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# **PLANNING THE CONSTRUCTION OF HIGH-SPEED LINES IN THE CZECH REPUBLIC AND ITS METHODOLOGICAL EVALUATION IN TERMS OF TRANSPORT SERVICE OF REGION**

**CTU in PRAGUE FACULTY of TRANSPORTATION SCIENCES**

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# **Czech high-speed railway network development**

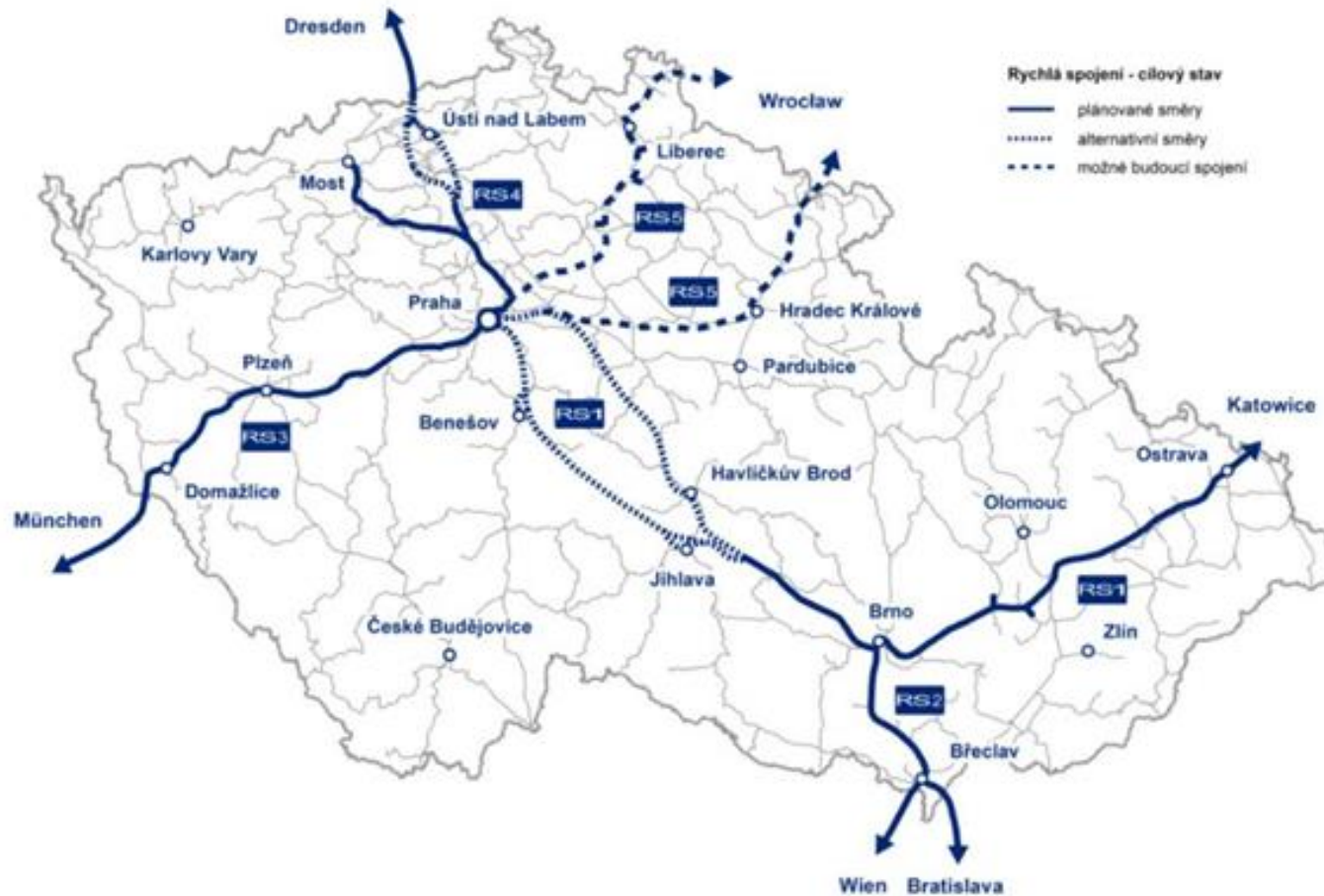
- **The Fast Connections ("Rychlá spojení" in Czech, abbreviation "RS") = combination of newly build HSL and upgraded existing railway sections**
- **Cooperation of infrastructure and railway operation**
- **Proposed sections:**
  - RS1 Praha – Brno – Ostrava – [Poland],
  - RS2 Brno – [Slovakia/Austria],
  - RS3 Praha – Plzeň – [Germany] (western direction – München),
  - RS4 Praha – [Germany] (northern direction – Dresden) with branch (Most – Chomutov, Žatec, Louny),
  - RS5 Praha – Hradec Králové/Liberec – [Poland].



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# Czech high-speed railway network development



# **STEM Method**

- **optimization method STEM (Step Method)**
- **mathematical problems with more purpose functions**
- **compromise solutions with most benefits**

## STEP 1

**Solver calculates optimal solution for individual criterions (purpose function) separately. The number of calculations fits the number of criterions.**

## STEP 2

**Solver calculates the scales of individual criterions according to the formula:**

$$W_i = \frac{Z_{ii} - \min_{j=1 \dots k} Z_{ij}}{Z_{ii}} \frac{\alpha}{\sqrt{\sum_{i=1}^n c_{ij}^2}}$$

## STEP 2

**Linear programming (Fico Xpress, mosel language) – optimization task (solution with best benefit-cost ratio)**

$$\min f(x, d) = d$$

$$d = \max_{i=j \dots k} \left\{ w_i \left( z_{ii} - \sum_{j \in J} c_{ij} X_j \right) \right\}$$

## **STEP 3**

**Solver presents the results to the submitter. The submitter must modify the criterions or add/remove some of them, if he does not find the results acceptable. Solver goes back to step 2.**

## **STEP 4**

**Solver has found compromise solution, if the submitter is satisfied with the result.**



# **STEM application to RS network**

- **Six high-speed railway sections**
- **Five criteria**

# **STEM application to RS network**

- **Six high-speed railway sections**
  1. Praha – Brno,
  2. Brno – Ostrava – [Poland],
  3. Brno – [Slovakia/Austria],
  4. Praha – Plzeň – [Germany],
  5. Praha – Ústí – [Germany],
  6. Praha – Hradec Králové/Liberec – [Poland].

# **STEM application to RS network**

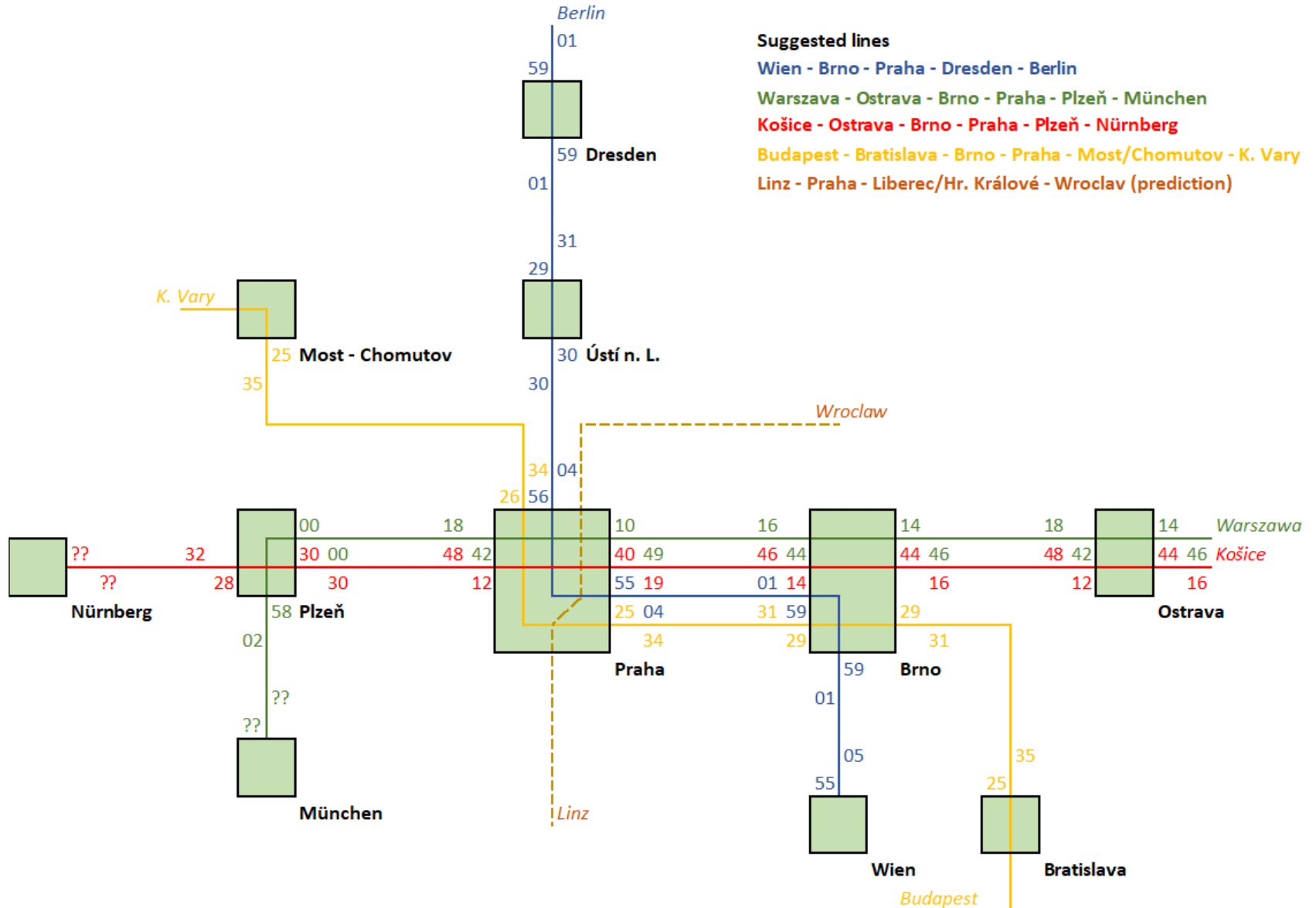
- **Five criterions**
  - average coefficient of reduced travel times in chosen connections
  - number of redirected long-distance lines expressed as an importance
  - routing difficulty
  - road traffic redirection potential
  - agglomeration potential

## **Average coefficient of reduced travel times in chosen connections**

- **calculation of shorter travel times compared to the current situation and in the case RS section is realized.**
- **distribution on individual RS sections and calculation of the average for these sections**

# **Number of redirected long-distance lines expressed as an importance**

- **1: up to 10 redirected long-distance routes in both directions per day,**
- **2: up to 30 redirected long-distance routes in both directions per day,**
- **3: over 30 redirected long-distance routes in both directions per day.**



## **Number of redirected long-distance lines expressed as an importance**

- **interval 15 minutes Praha – Brno,**
- **interval 30 minutes Praha – Ostrava,**
- **interval 30 minutes Praha – Plzeň.**

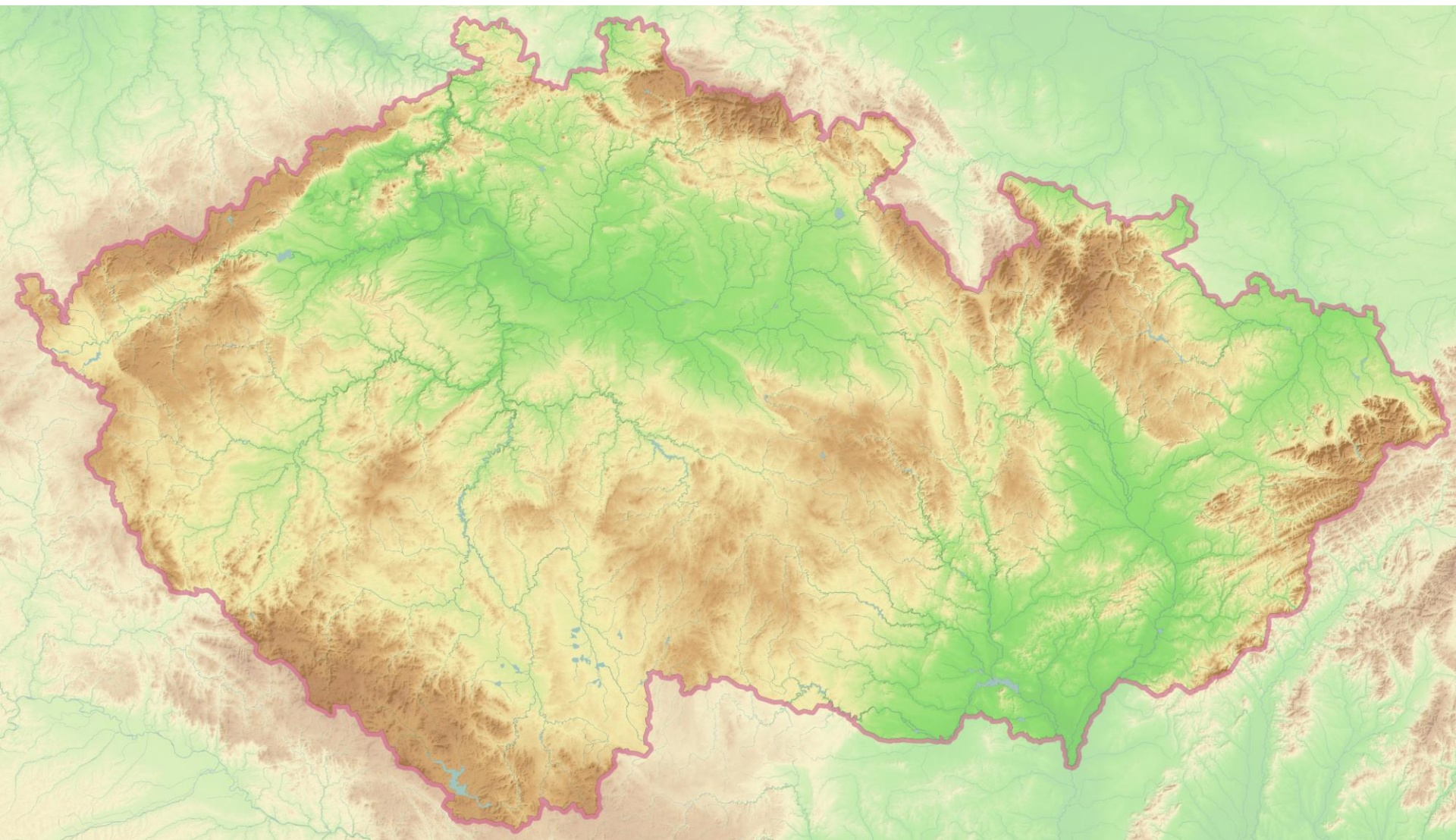
# Routing difficulty

- **1: very difficult routing,**
- **1,5: difficult routing,**
- **2: medium difficult,**
- **2,5: routing without major problems,**
- **3: simple routing,**





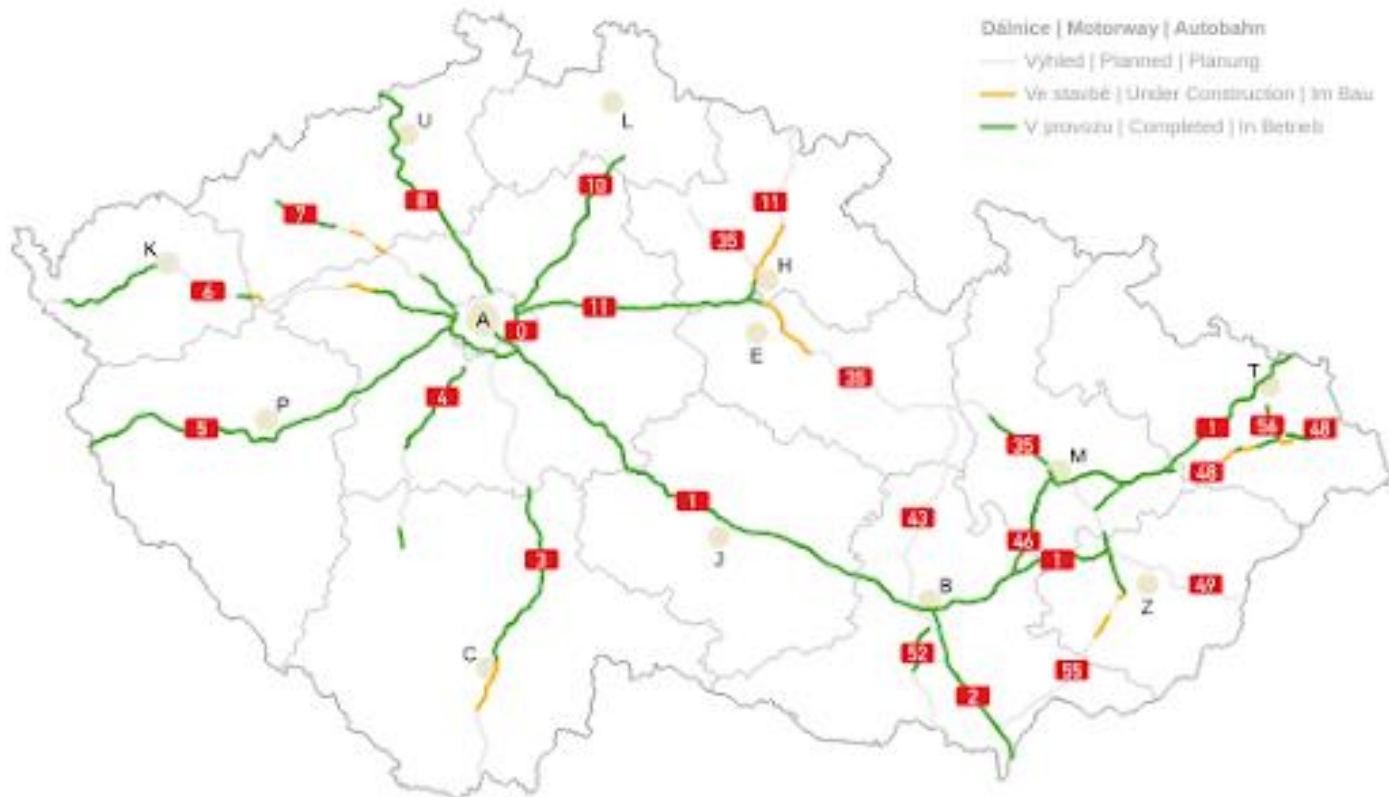
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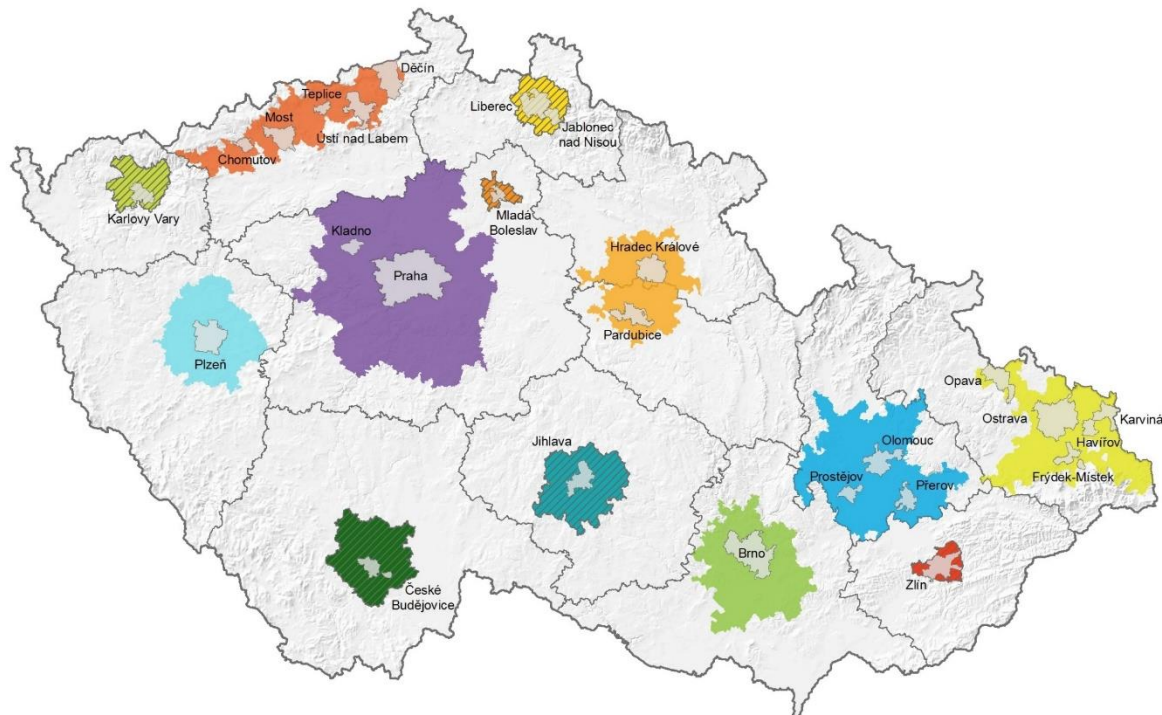
# Road traffic redirection potential

- calculated from traffic density on parallel highways  
(National traffic census 2016)



# Agglomeration potential

- **calculated from the number agglomerations served by individual sections and the number of inhabitants of the agglomeration**



# STEM application to RS network

section of railway line RS	average coefficient of reduced travel times in chosen connections [-]	number of redirected long-distance lines expressed as an importance [-]	routing difficulty [-]	road traffic redirection potential [vehicles per day in thousands in chosen point of a road network]	agglomeration potential [-]
Praha - Brno	2,13	3	1,6	39	22
Brno - Ostrava - PL	1,85	2	2,5	22	15
Brno - SK/A	1,85	2	3,0	23	21
Praha - Plzeň - D	1,73	3	1,6	31	13
Praha - Ústí n. L. - D	2,23	2	1,5	24	20
Praha - HK/Lbc - PL	2,39	1	1,9	23	12

# STEM application to RS network

	weight criteria for selecting 2 projects	weight criteria for selecting 4 projects
average coefficient of reduced travel times in chosen connections [-]	0,181	0,251
number of redirected long-distance lines expressed as an importance [-]	0,407	0,372
routing difficulty [-]	0,361	0,337
road traffic redirection potential [vehicles per day in thousands in chosen point of a road network]	0,024	0,013
agglomeration potential [-]	0,027	0,028

# Results

**The two top prioritized high-speed railway line sections set by the STEM method:**

- **Praha – Brno,**
- **Brno – [Slovakia/Austria]**

**Sections with middle priority:**

- **Brno – Ostrava – [Poland],**
- **Praha – Plzeň – [Germany].**

**Sections with a low building priority:**

- **Praha – Ústí nad Labem – Germany with branch,**
- **Praha – Hradec Králové/Liberec – [Poland].**

# Discussion of results

- **STEM method – very useful for the assessment of priorities of new projects**
- **Calculated priorities are similar to real ones**
- **Next research**

**THANK YOU FOR YOUR ATTENTION!**

**DZIĘKUJĘ ZA UWAGĘ!**

