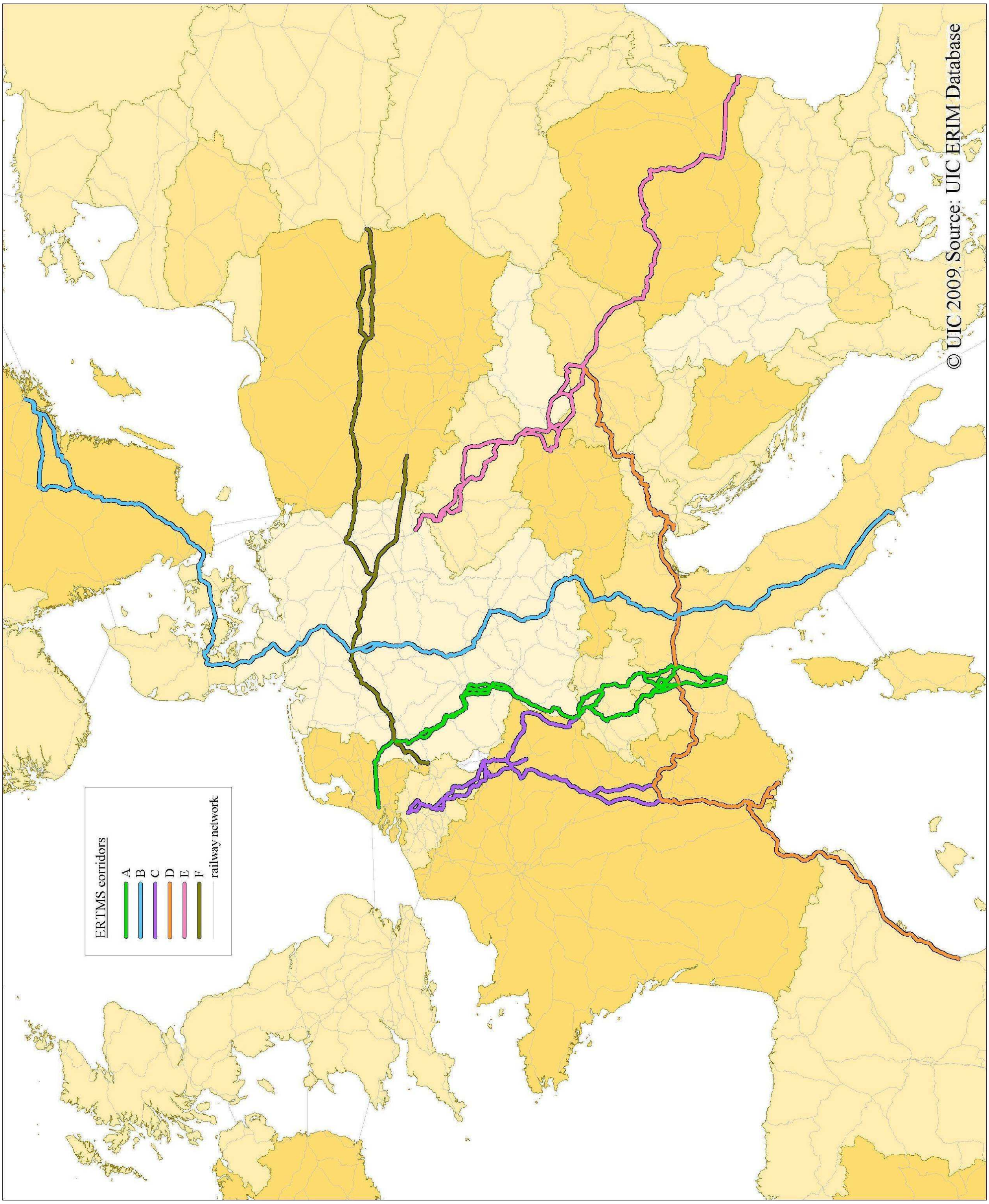
Appendix 3 : **Pan-European Corridors**

Appendix 4: **Trans-European Transport Network (TEN-T). Priority axes and projects**

Appendix 5 : **RailNetEurope (RNE) Network**

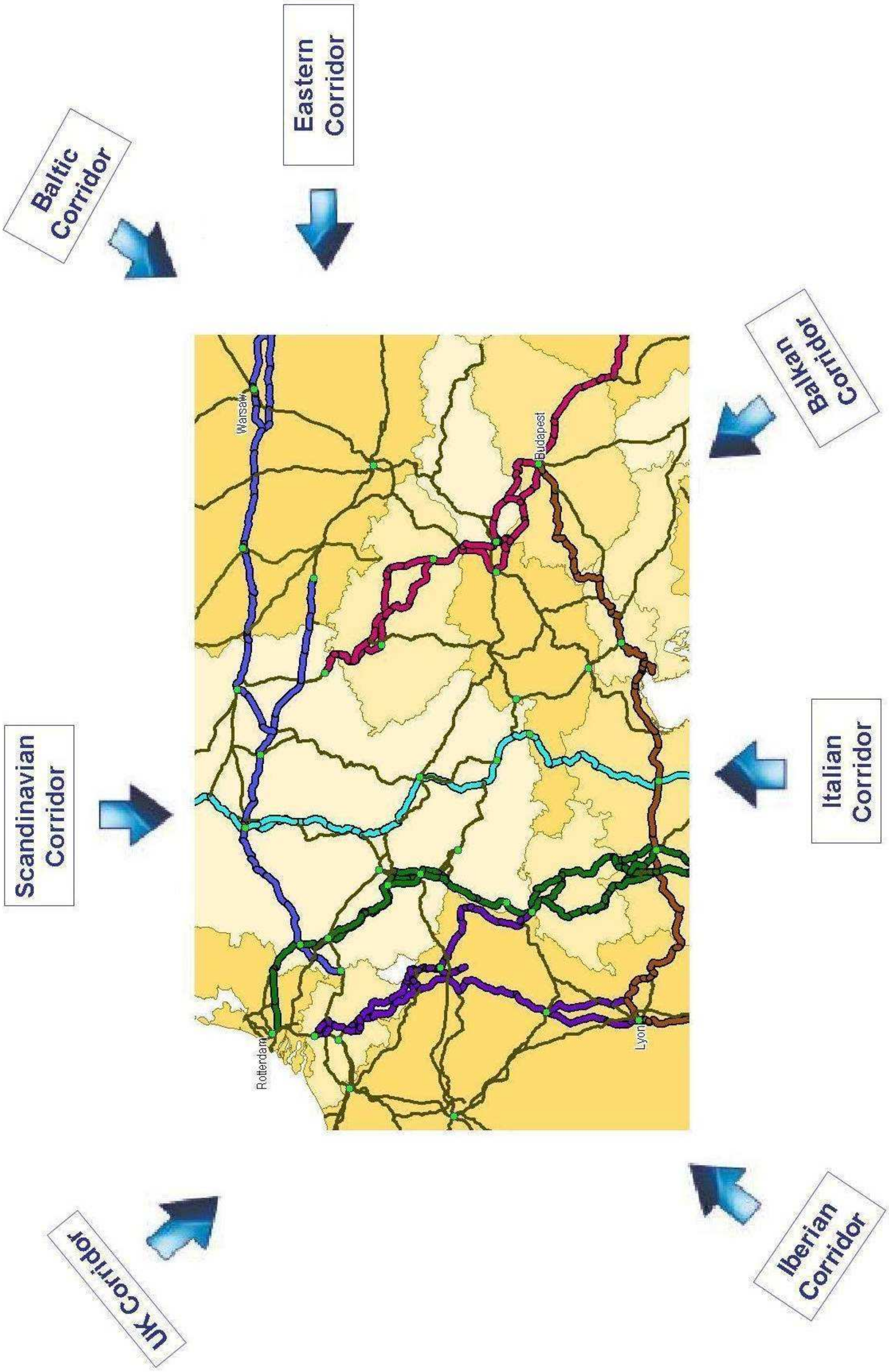
Appendix 6 : **High Speed Network**

6.1 ERTMS corridors



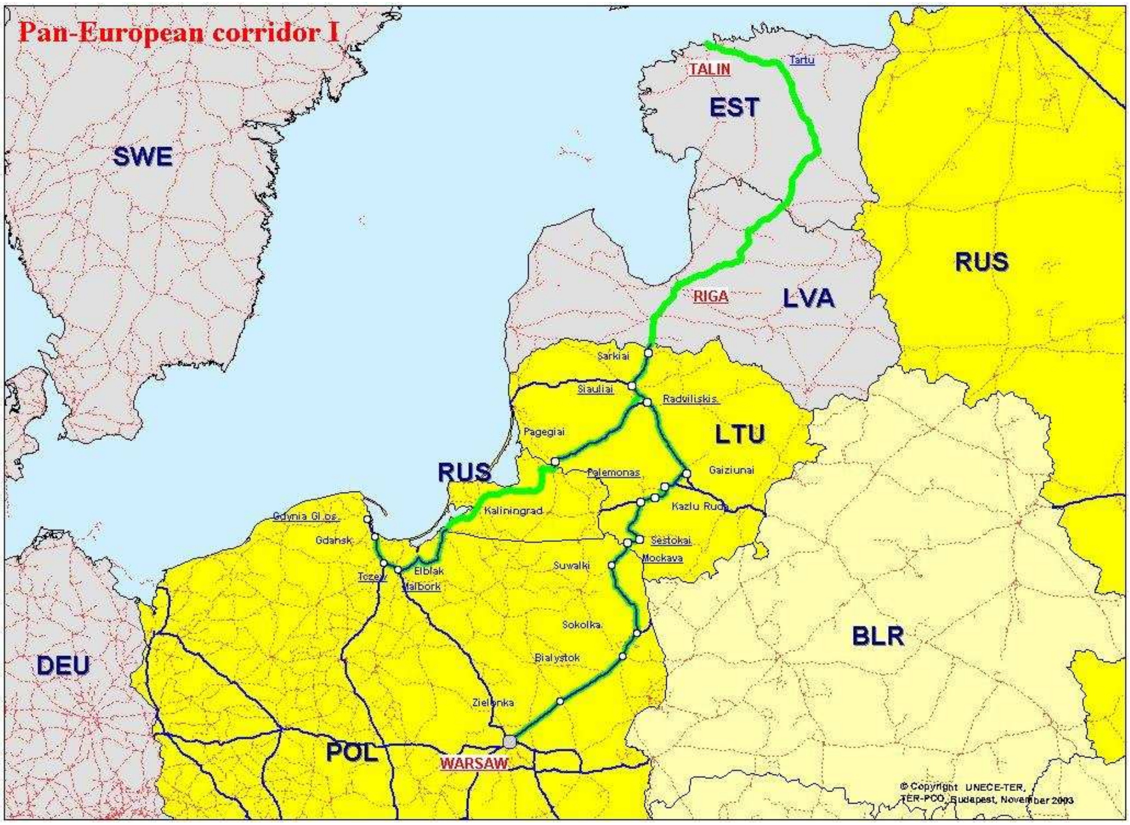
6.2 Central European Railway Area with Adjoining Regional links

Whilst supporting the corridor based approach, ERIM has also offered another geographical perspective based on the idea of central European railway area with adjoining regional links. Whereas the central area (which is roughly delimited by ERTMS corridors) should be regarded as a network in itself, the regional links having often natural itineraries and regional characteristics could be developed according to the corridor approach.

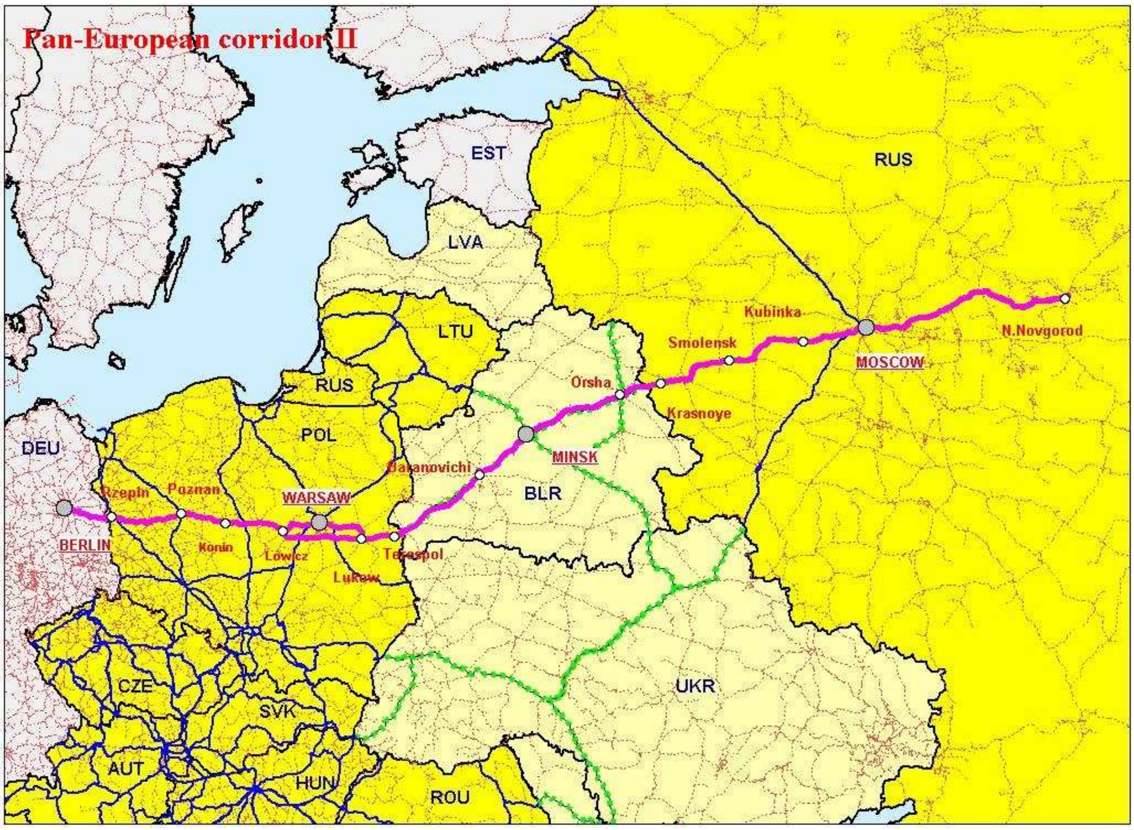


Source: UIC ERIM

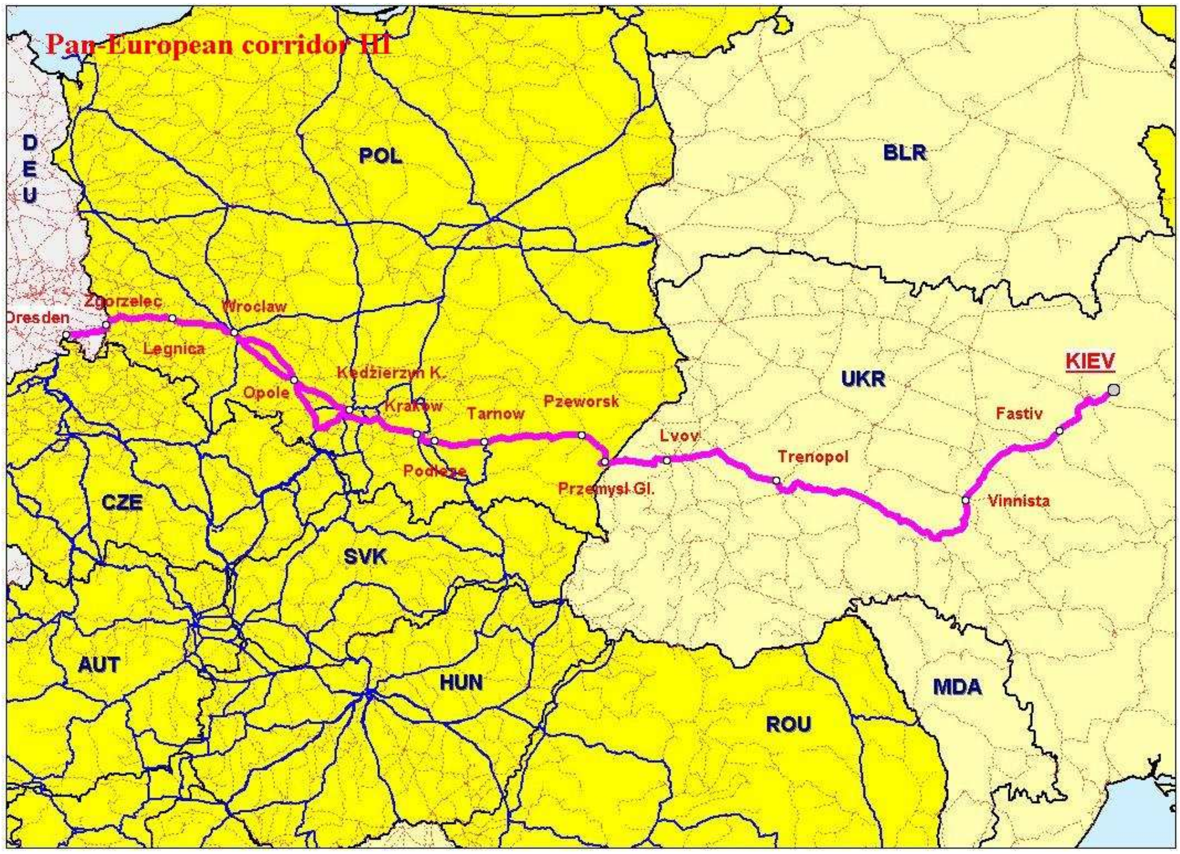
6.3 Pan-European Corridors,



Pan-European Corridor II, source : European Commission

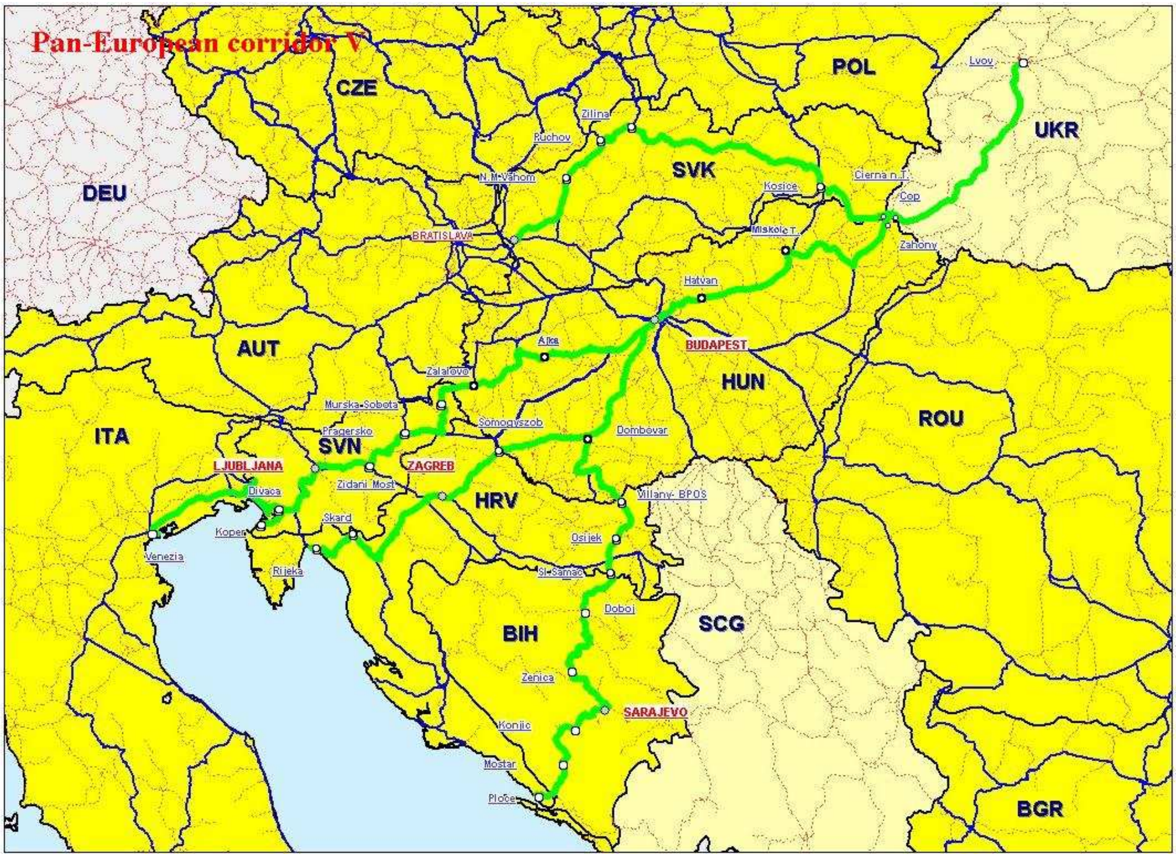


Pan-European Corridor II, source : European Commission

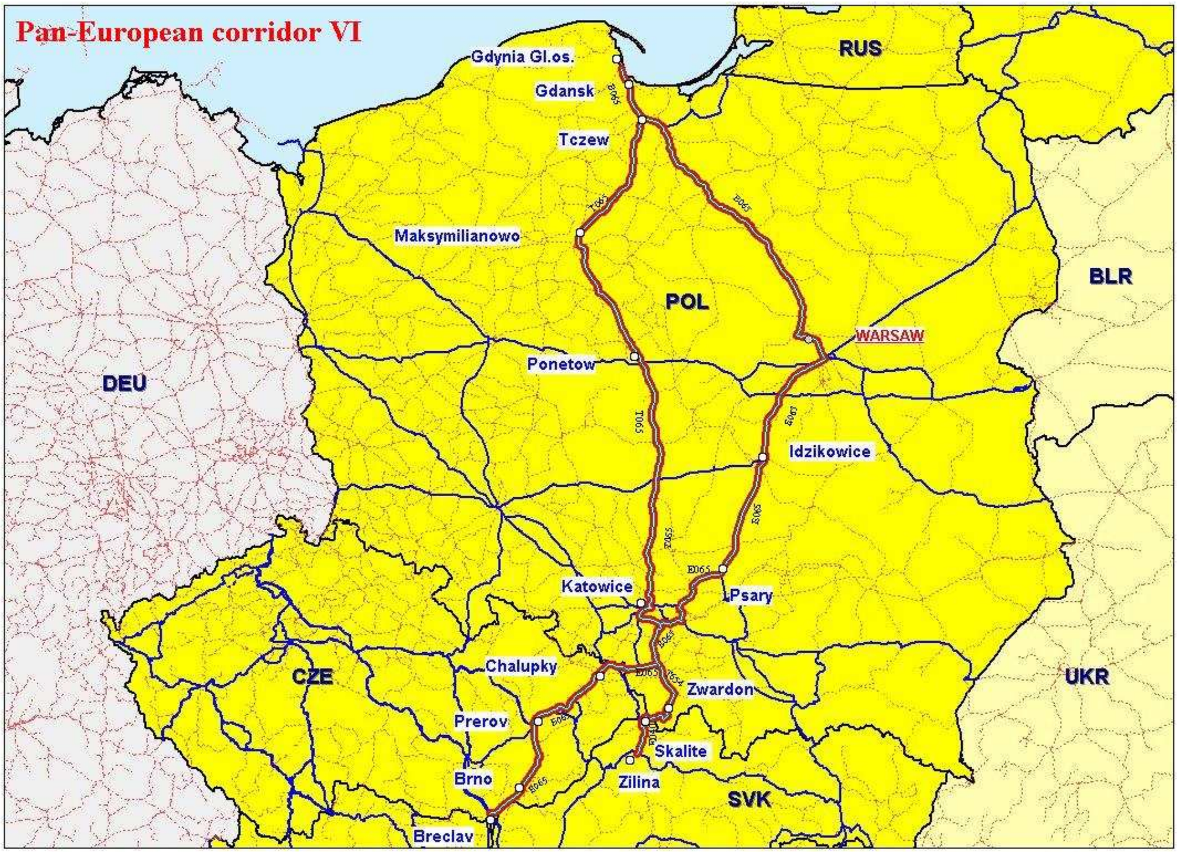


Pan-European Corridor III,   source : European Commission

Pan-European Corridor IV,   source : European Commission

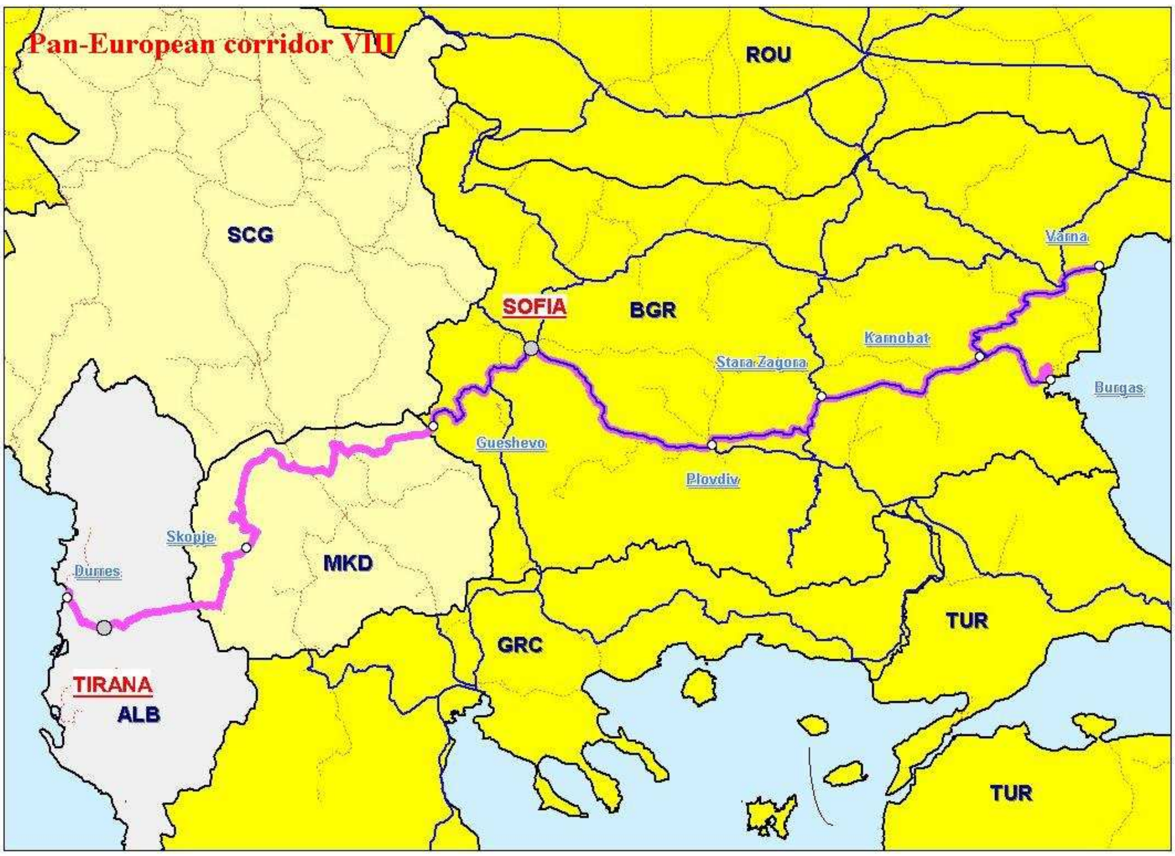


Pan-European Corridor V, source : European Commission

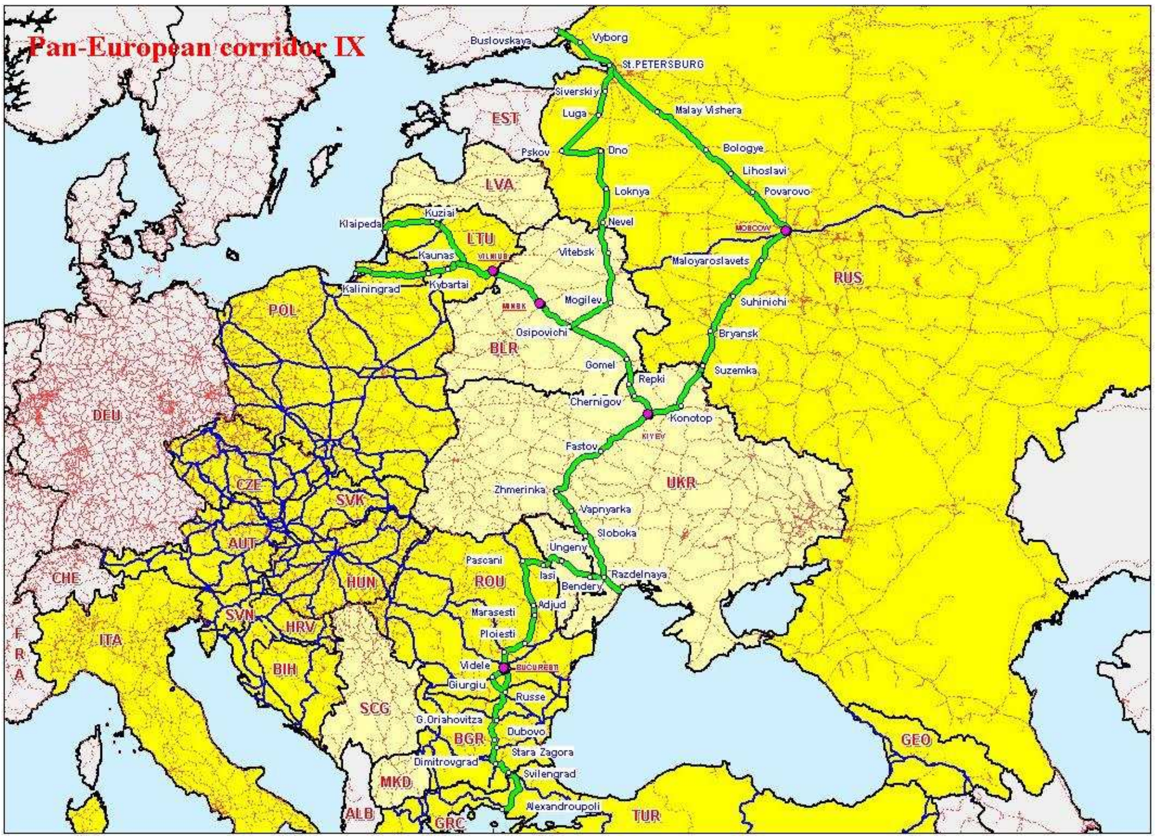


Pan-European Corridor VI, source : European Commission

Pan-European Corridor VII, source : European Commission



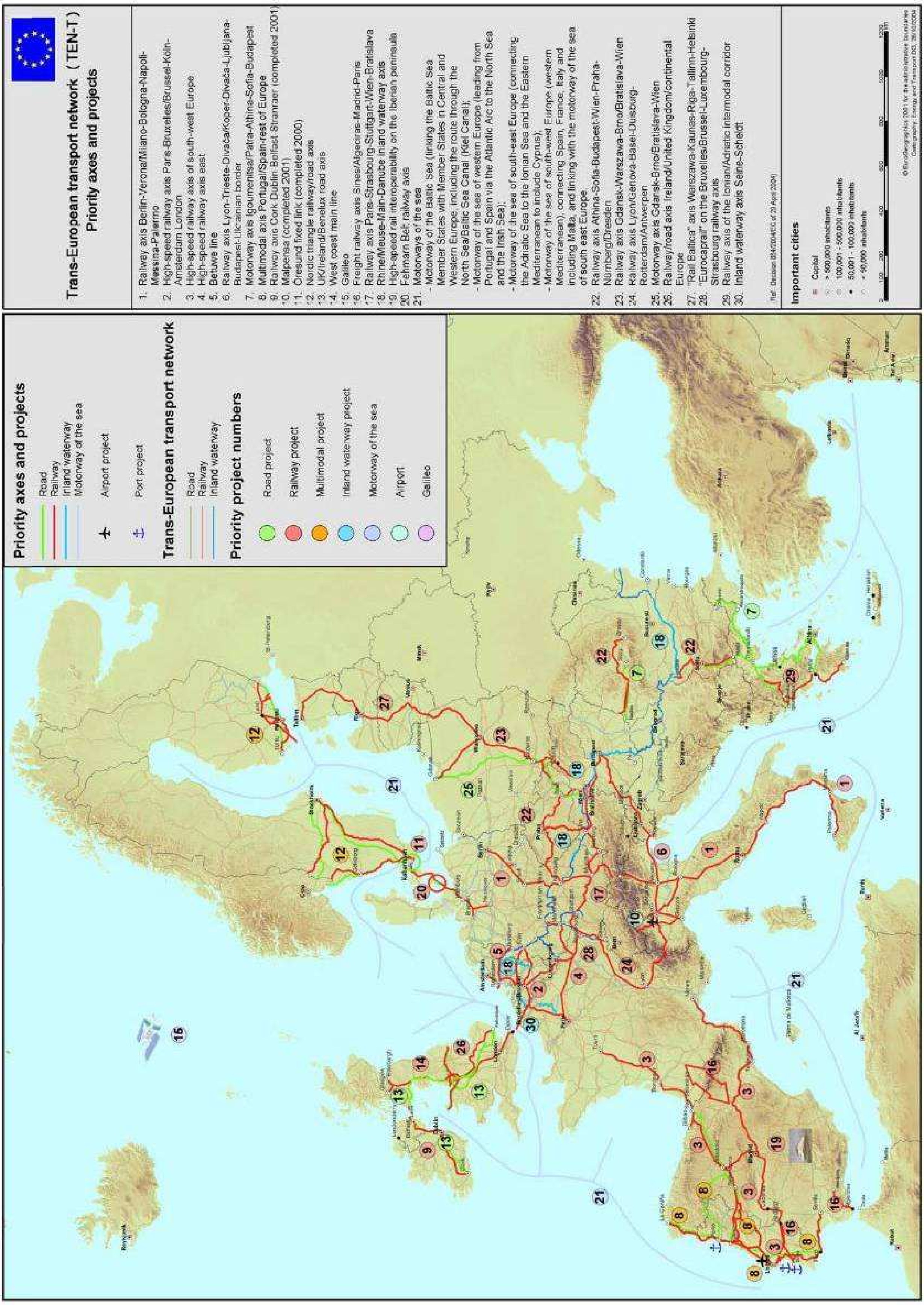
Pan European Corridor VIII, source : European Commission



Pan-European Corridor IX,   source : European Commission

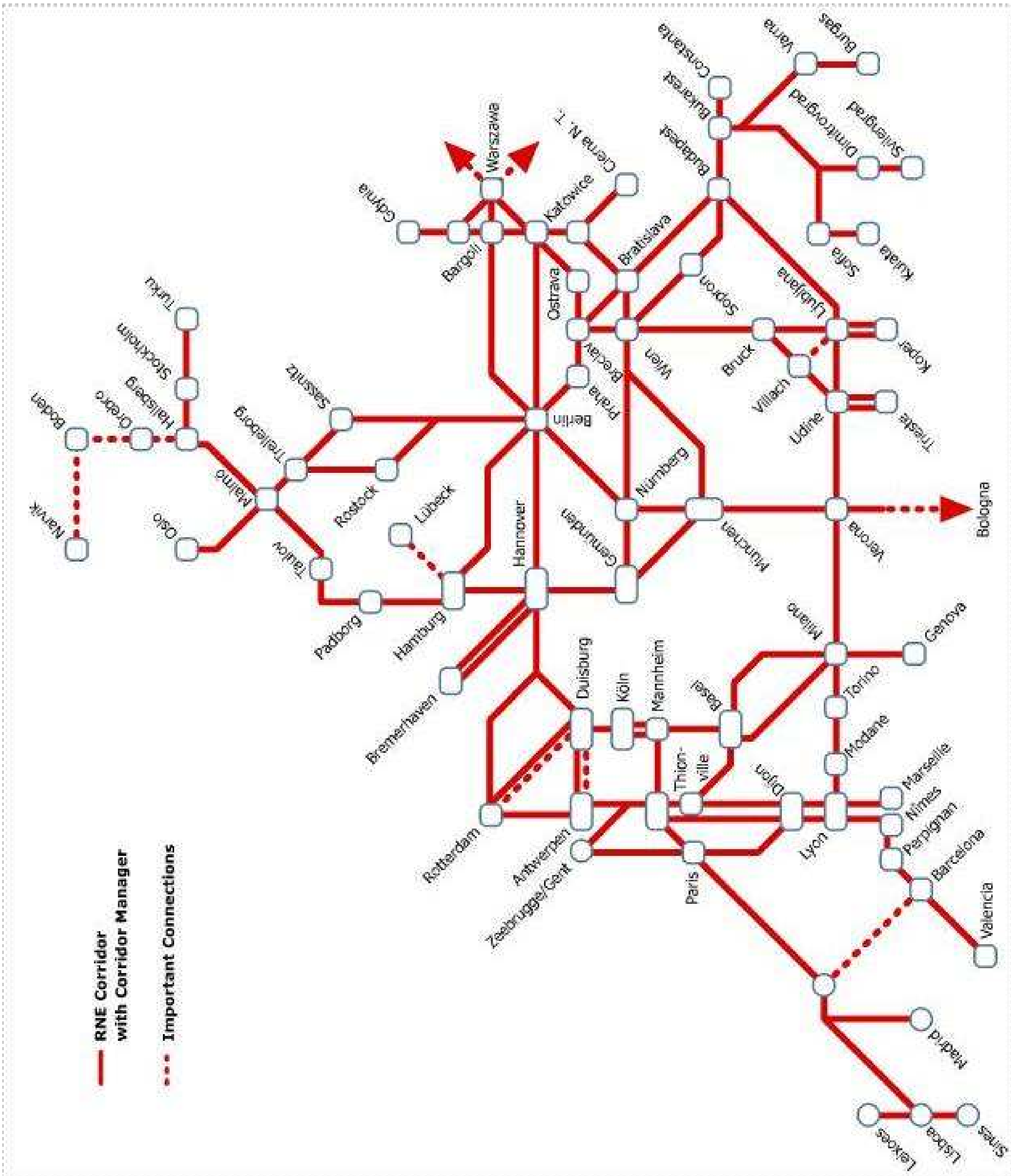
Pan-European Corridor X,   source : European Commission

6.4 Trans-European Transport Network (TEN-T), Priority axes and projects



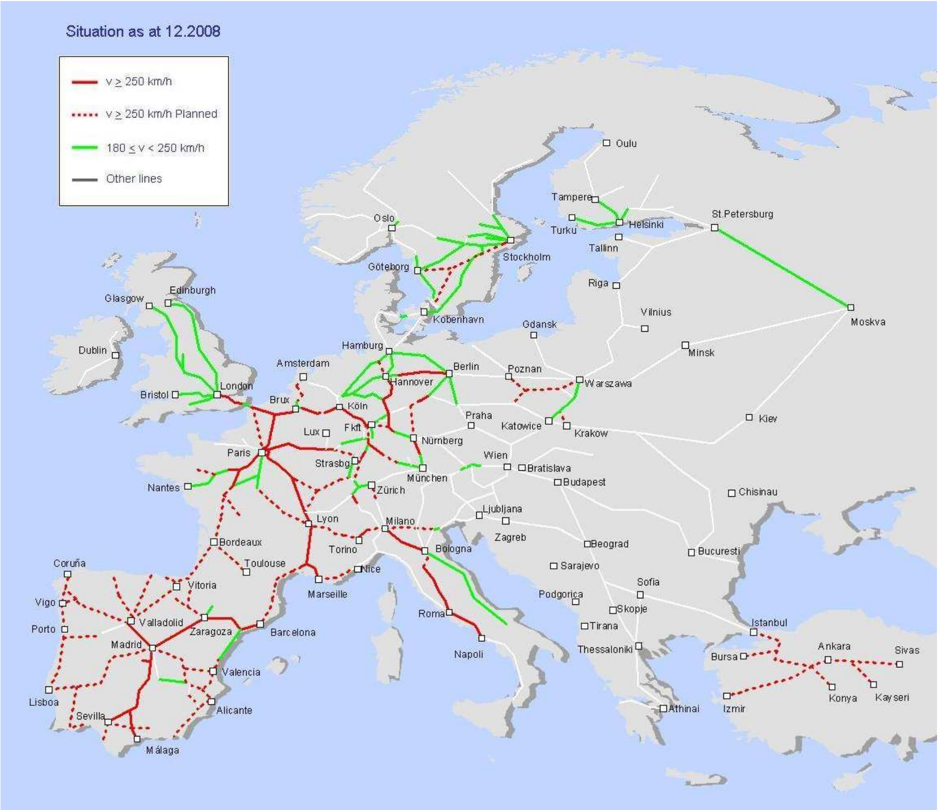
Source: European Commission, DG TREN

6.5 RailNetEurope (RNE) Network,

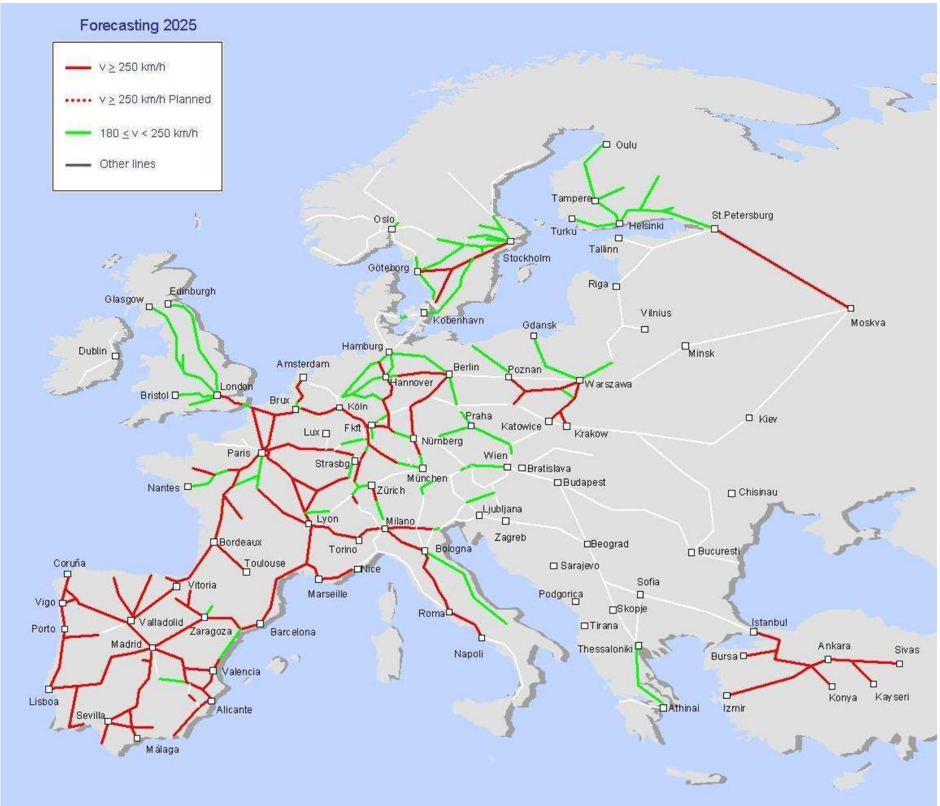


Source: RNE website www.railneteurope.com

6.6 High Speed Network,



High Speed Network in 2008, source UIC



High Speed Network in 2025, source UIC

UIC Atlas 2008
of infrastructure in the ERIM Network

UIC Atlas of infrastructure in the ERIM Network is a high-level infrastructure supply side over view of major international rail corridors, mainly for freight, within and between 32 countries. The ERIM network does not cover all the priority routes of each individual country but seeks to provide each country with a connection to the remainder of the European network.

The ERIM corridors represent approximately 50 000 km of route length being only 22% of the total route length but which carried, in 2007, approximately 50% of all passenger-kms and 59% of all tonne-kms in the 32 countries.

ERIM has also established, in collaboration with its member Railways, an estimation of traffic growth by 2020. The ERIM growth forecast is approximately 30% for passenger traffic and 80% for freight traffic for the period from 2007 to 2020.

In order to analyse whether the planned infrastructure is sufficient to carry the future traffic loads, two different analyses have been made to quantify the amount of routes being possibly capacity constrained in 2020. The results range between 3 000 route-km and 16 000 route-kms according to the scenario and probably the plausible amount of capacity constrained routes is somewhere between them.

27 countries have communicated to ERIM their investment plans summing up to 173 Billion euros. In addition, ERIM has identified an investment gap of 29 Billion euros to upgrade the ERIM infrastructure to a minimum target level and to remove the bottlenecks summing up to a total investment budget of 202 Billion euros.

One of the major components of the ERIM activity has been the constitution of a database which contains all the aforementioned information, within the ERIM network, on infrastructure, traffic volumes, capacity utilisation and national investment plans up to 2020. The data is recorded in a Geographical Information System as interconnected segments of route enabling the corridors to be redefined to suit any particular business or political configuration.

International Union of Railways

UIC Infrastructure Department
16 rue Jean Rey - 75015 Paris