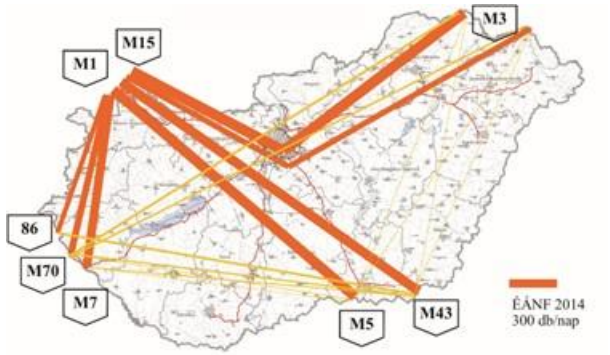
Network characteristics, Trans-European networks



Transport networks 5.

András Gulyás PhD habil
associate professor

Content

- Transport network characteristics
- The Hungarian road network
- European transport facts
- Trans-European networks – „E” roads, corridors
- Trans-European networks – TEN-T network
- The USA interstate highway network

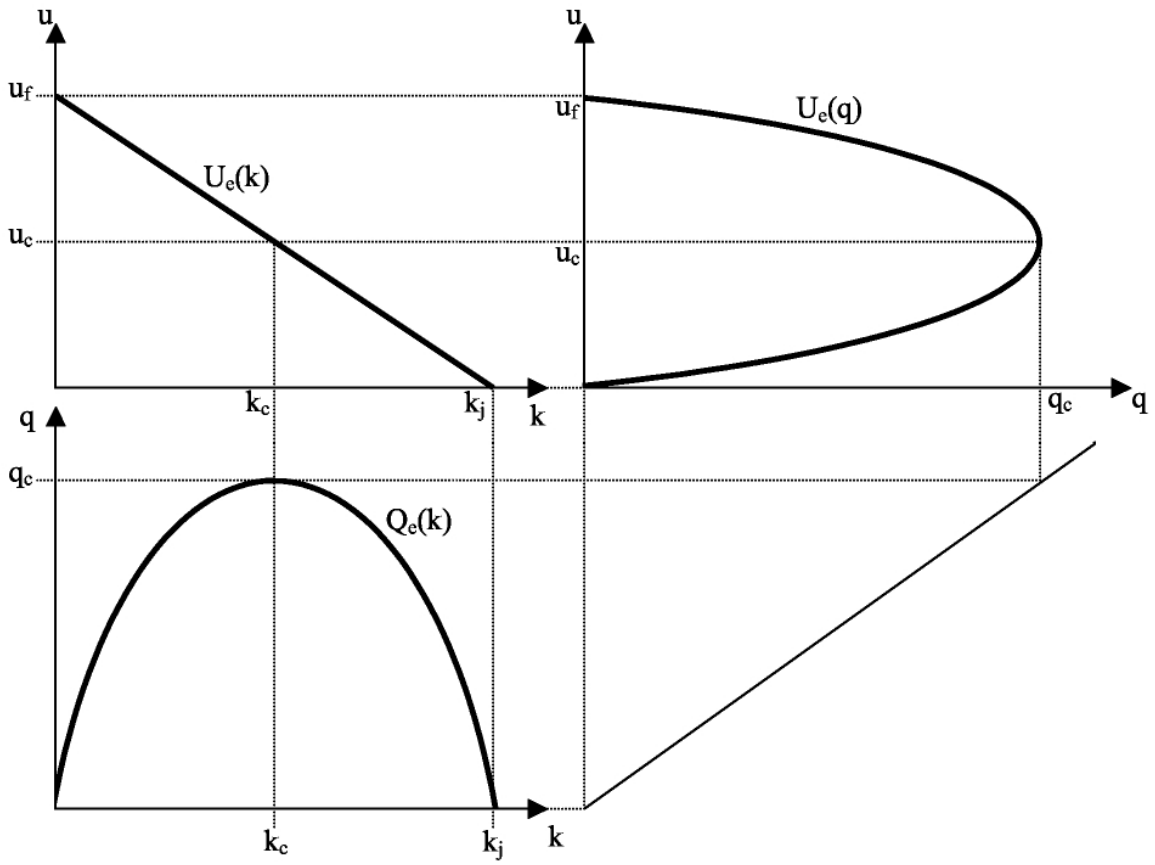
Transport network characteristics

- Basic road traffic characteristics are: Traffic volume, traffic density and speed.
- There are two different average speeds:
- Time average speed – arithmetical average of speeds of vehicles crossing a given cross-section in a certain time
- Spatial average speed – arithmetical average of speeds of vehicles on a certain road section at a given time snap. Always less than time average speed.

Transport network characteristics

- Traffic volume of a cross section is in linear proportion with traffic density and speed.

$$q\ (veh/h) = k\ (veh/km) * u\ (km/h)$$

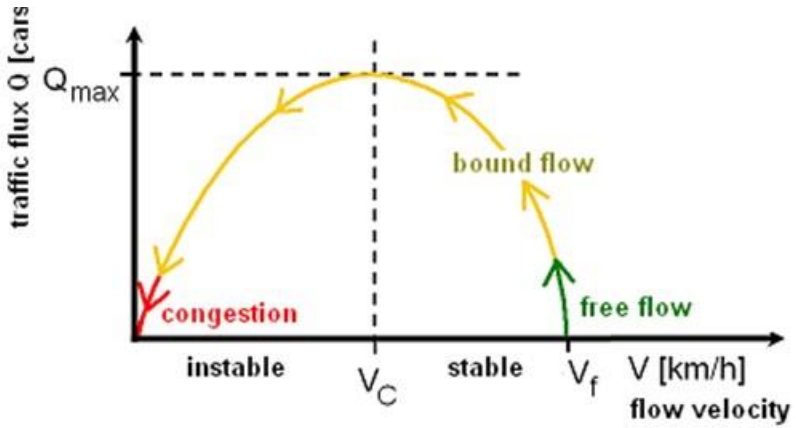


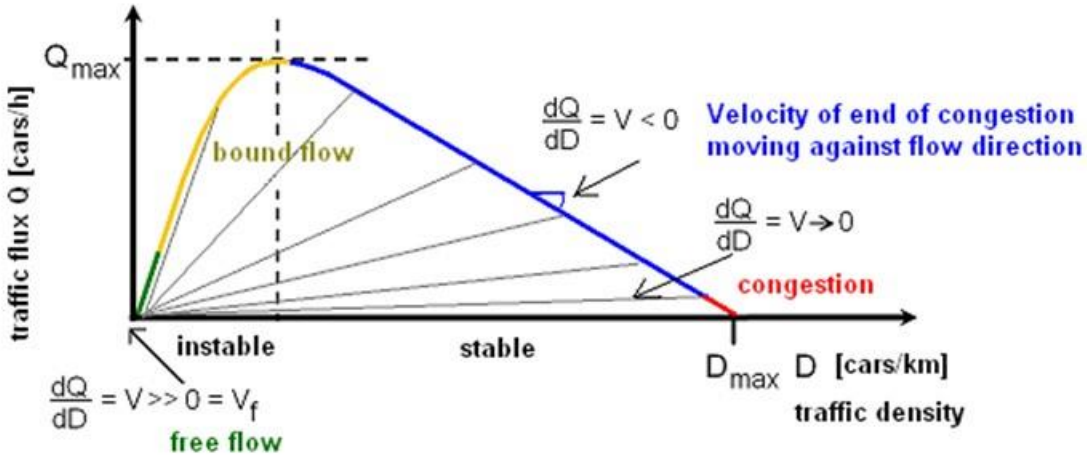
u - speed,
u_f - free speed,
u_c - critical speed,
k - traffic density,
k_c - critical density,
k_j - maximum density,
q - traffic volume,
q_c - maximum volume

Source: Prof. Immers, L.H., Logghe, S.: Traffic Flow Theory. Katholieke Universiteit Leuven, Faculty of Engineering, Department of Civil Engineering, Section Traffic and Infrastructure, 2002.

Transport network characteristics

- When the traffic density increases, the speed decreases and the free flow becomes bound, finally congested.
- There are two different speed values at a given traffic volume: a free and a congested. The maximum volume can be reached at the critical speed.
- There are two different density values at a given traffic volume: a free and a congested. The maximum density can be reached at the congestion.





Transport network characteristics

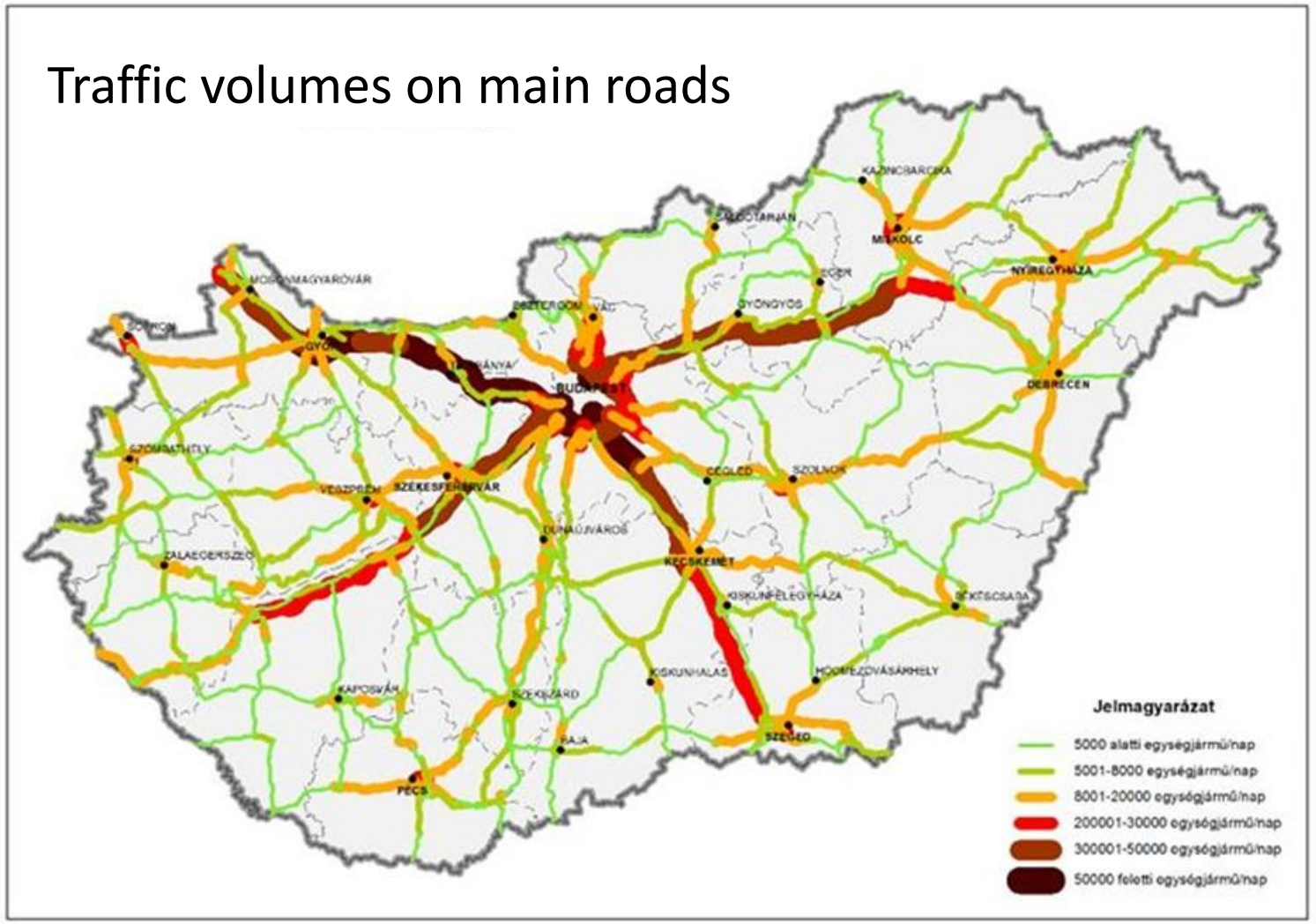
- Main transport network characteristics:
  - Number of junctions and sections,
  - Network density (km / km^2, km / 1000 inhabitants),
  - Capacity of network elements,
  - Volume and composition of traffic,
  - Traffic performance (Σ section length * volume),
  - Travel times (between given points),
  - Network sensitivity (critical sections),
  - Traffic control (one-way sections, turning possibilities at junctions, constraints etc.)

The Hungarian road network

- The Hungarian road network consists of public roads and private roads. Public roads are partially state (national) roads (length of 32 400 km) and partially municipal (local) roads (length of about 169 000 km).
- The state road network bears about 75 % of the total traffic. Within traffic performance, the proportion of high-speed roads is about ten times more than the proportion of their length.
- About 27 % of length of state roads goes through settlements, therefore these road sections have an important role in serving the inner traffic of settlements.

Source: Hungarian Public Roads Co.

The Hungarian road network



Source: Hungarian Public Roads Co.

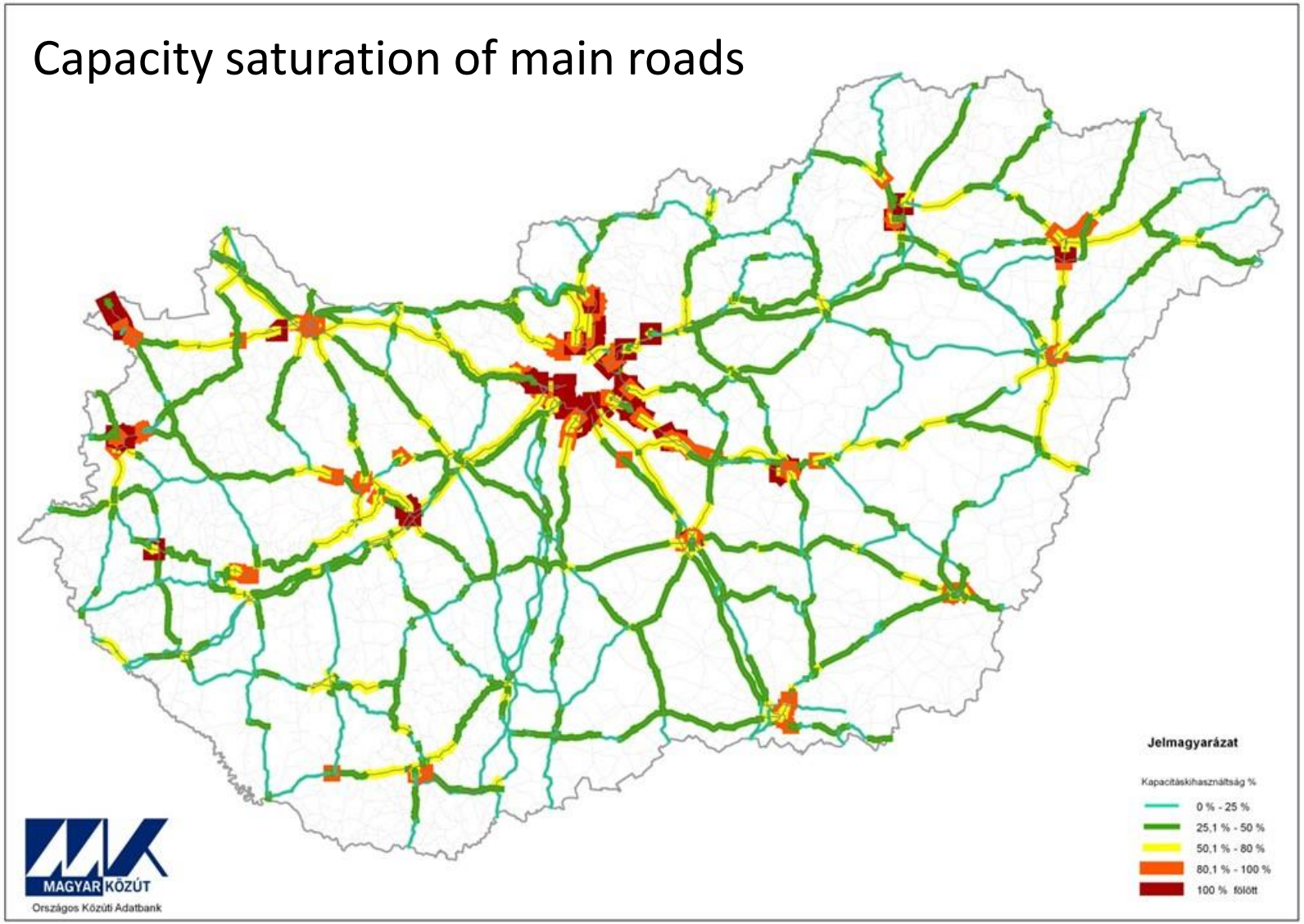
The Hungarian road network

Capacity of rural roads by the Hungarian Technical Guideline

level of service	recommended	tolerable
pcu = personal car unit	traffic volume (pcu/h) at level of service	
Motorway, per lane	1200	1700
Half-motorway, per lane	1100	1600
High speed road, two lanes, the two directions together	1200	2000
Roads with more than one lane per direction, per lane	1000	1400
Two lane road, the two directions together	1400	2000

Source: Hungarian Road Society

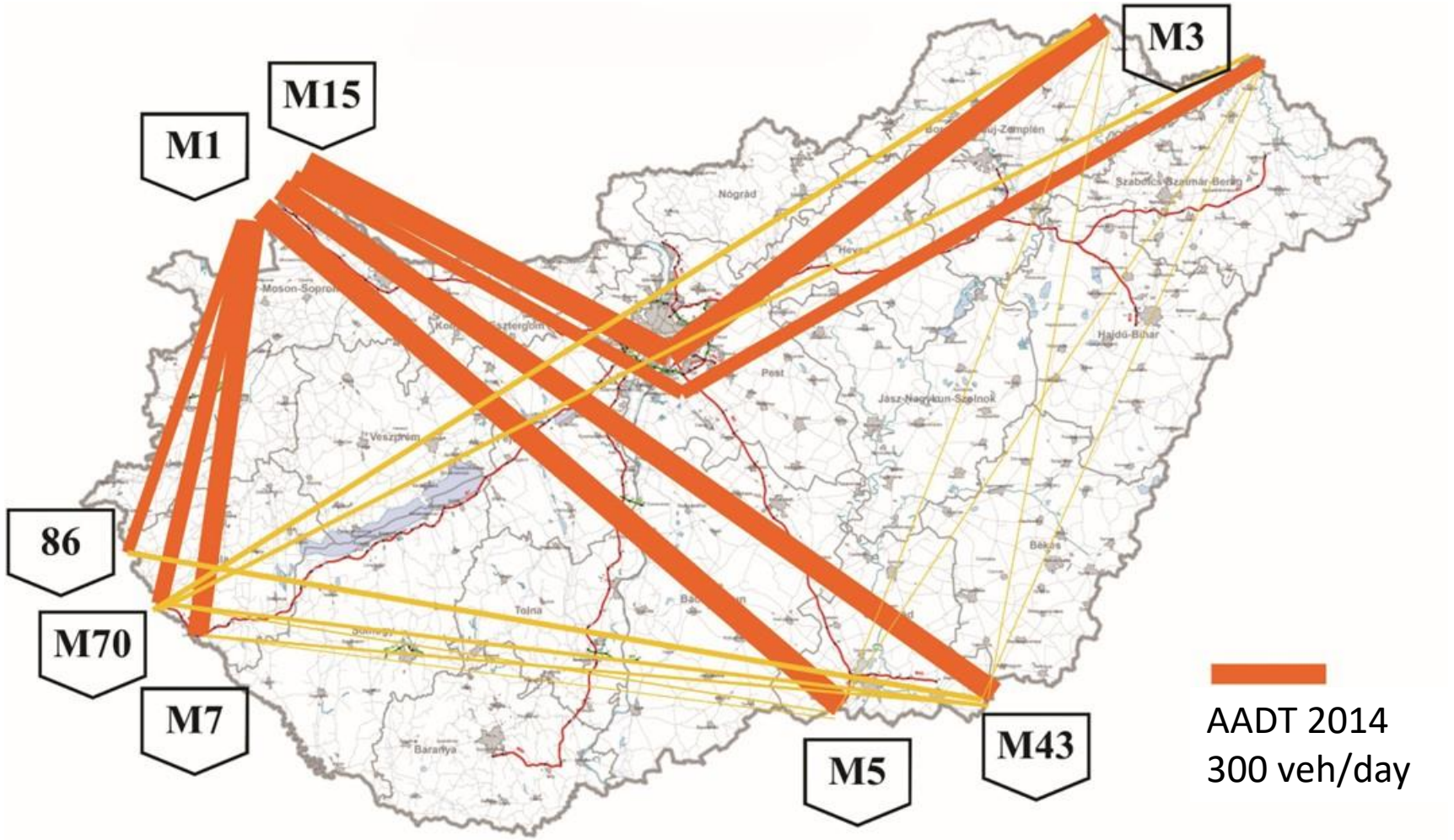
The Hungarian road network



Source: Hungarian Public Roads Co.

The Hungarian road network

Transit heavy traffic origin – destination flows



Source:: Gulyás A., Lindenbach Á., Nagy Á., Tomaschek T.: Az autópálya-hálózat forgalmimenedzsment-tervének előkészítő vizsgálatai – forgalmi elemzések. Közlekedéstudományi Szemle 2016. 12. (in Hungarian)

European transport facts

- There are more than 10 million employees in the European transport sector, that is 4.5 % of all employees.
- The transport sector provides 4.6 % of the GDP, moreover the vehicle production provides further 1.7 % of the GDP and further 1.5 % of employment.
- An average European household has a transport spending of 13.2 % of its total income.
- The yearly cost of traffic congestion reaches approximately 1 % of the European GDP.

Source: http://ec.europa.eu/transport/strategies/facts-and-figures/index_en.htm

European transport facts

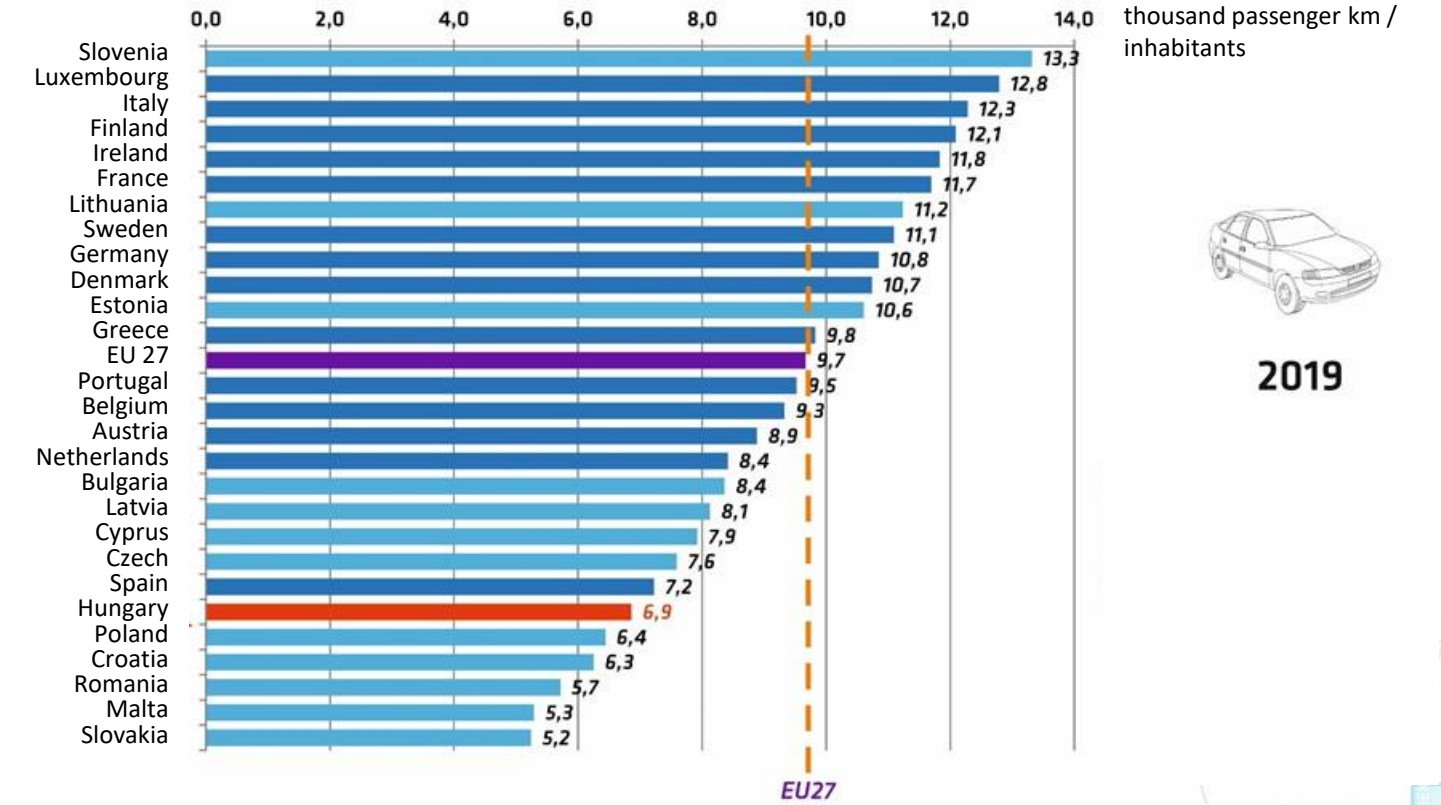
- Vehicle stock in the European Union represents on third of the total 750 million vehicles of the world.
- An average vehicle emits 28 time less carbon-monoxide than 20 years ago. It consumes 15 % less fuel than 10 years ago.
- The length of the Trans-European transport network is 25 800 km, consisting of nine north-south and four east-west corridors.
- On the European railway network there are seven different gauges, seven types of traction current and more than seven various signalling system.

Source: http://ec.europa.eu/transport/strategies/facts-and-figures/index_en.htm

European transport facts

KTI.hu

Personal car specific passenger transport performance in the EU, per inhabitants

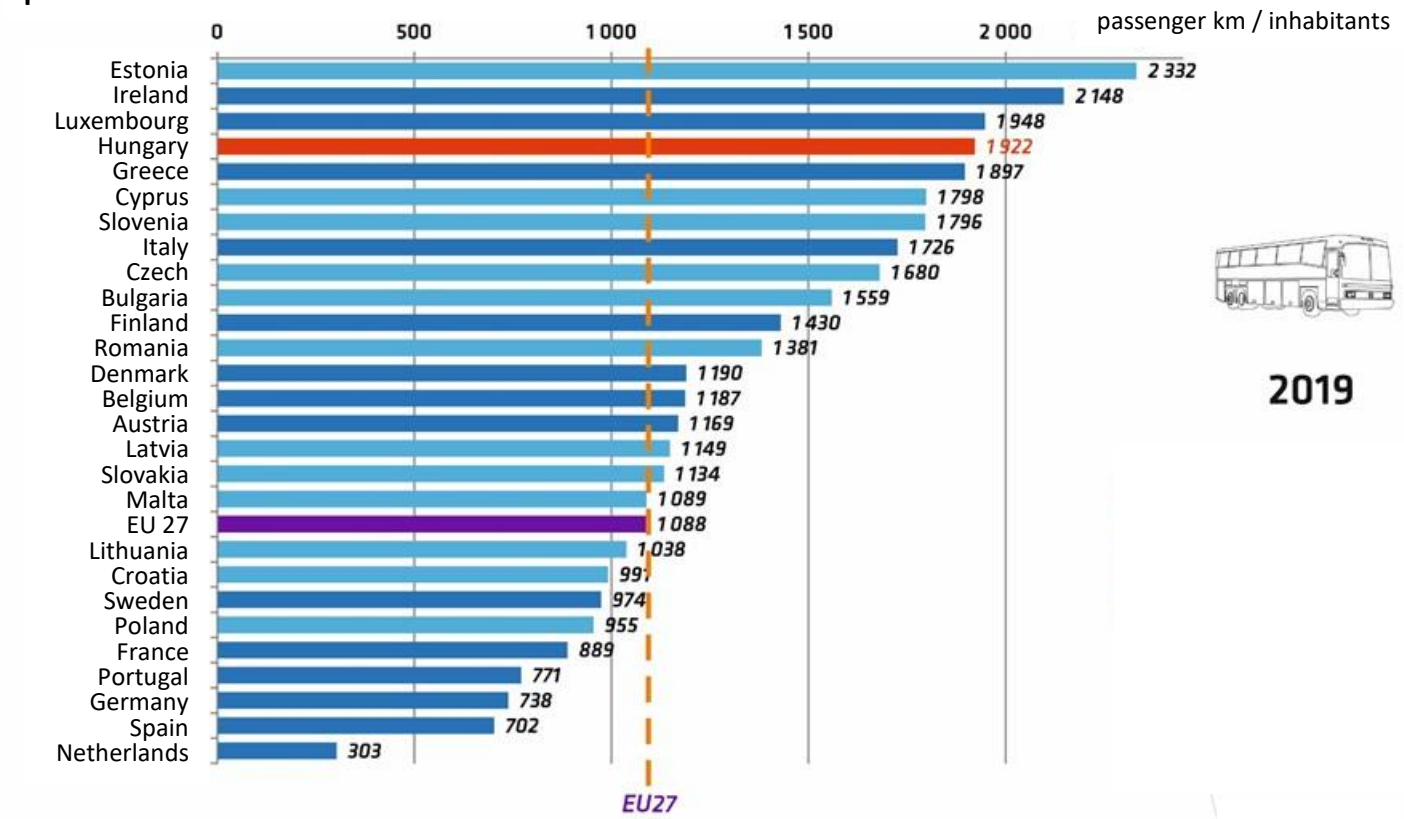


Data source: Eurostat 2021

Source: Institute for Transport Sciences

European transport facts

Bus specific passenger transport performance in the EU, per inhabitants



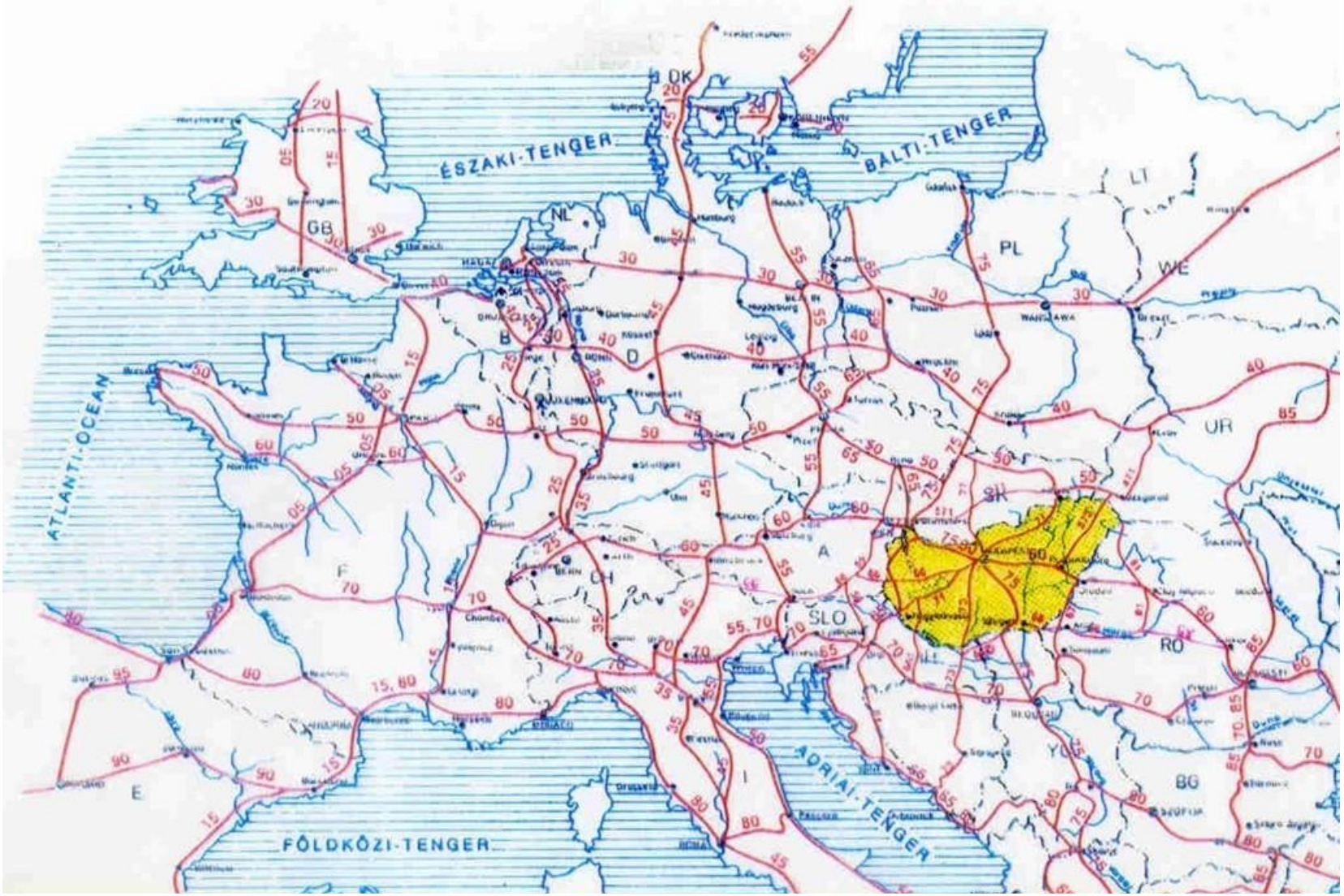
Data source: Eurostat 2021

Source: Institute for Transport Sciences

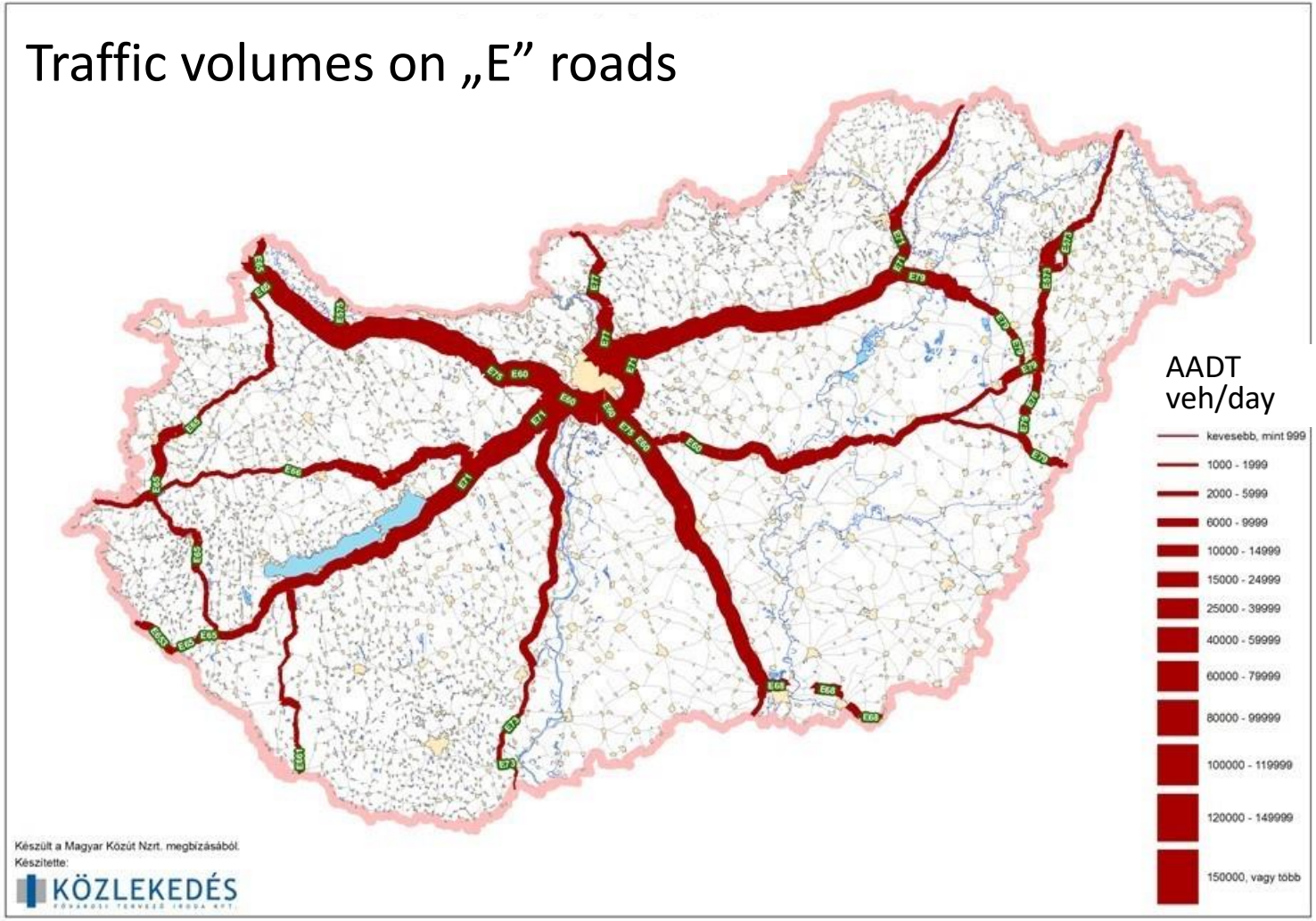
Trans-European networks – „E” roads

- A general European road network has been defined by the European Agreement on Main International Traffic Arteries (AGR) done at Geneva on 15 November 1975 of the United Nations Economic Commission for Europe, UN ECE.
- The Agreement recommends a unified signing and numbering as well as levels of service:
  - E10, E20, E30, E40, E50, E60 numbered in east-west direction,
  - E5, E15, E25, E35, E45, E55, E65 numbered in north-south direction,
  - further numbered supplementary and connecting section.
- In Hungary there are 2 254 km of "E" roads.

Trans-European networks – „E” roads



Trans-European networks – „E” roads



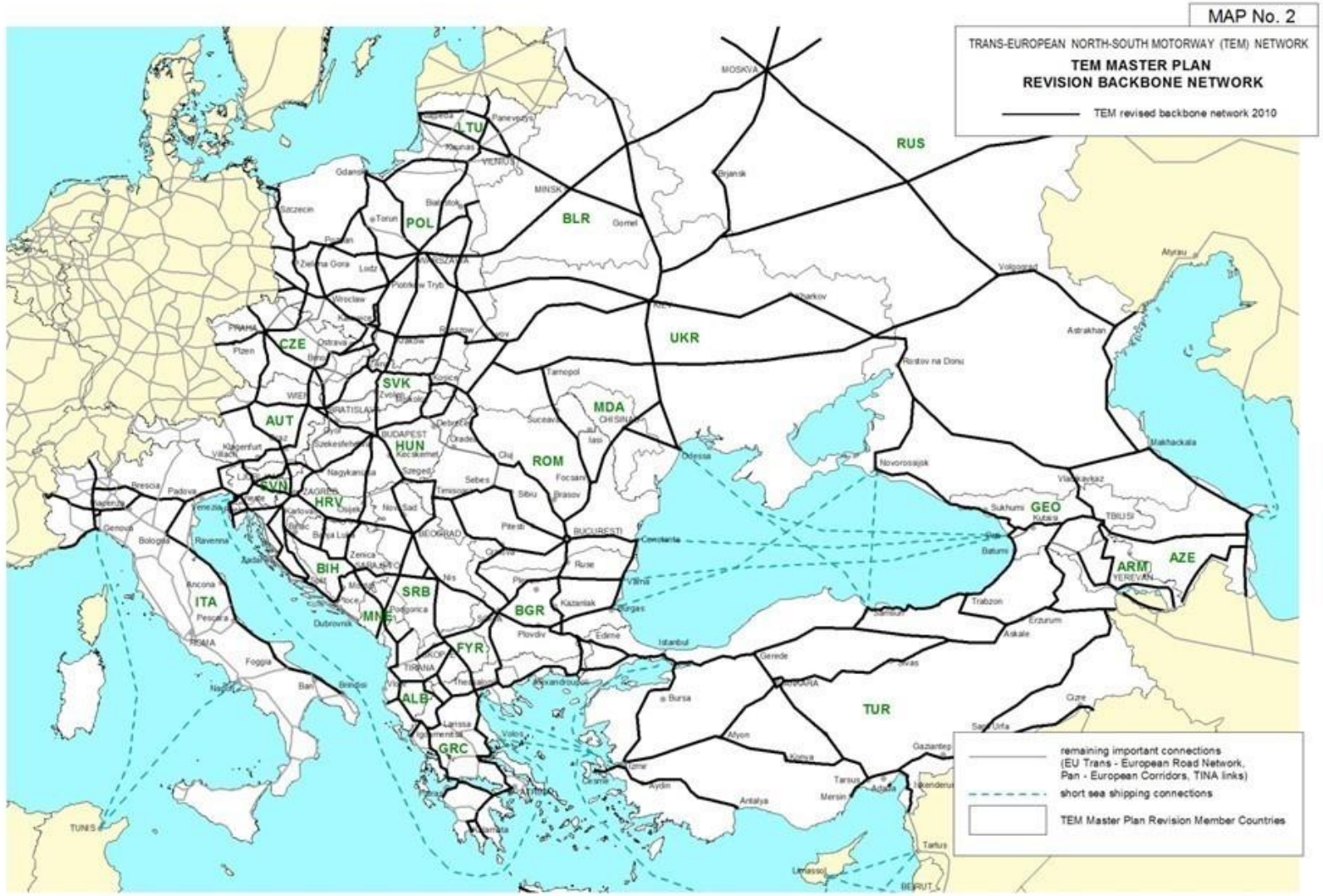
Source: Hungarian Public Roads Co.

Trans-European networks – „TEM”

- The UN ECE has initiated a transport network development project covering Central-Europe, East-Europe and South-Europe, which has a road network part and a railway network part:
  - TEM Trans-European Motorways,
  - TER Trans-European Railway.
- There is a regular co-ordination with the transport network development plans of the European Union.
- Unfortunately, the current financial situation makes possible only the preparation of feasibility studies but no real construction activity.

Source: http://www.unece.org/trans/main/tem/tem.html

Trans-European networks – „TEM”



Source: http://www.unece.org/fileadmin/DAM/trans/main/tem/Tryptique_TEM_English.pdf

Trans-European networks – corridors

- At the end of the last century, the transport network connections with the eastern part of Europe had come to the front, applying special tools:
  - the system of Pan-European Corridors,
  - the TINA (Transport Infrastructure Needs Assessment) project.
- The objective of the Pan-European network had been the extension of the existing Trans-European Network (TEN) in the frame of Conferences in Prague, 1991, in Crete, 1994 and in Helsinki, 1997.
- Within this process, the Conferences had established ten transport corridors for the extension of the existing TEN.

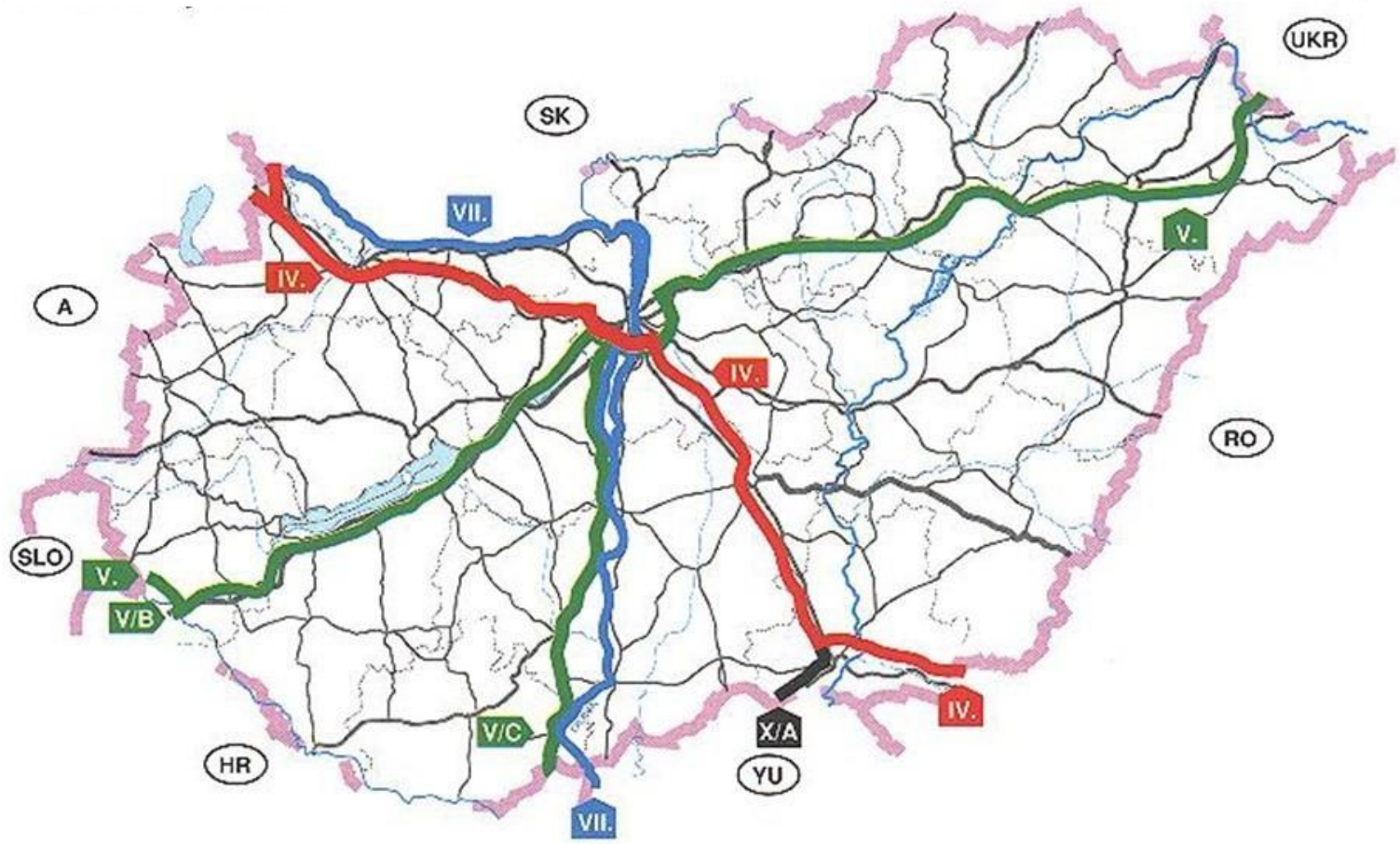
Source: Fleischer Tamás: A közlekedéspolitika és a fenntartható fejlődés dilemmái, különös tekintettel a közúthálózatokra. Falu Város Régió 2003/3. (in Hungarian)

Trans-European networks – corridors

The so-called Helsinki corridor-system (1997)

Trans-European networks – corridors

Helsinki corridors in Hungary 1998



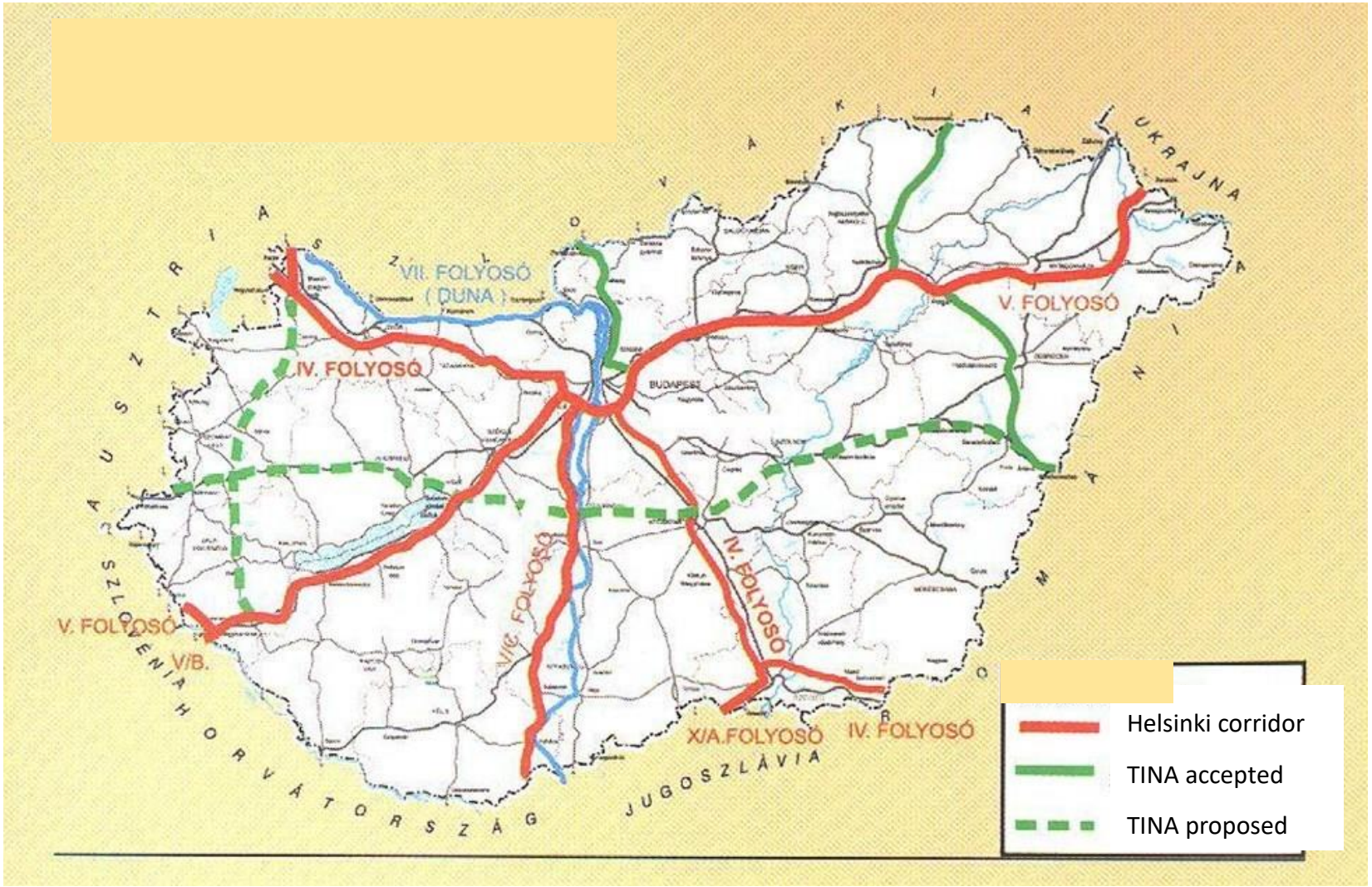
Trans-European networks – corridors

- The TINA (Transport Infrastructure Needs Assessment) project has been started in 1995 in the countries preparing for EU accession.
- The TINA distinguished between two network priorities:
  - a core network established centrally
  - a comprehensive network proposed by the countries
- The importance of the TINA had been the incorporation of the EU funds into the network development: PHARE (Poland and Hungary: Assistance for Restructuring their Economies, later covering ten candidate countries), ISPA (Instrument for Structural Policies for Pre-Accession), Cohesion Fund, European Regional Development Funds.

Source: Fleischer Tamás: A közlekedéspolitika és a fenntartható fejlődés dilemmái, különös tekintettel a közúthálózatokra. Falu Város Régió 2003/3. (in Hungarian)

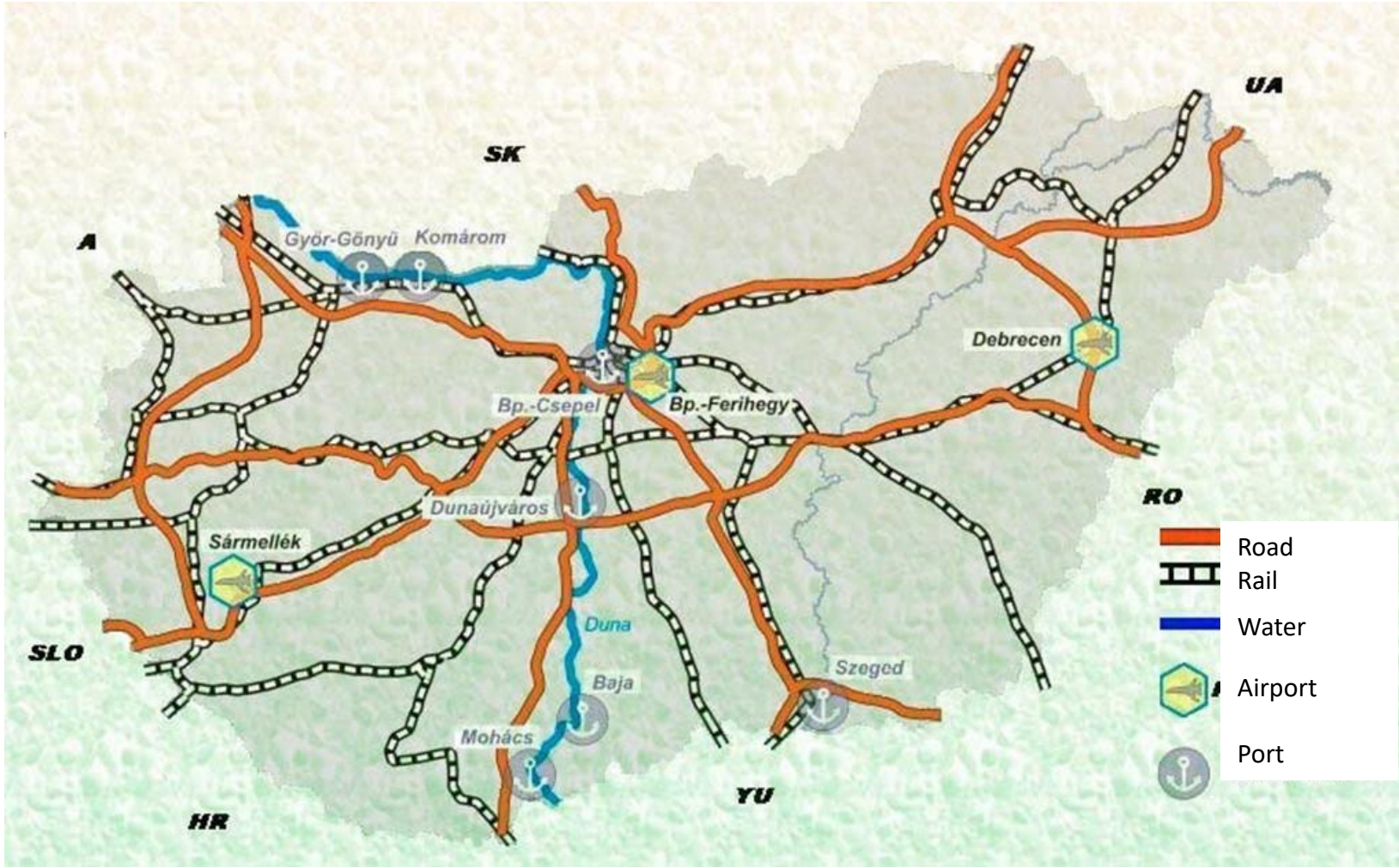
Trans-European networks – corridors

Accepted and proposed supplementary elements of the TINA network 2000



Trans-European networks – corridors

Pan-European corridors and TINA network elements



Source: Gazdasági és Közlekedési Minisztérium: Magyar közlekedéspolitika 2003-2015. (in Hungarian)

Trans-European networks – TEN-T

- The European Union have issued legal materials on the trans-European transport network (TEN-T) in 1996, in 2010 and in 2013.
- Regulation (EU) No 1315/2013 of the European Parliament and of the Council of 11 December 2013 on Union guidelines for the development of the trans-European transport network and repealing Decision No 661/2010/EU

Trans-European networks – TEN-T

- The TEN-T core network consists of 9 European transport corridors, its completion is expected by 2030.
- The core network is supplemented by a comprehensive network until 2050. The core network and the comprehensive network together ensures the total transport coverage of all EU regions.
- Both network types include all transport modes: road, railway, air, water (inland and maritime) as well as intermodal solutions.

Trans-European networks – TEN-T

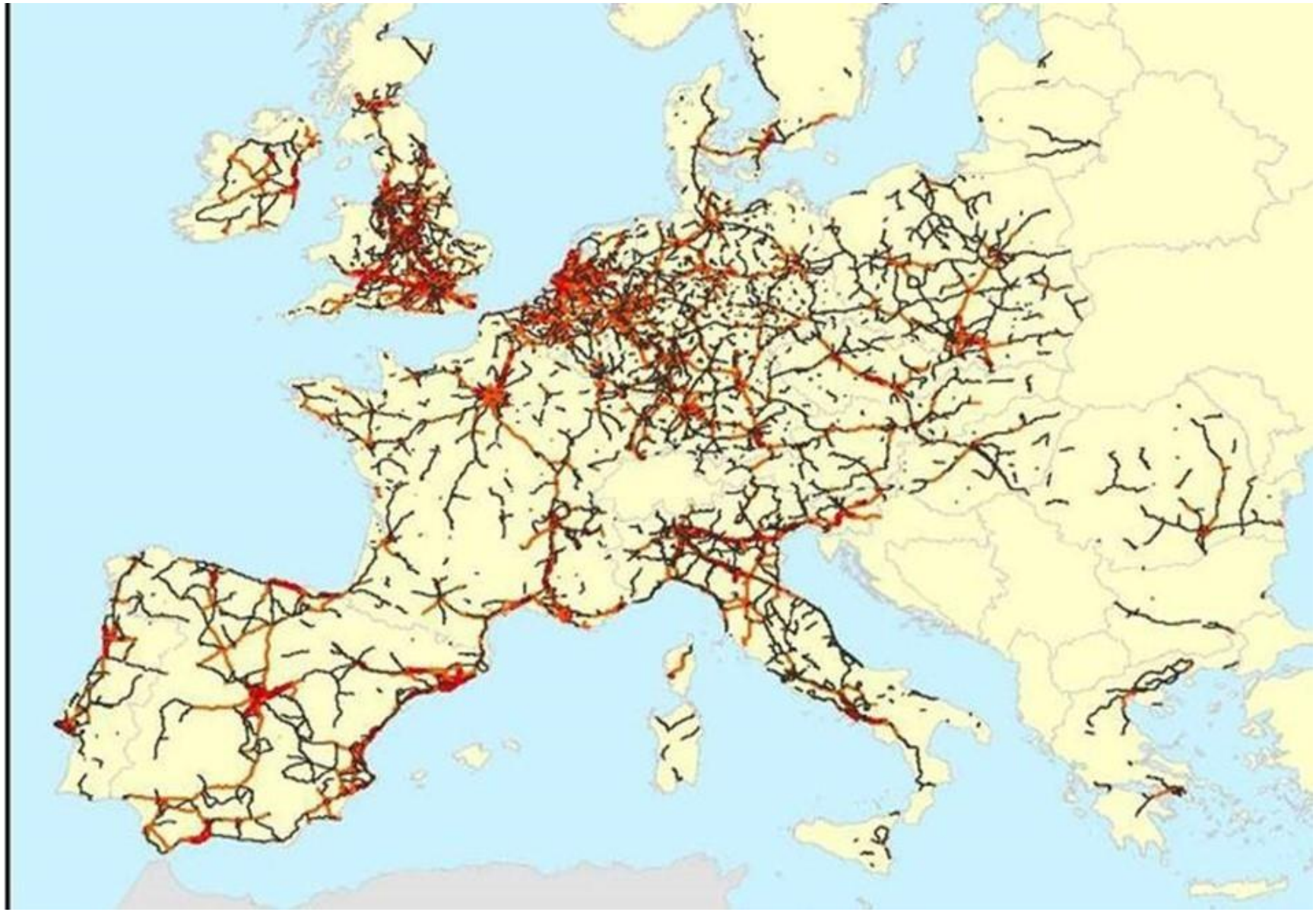
- The European Commission has determined common technical guidelines for the TEN-T infrastructure, ensuring connections among networks and within networks as well as the interoperability of these networks.
- TEN-T financial and technical guidelines issued in 2014:
  - COM(2013) 940 final Communication from the Commission: Building the Transport Core Network: Core Network Corridors and Connecting Europe Facility
  - SWD(2013) 542 final Commission Staff Working Document: The planning methodology for the trans-European transport network (TEN-T)

Trans-European networks – TEN-T

TEN-T developments up to 2011

Source: The new Trans-European transport network. A core network: blueprint for 2030

TEN-T network proposal 2012



Source: http://ec.europa.eu/transport/infrastructure/doc/web_methodology.pdf

TEN-T network proposal 2012

- The country by country assessment of the TEN-T network proposal describes Hungary in an advantageous situation.
- Budapest forms a main transport junction and because of its geographical location, the core network is very dense there, containing almost all main axles and supplementary elements, that are included into the Hungarian development plans. Such elements are the river Danube and its ports as well as railway and road connections toward Vienna, Bucharest, Belgrade, Zagreb, Ljubljana and Bratislava.
- Consequently, Hungary is very well covered from both network level and project level points of view.

Source: Trans-European Transport Networks The TEN-T Core Network: Country by Country 2011. http://ec.europa.eu/transport/infrastructure/connecting/doc/revision/background-country.pdf

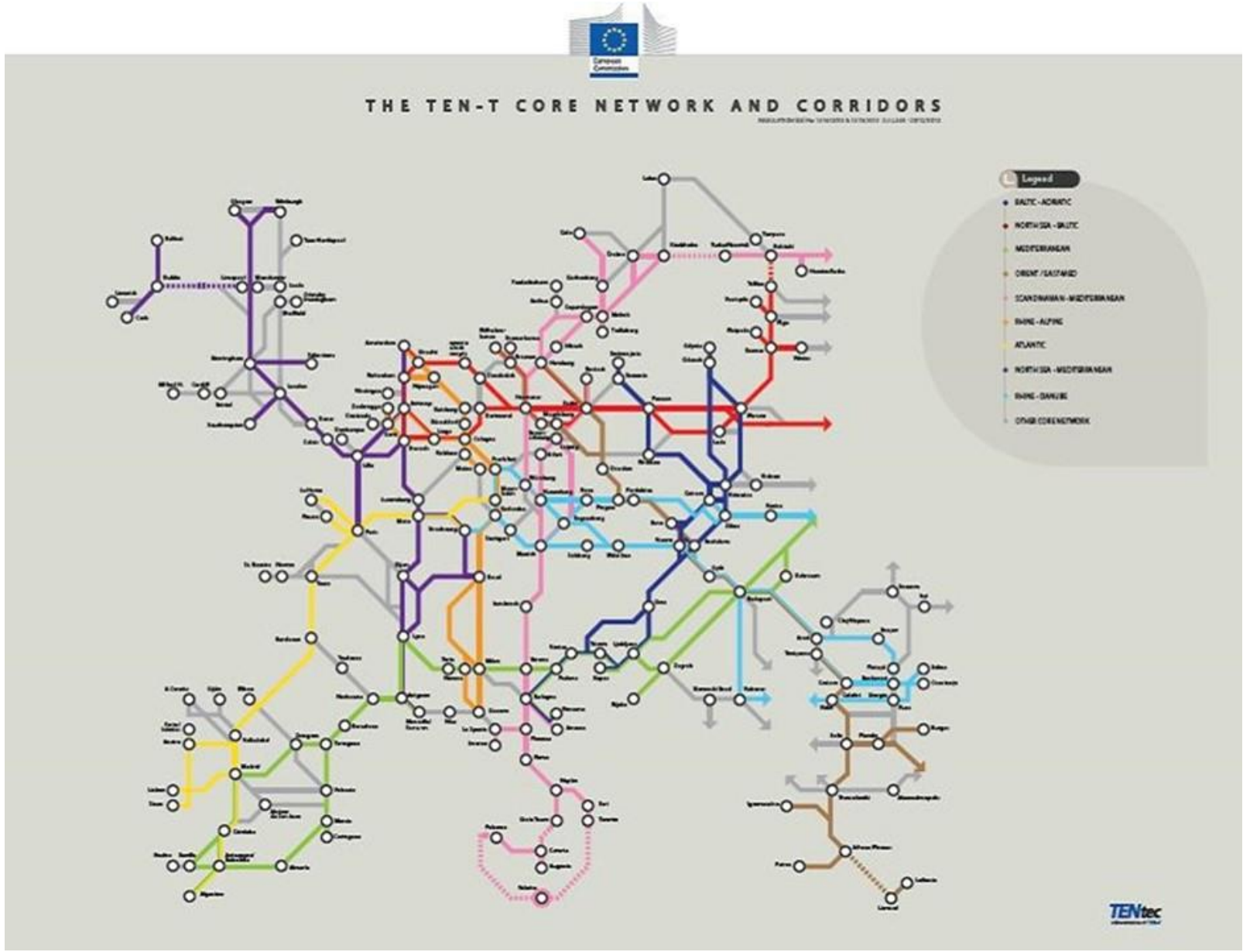
TEN-T network 2017

- The refreshed version of the 9 corridors is described in:
- Commission Delegated Regulation (EU) 2017/849 of 7 December 2016 amending Regulation (EU) No 1315/2013 of the European Parliament and of the Council as regards the maps in Annex I and the list in Annex II to that Regulation
- Core network corridors in Hungary are: the Mediterranean, the Orient – EastMed and the Rhine - Danube.

Source of next maps on slides 34 - 52:

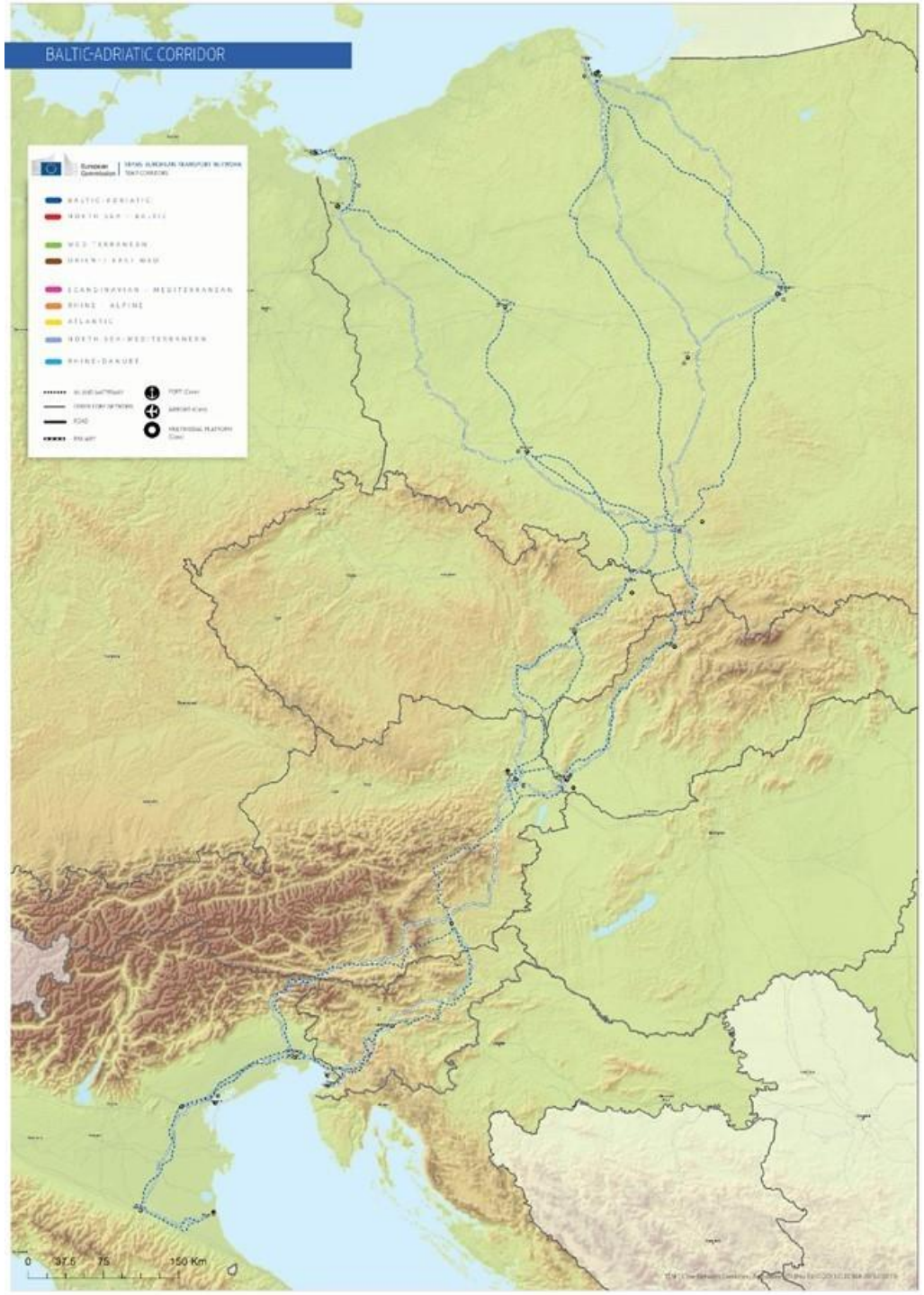
http://ec.europa.eu/transport/infrastructure/tentec/tentec-portal/site/en/maps.html

TEN-T network 2017



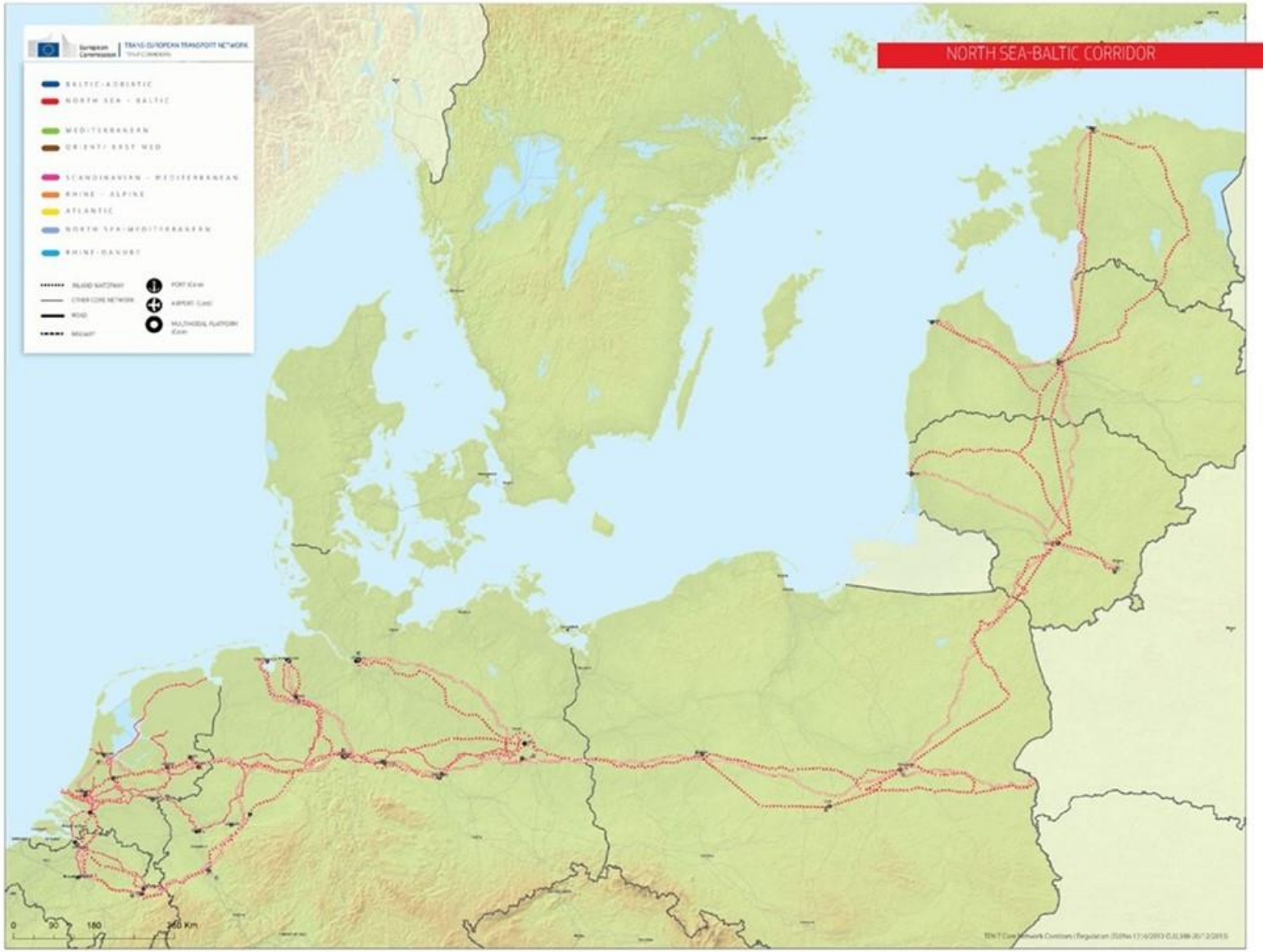
Proposed core network corridors in a schematic map

Next slides show each corridor separately on maps

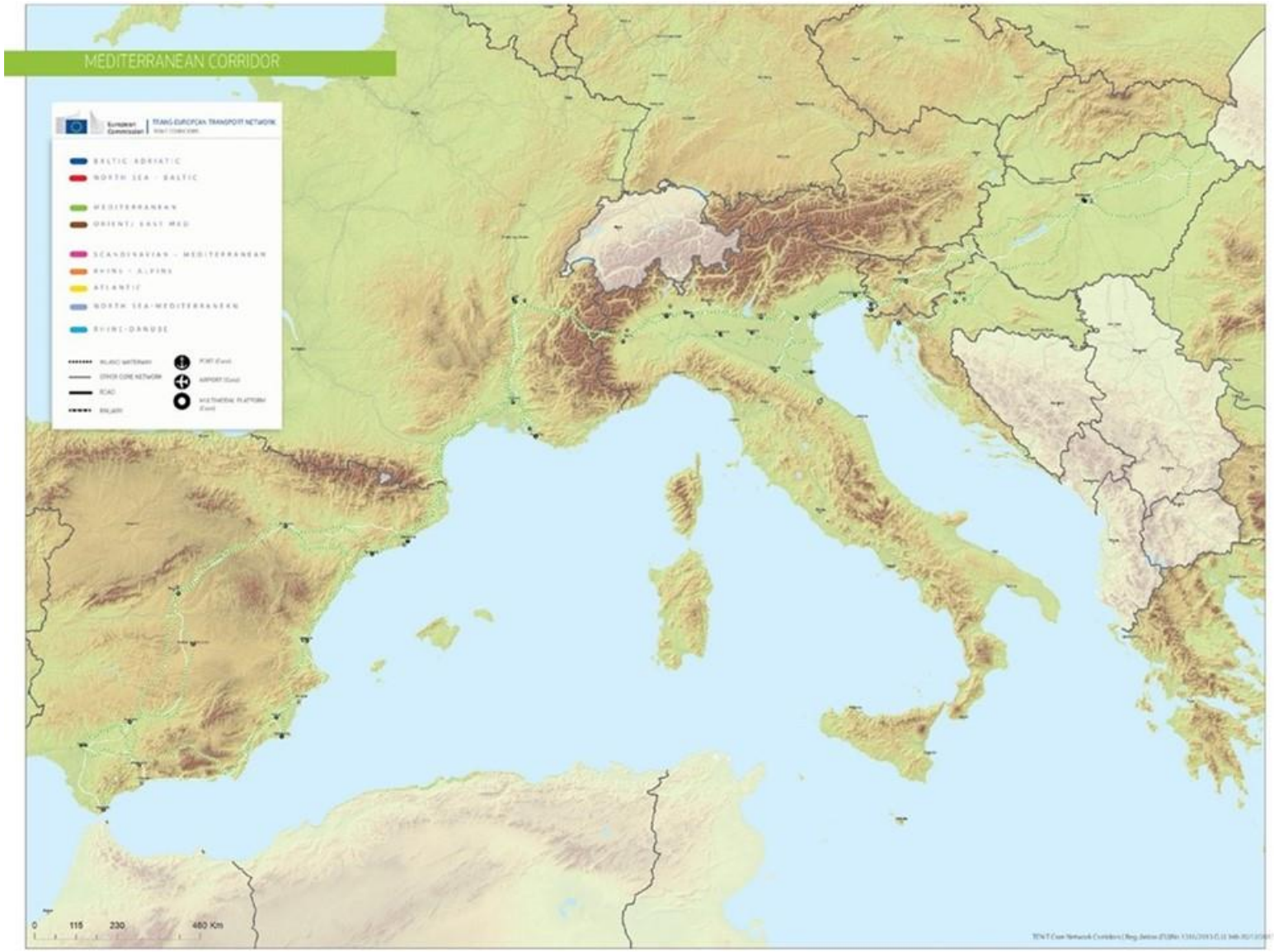


Baltic-Adriatic

Northsea - Baltic

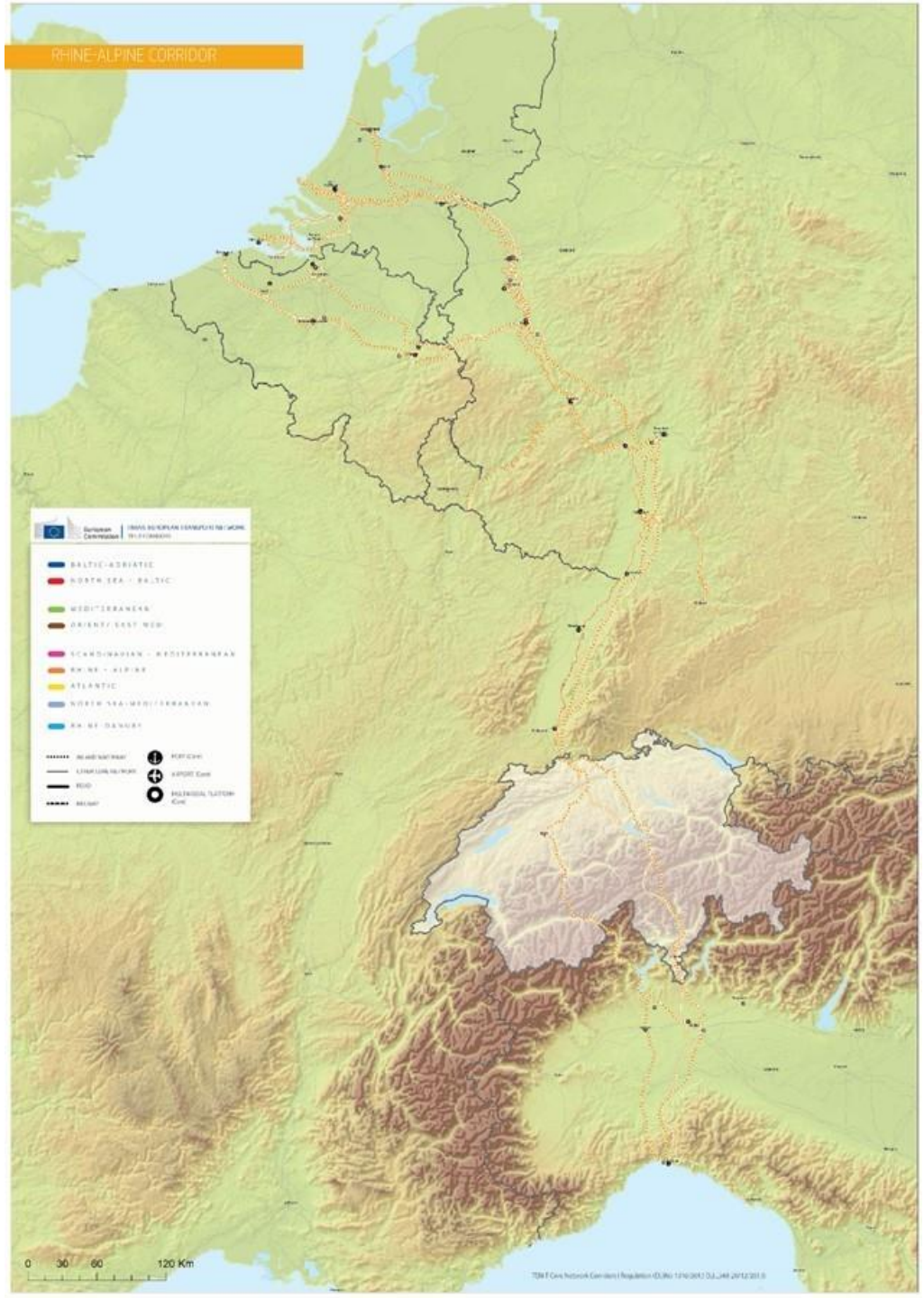


Mediterranean



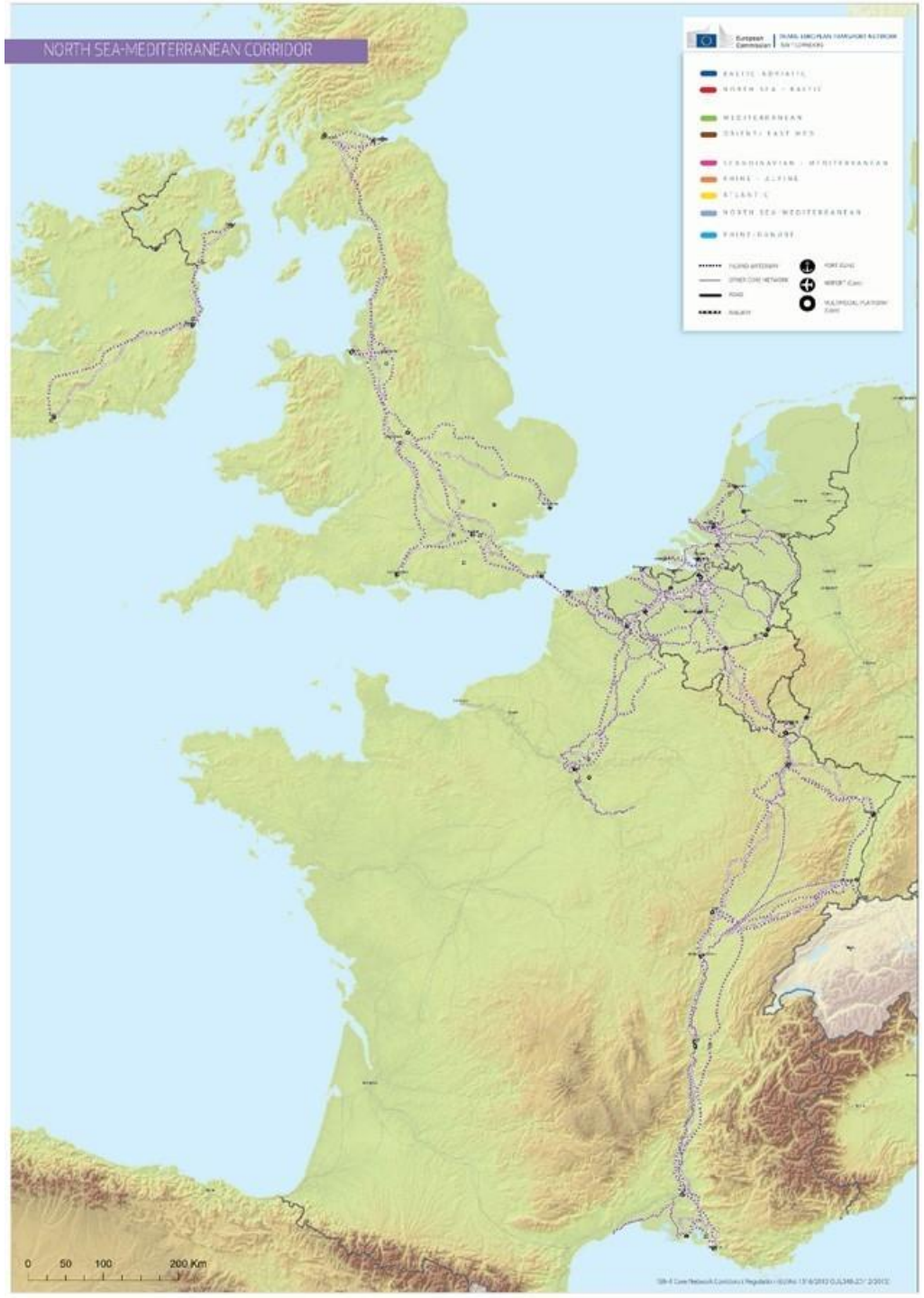
Orient - EastMed

Scandinavian - Mediterranean



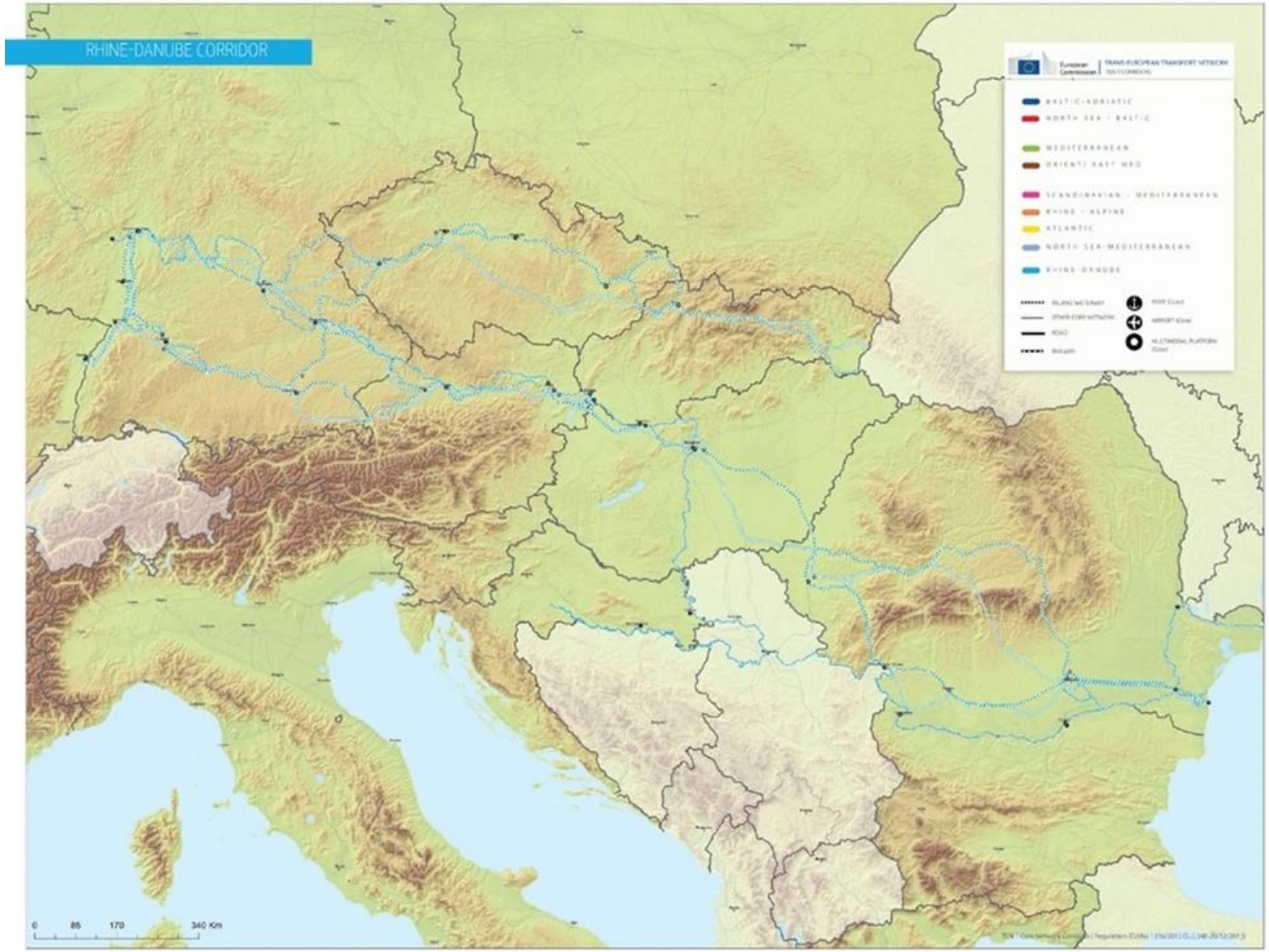
Rhine -Alpine

Atlantic

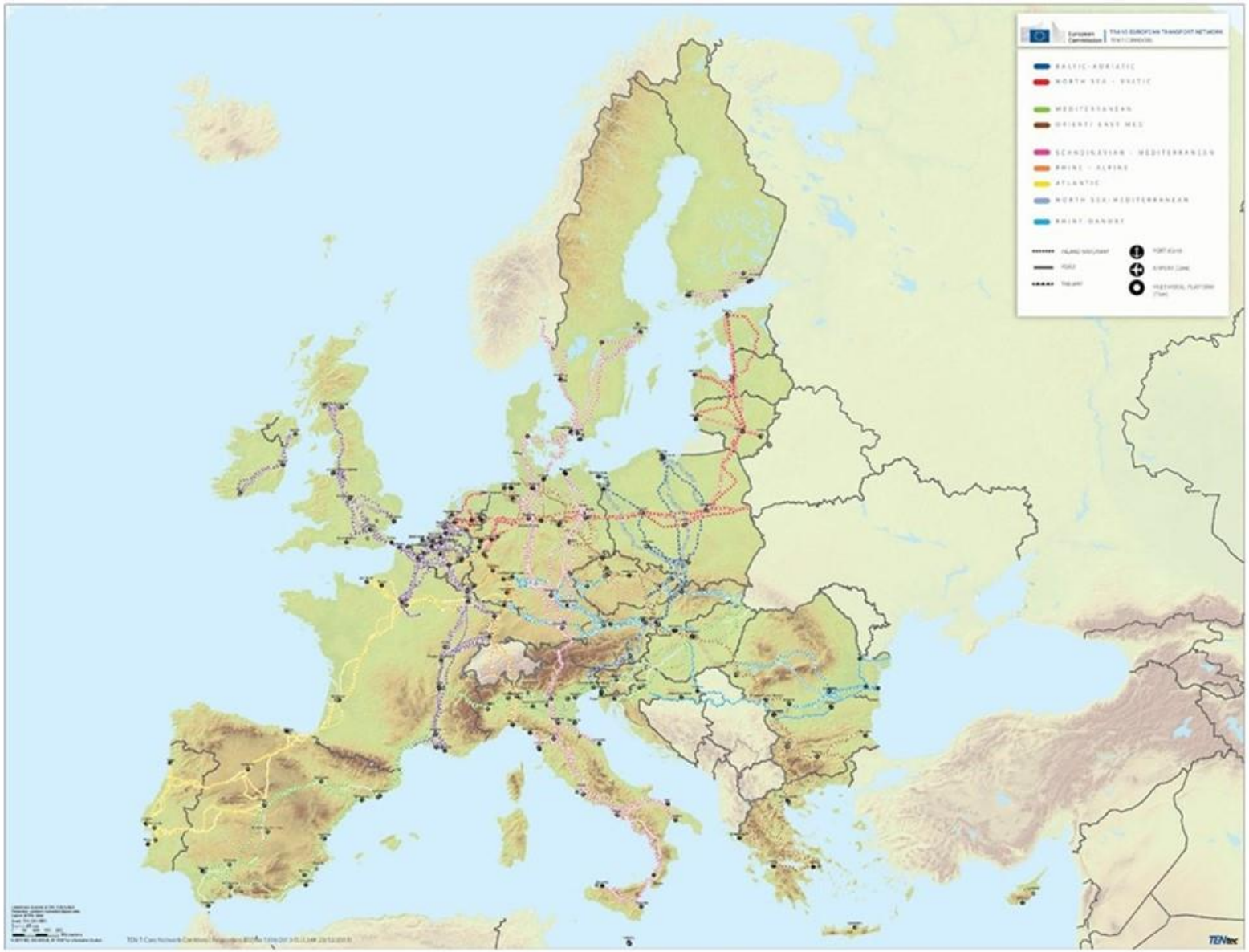


Northsea - Mediterranean

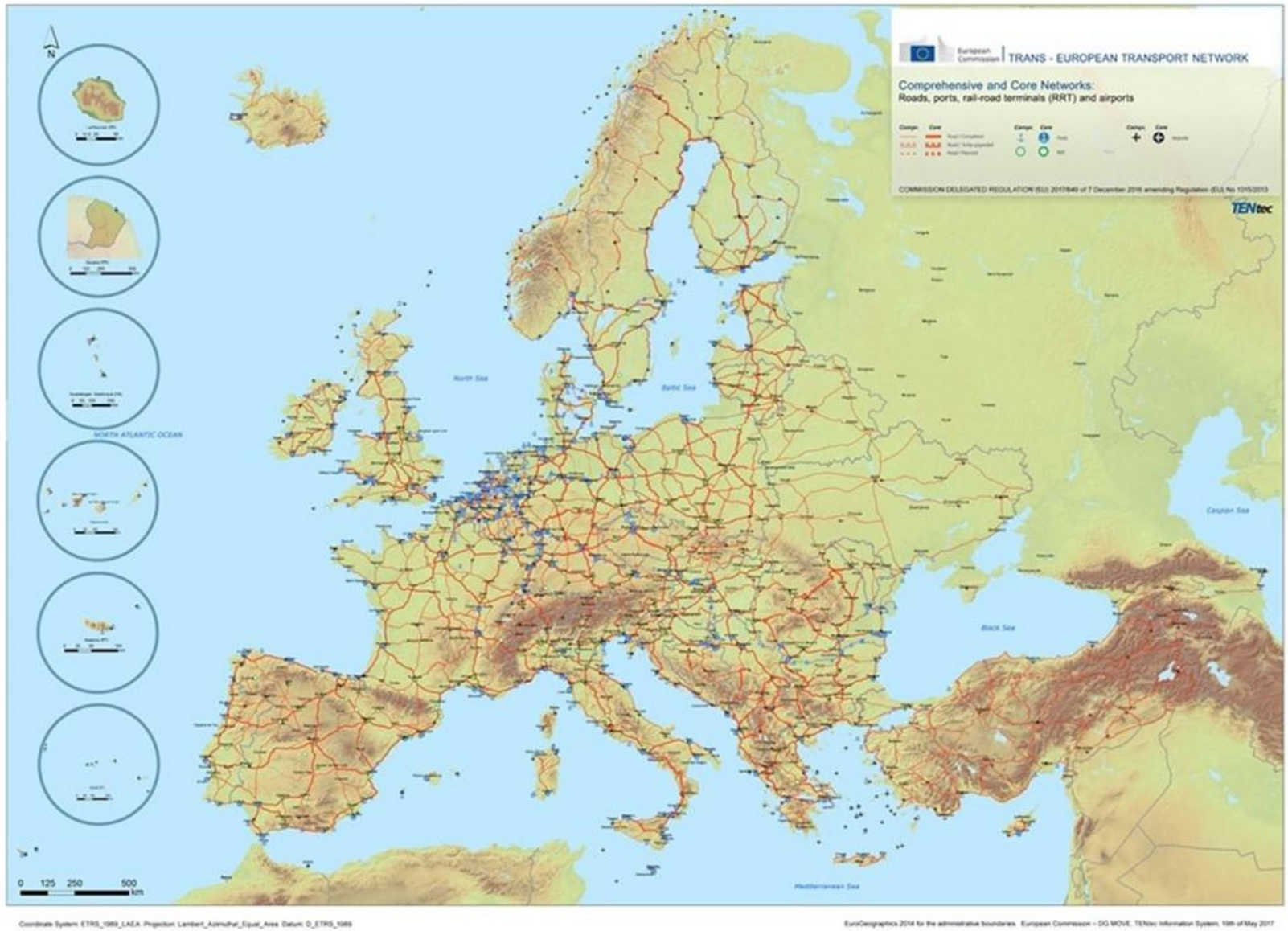
Rhine - Danube



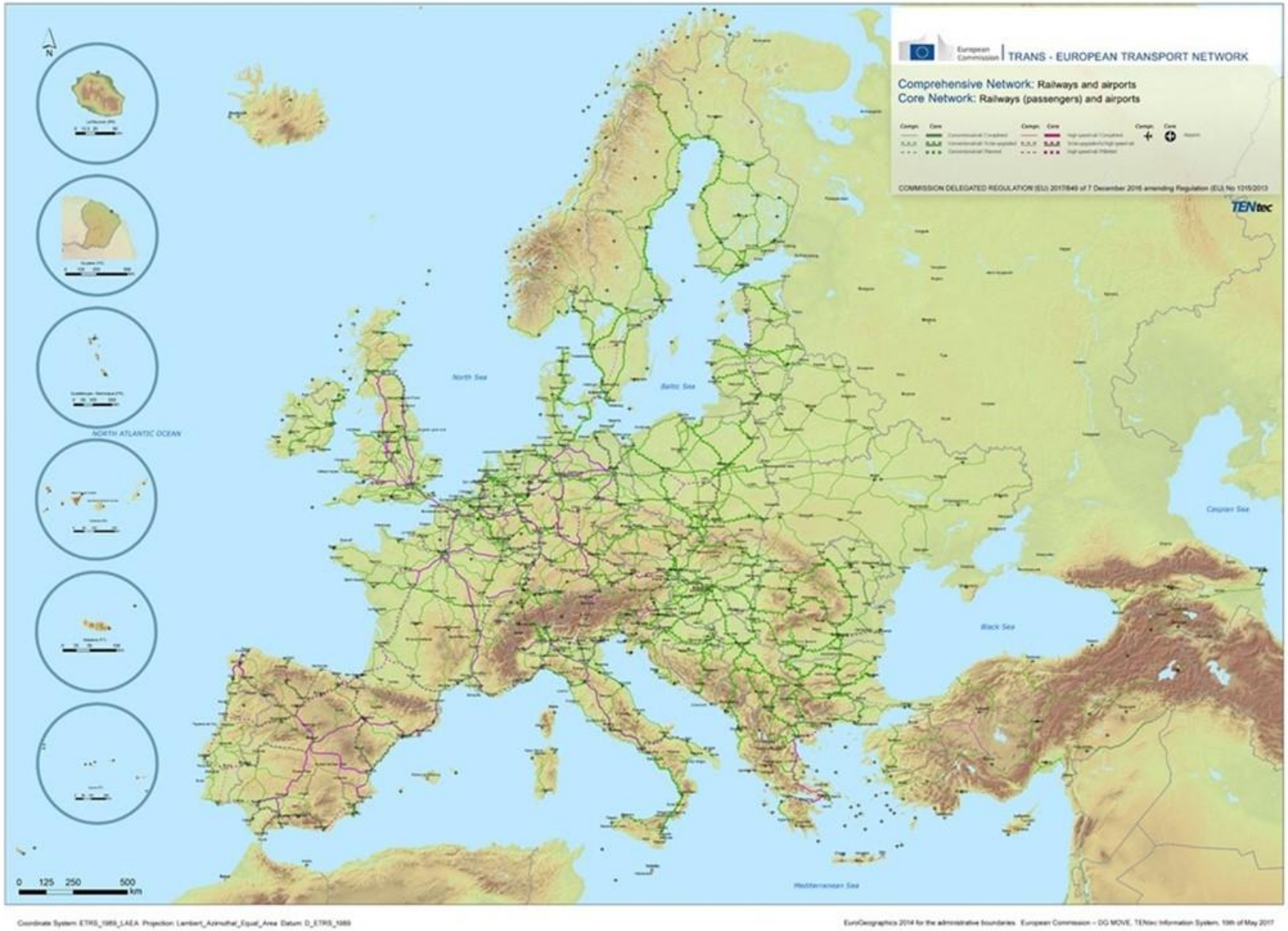
TEN-T corridors 2017



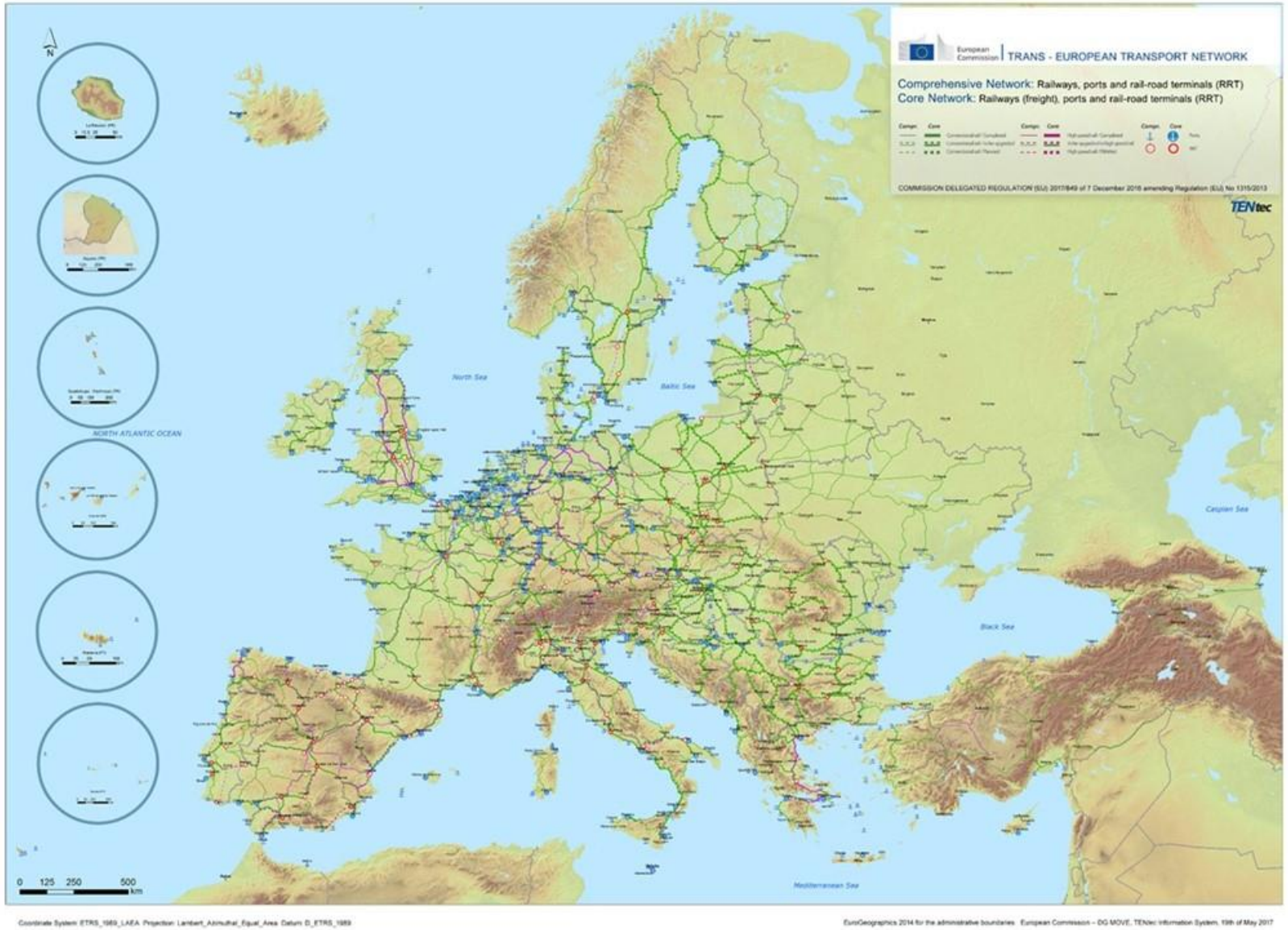
TEN-T corridors 2017 – roads



TEN-T corridors 2017 – rail, air

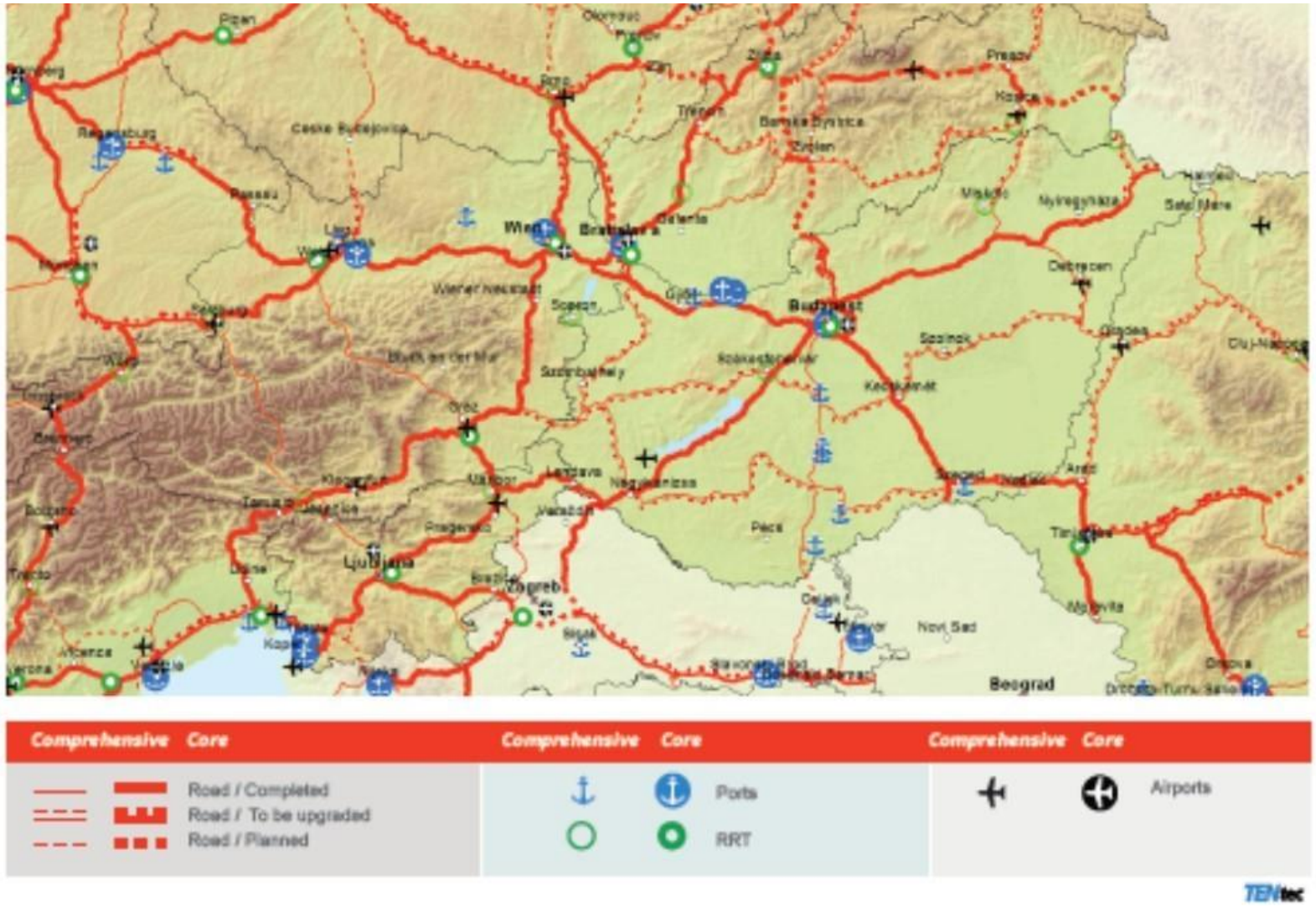


TEN-T corridors 2017 – freight



TEN-T corridors 2017 – waterways

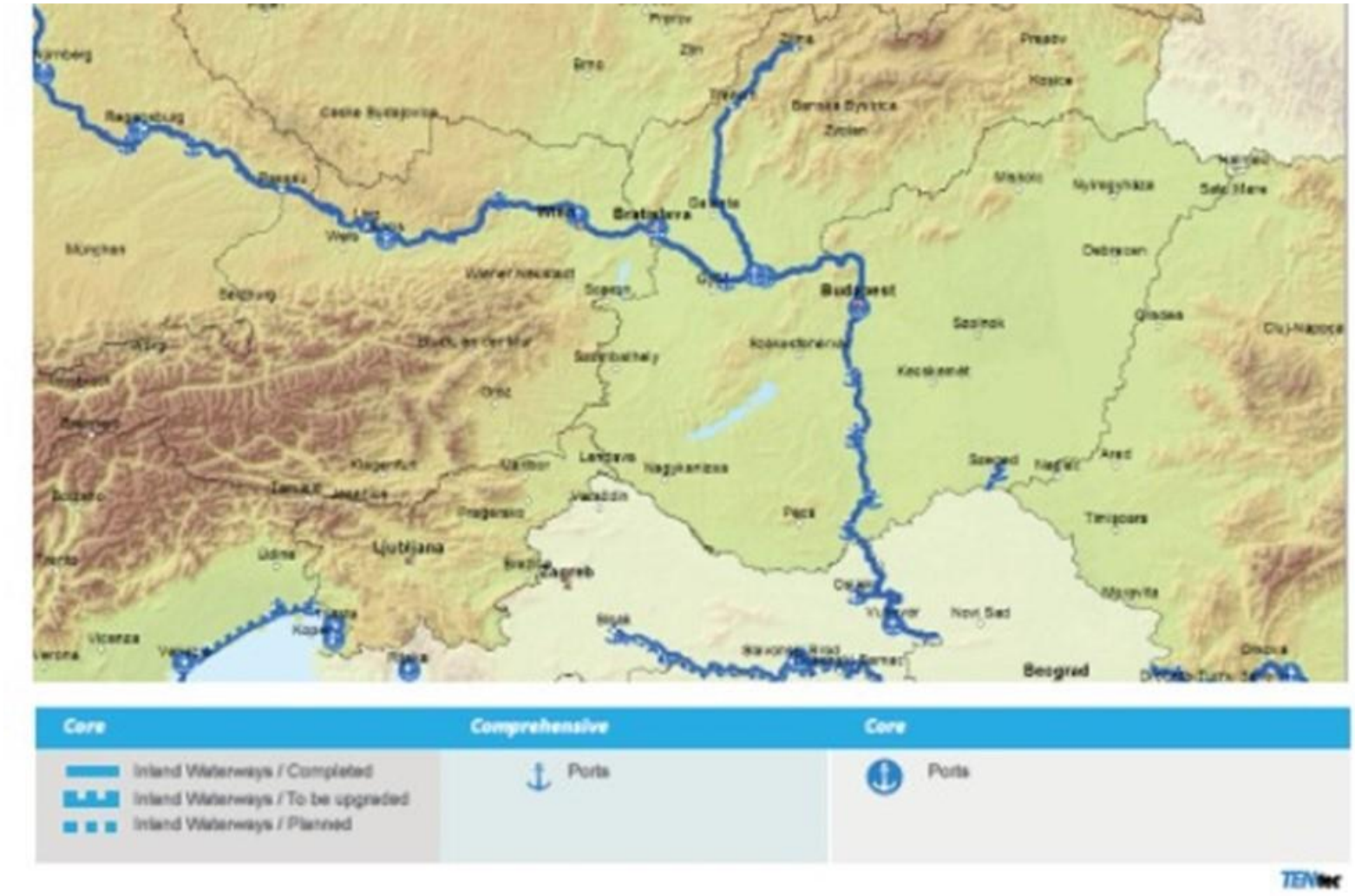
TEN-T corridors 2017 – roads in Hungary



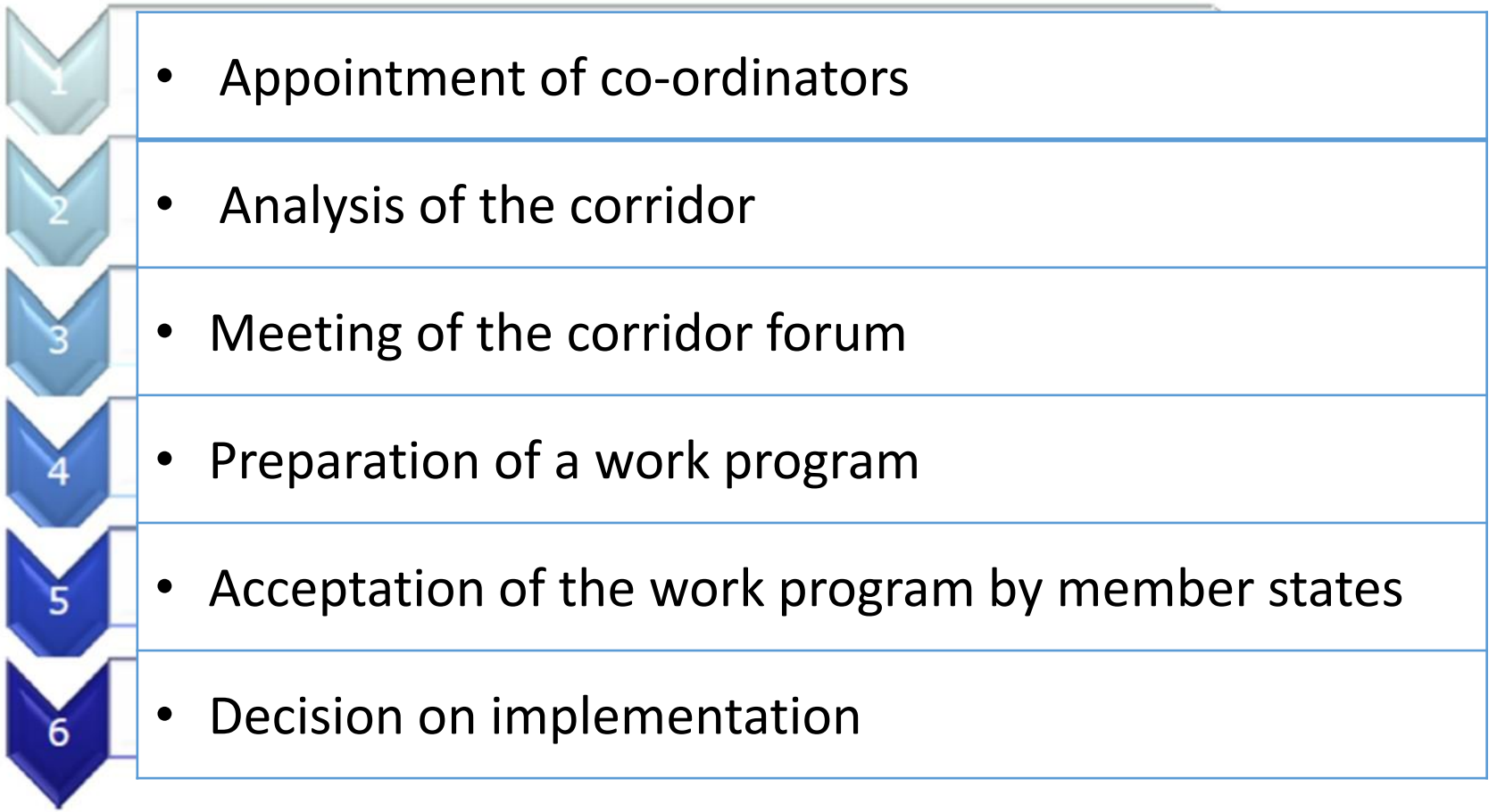
TEN-T corridors 2017 – rail, air in Hungary

TEN-T corridors 2017 – freight in Hungary

TEN-T corridors 2017 – waterways in Hungary



TEN-T corridor establishment process



The USA interstate highway network

- Seen from a satellite, the U.S. is crisscrossed by a grid of 62 major superhighways, 27 running east and west, and 35 north and south.
- Built largely in the 60s and 70s, the system grew to 47 000 miles (76 000 km) and launched the nation on an era of unparalleled economic growth, besides its important defence function.
- Representing only one percent of total highway miles, today's Interstates carry 24 percent of all traffic and 41 percent of combination-vehicle truck traffic.
- The heavily used Urban Interstate System represents only 32 percent of Interstate route miles, but it carries 63 percent of Interstate traffic.

Source: Transportation Reboot: Restarting America's Most Essential Operating System http://ExpandingCapacity.transportation.org

The USA interstate highway network

- As the 210 000 lane miles of the Interstate System reach 40 to 50 years of life, major portions will need to have their foundations completely reconstructed. The Interstate System has almost 15 000 interchanges, many of which do not meet current operational standards and create bottlenecks or safety problems.
- The Interstate Highway System has more than 55 000 bridges, many of which are reaching 40 to 50 years of age.
- Preservation must go hand-in-hand with highway safety and operational performance. Rehabilitation and capacity expansion are not separate activities, but aspects of a larger process of maintaining a transportation system in optimal performance.

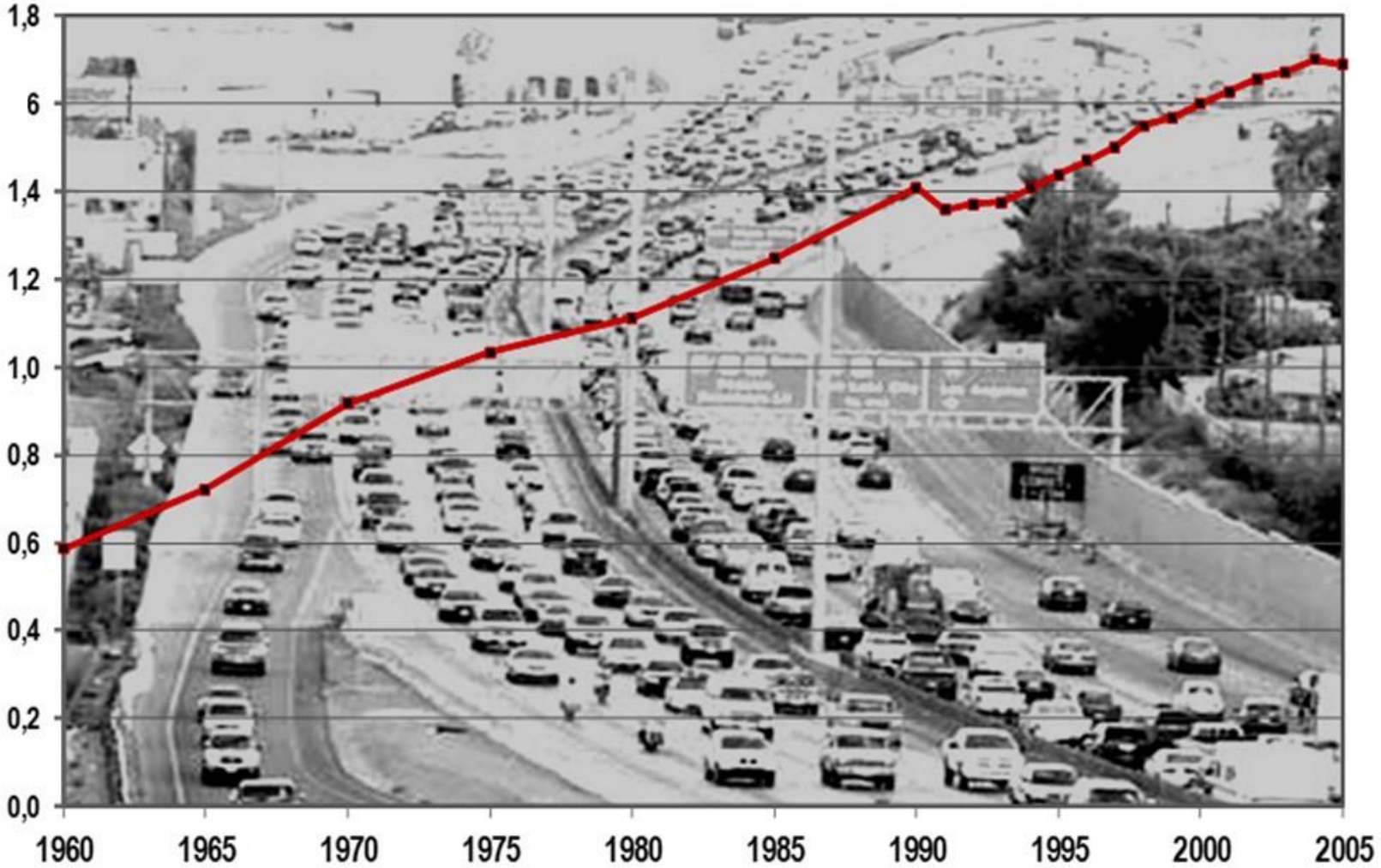
Source: Transportation Reboot: Restarting America's Most Essential Operating System http://ExpandingCapacity.transportation.org

The USA interstate highway network

Source: http://en.wikipedia.org/w/index.php?title=File:Map_of_current_Interstates.svg&page=1

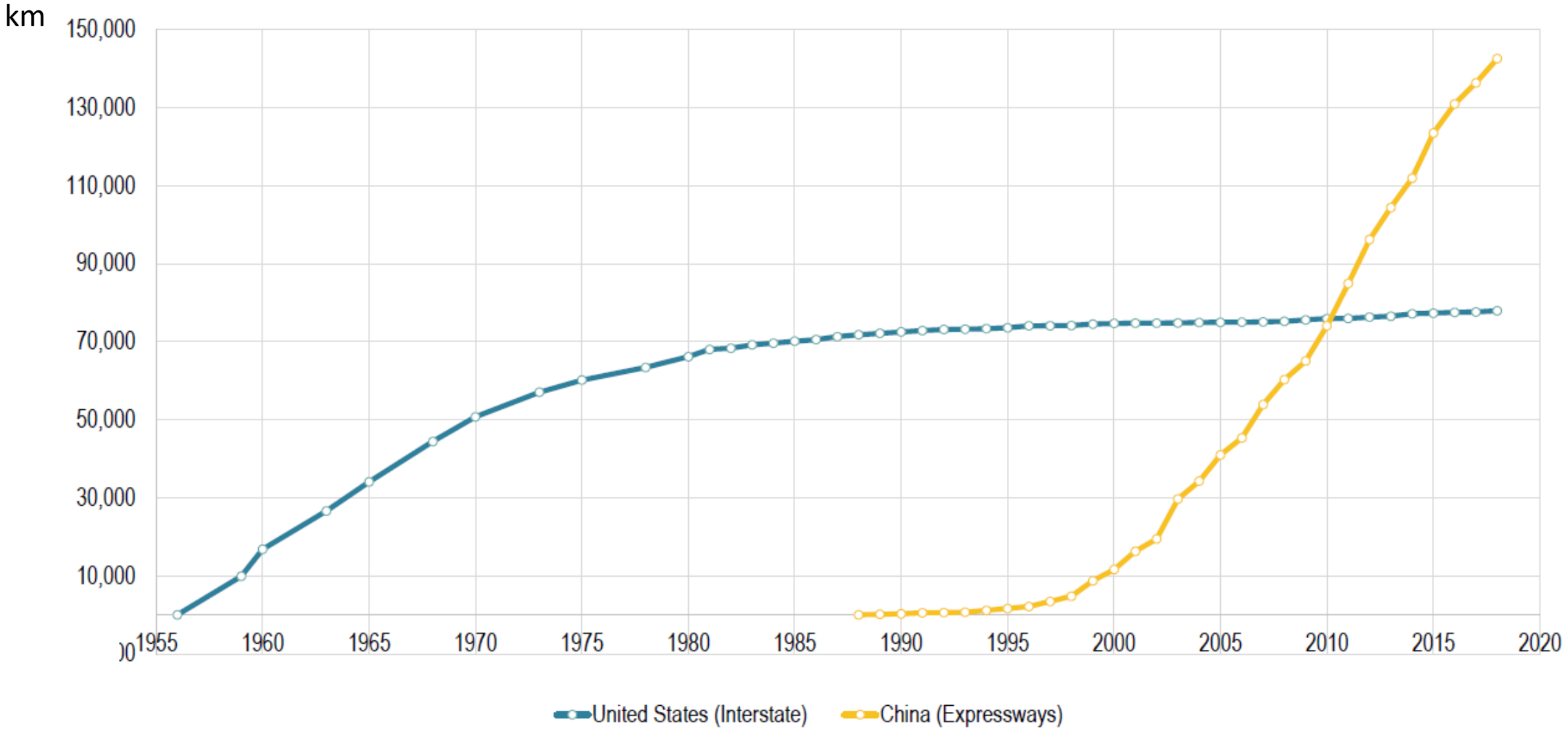
The USA interstate highway network

Traffic performance (billion vehicle km) on the total network



The USA interstate highway network

Length of the Interstate Highway System and of the Chinese Expressway System 1959-2018



Source: Rodrigue, J-P et al. (2020) The Geography of Transport Systems, Hofstra University, Department of Global Studies & Geography, https://transportgeography.org/

Summary

- Traffic volume of a cross section is in linear proportion with traffic density and speed.
- Public roads consist of state (national) roads and municipal (local) roads.
- A general European road network has been defined in 1975 by the Geneva Agreement of the United Nations Economic Commission for Europe.
- The transport network of Central- and Eastern-Europe has been developed by the system of Pan-European Corridors, and the TINA (Transport Infrastructure Needs Assessment) project.
- The current trans-European transport network (TEN-T) has been established in 2013. The TEN-T network consists of 9 European transport corridors, including elements of the core network and the comprehensive network.

Thank you for your attention!

András Gulyás

associate professor

e-mail: gulyasandras@hotmail.com