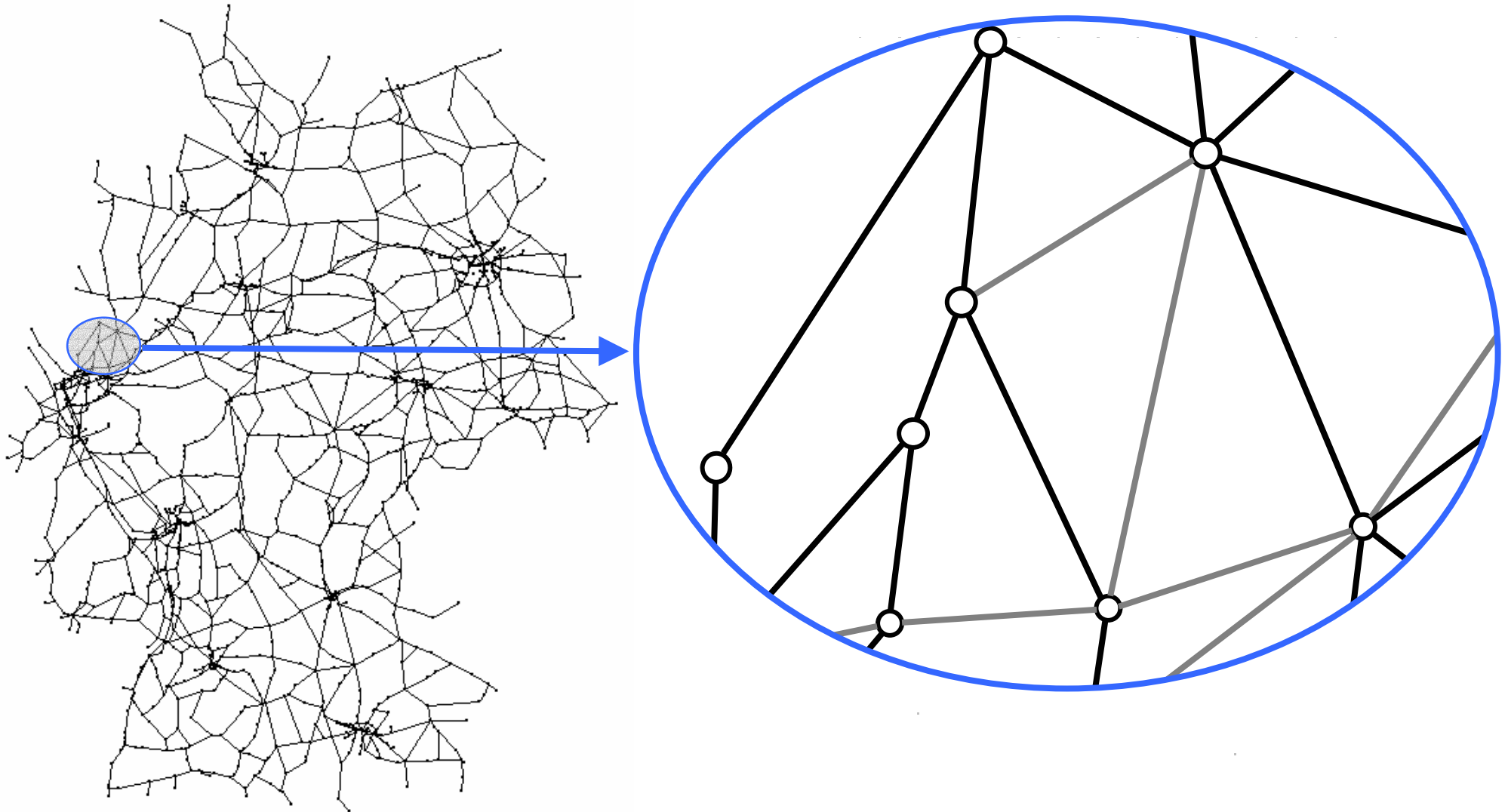

Matching supply and demand in large networks with focus on railways

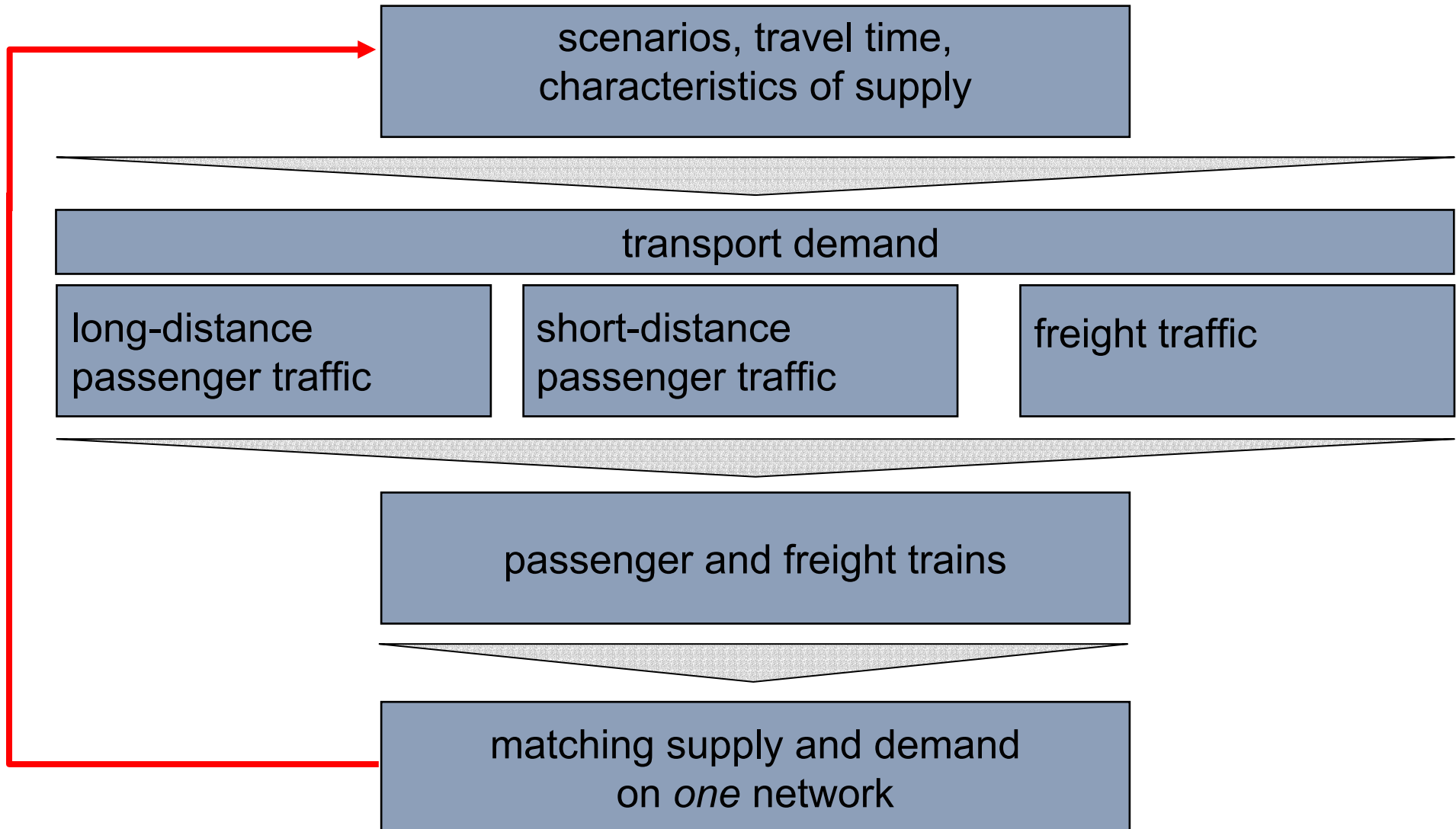
Dr. Andreas Oetting

3rd International Conference on Applied Infrastructure Research
Berlin, 9th of October 2004

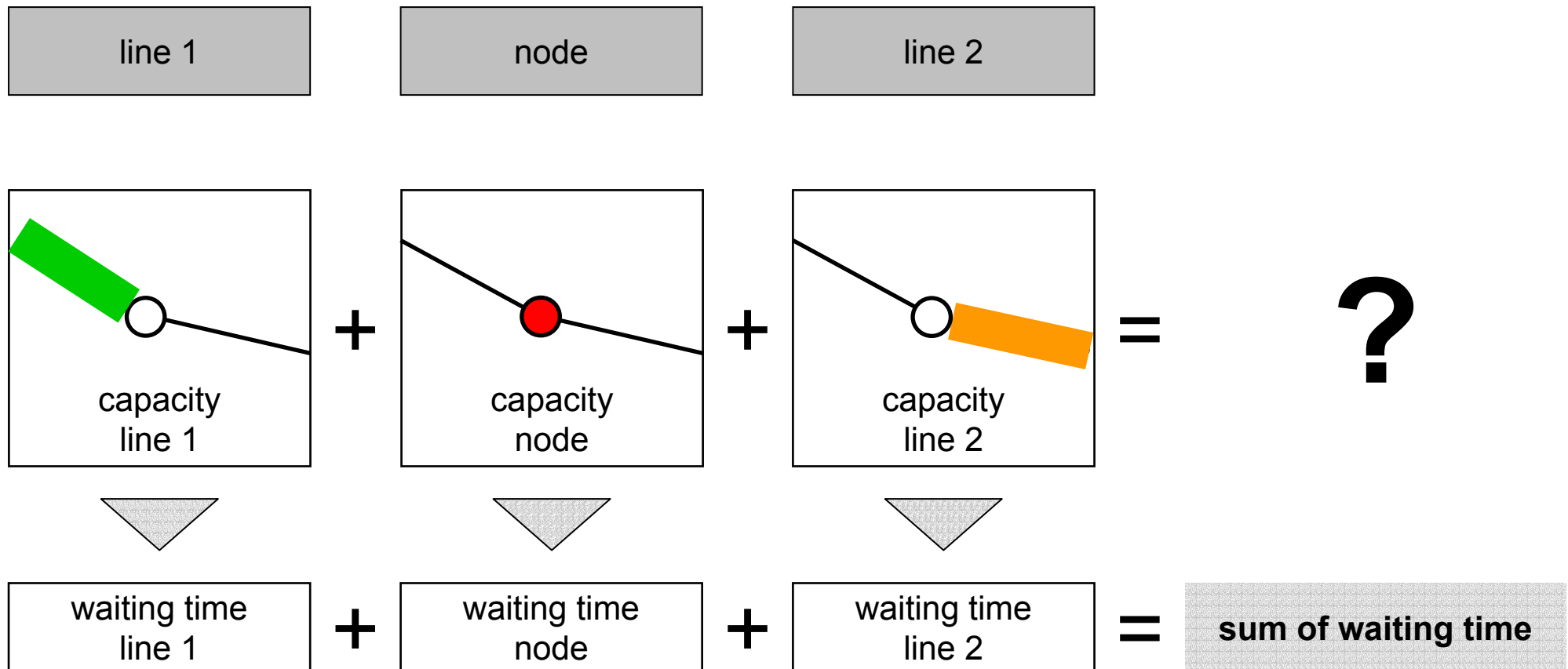
lines and nodes model the infrastructure



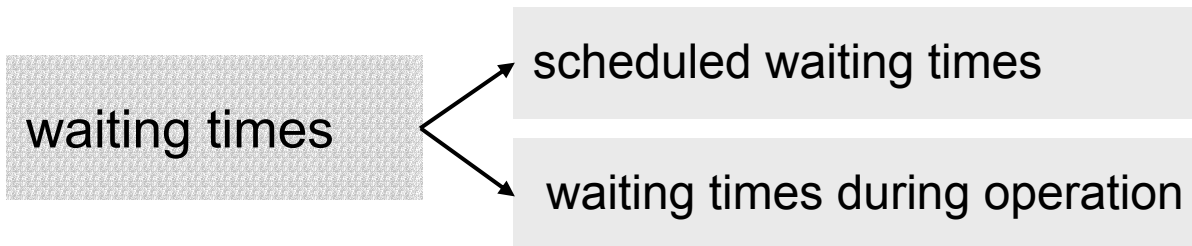
model design



capacity and waiting times as characteristics of supply



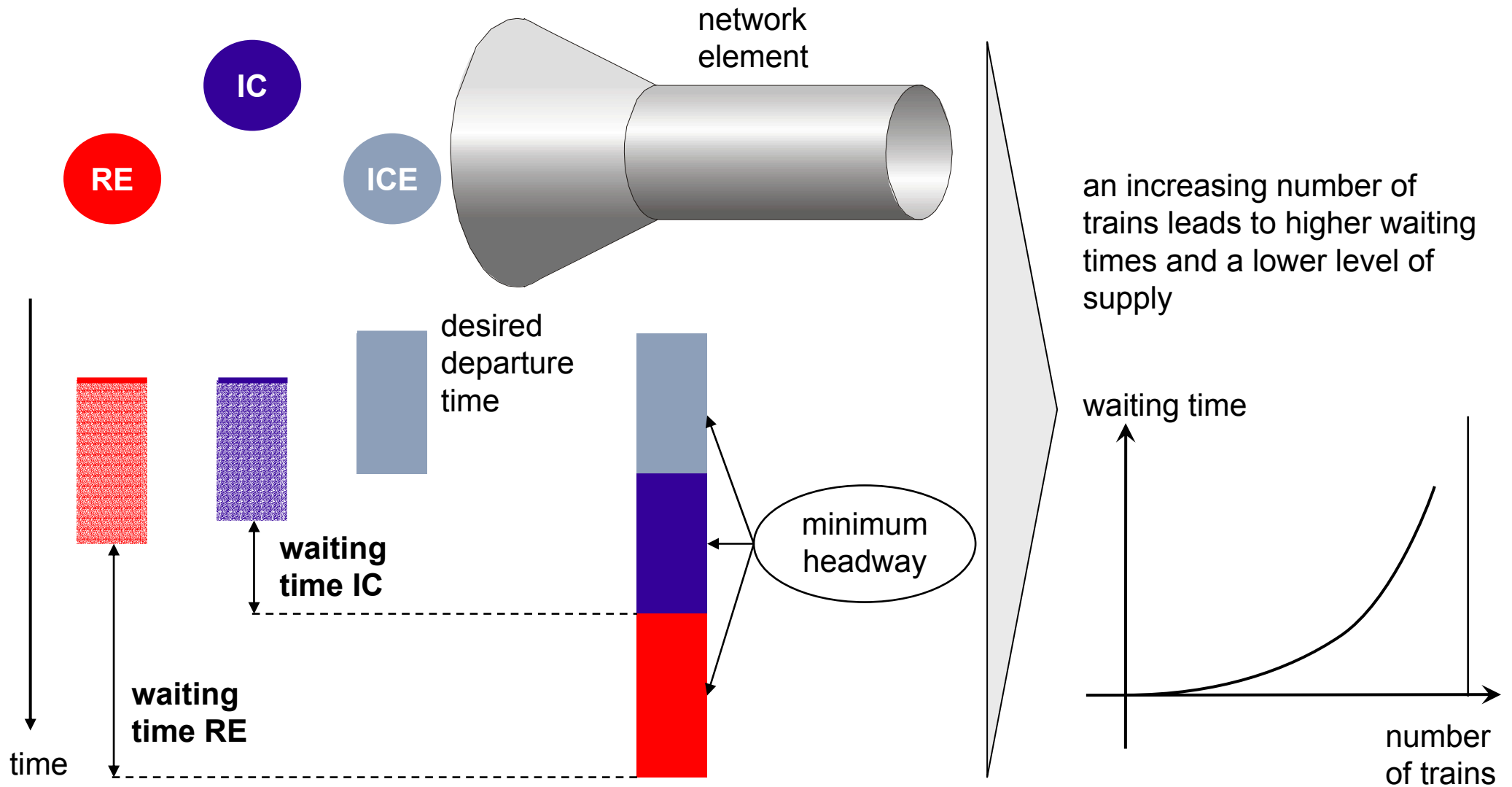
waiting times



-
- A box labeled 'waiting times' is followed by a bulleted list of characteristics:
- can be measured
 - are perceived by the user
 - may be processed together with other characteristics of supply
 - have an impact on route choice, transport demand, costs and benefits
 - can be communicated politically
 - quantify the quality of supply

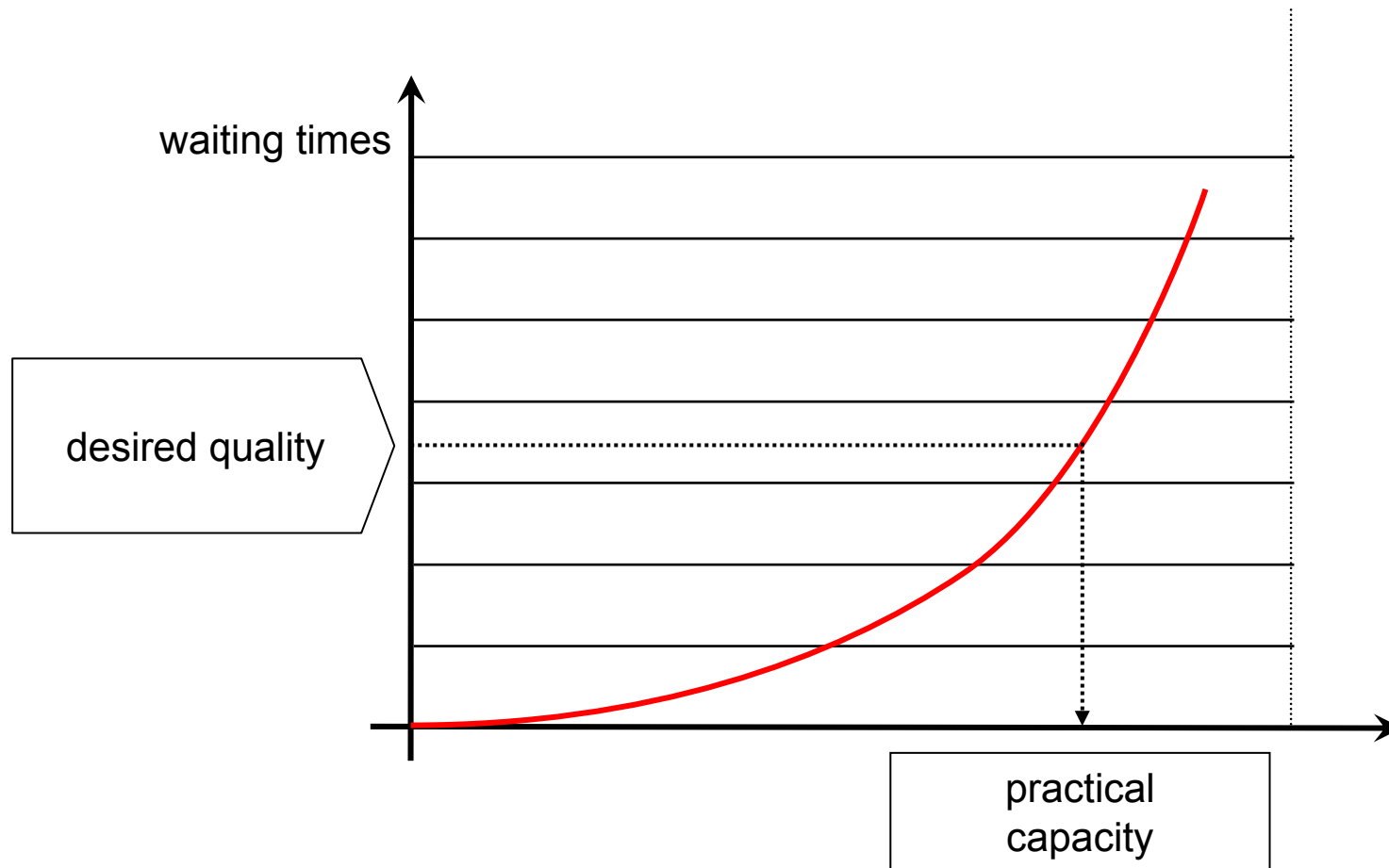
calculation of waiting times

example



waiting time and capacity

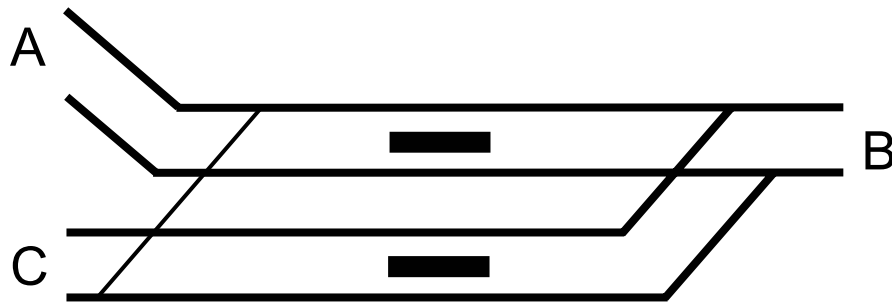
The calculation of waiting times is a condition for the determination of the capacity



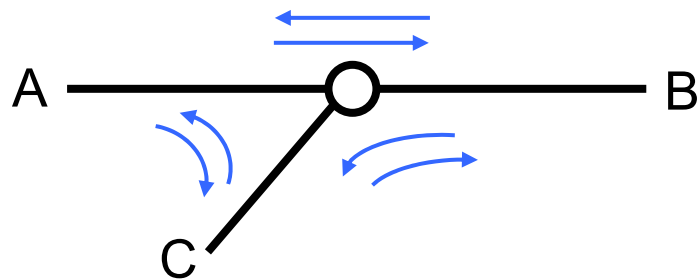
waiting times in nodes

input data

- infrastructure

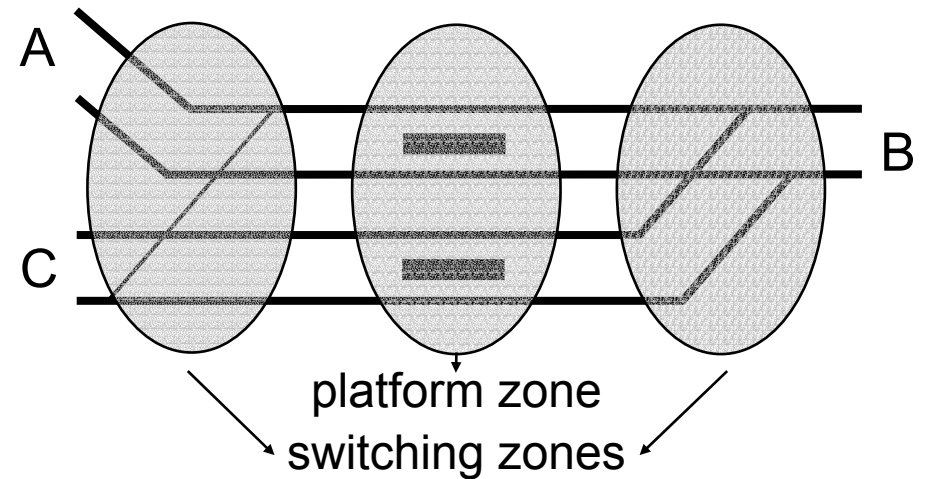


- flows in a node

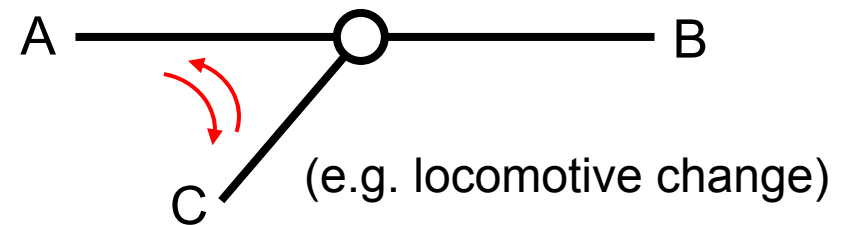


waiting times are produced

- load-dependant in 3 areas



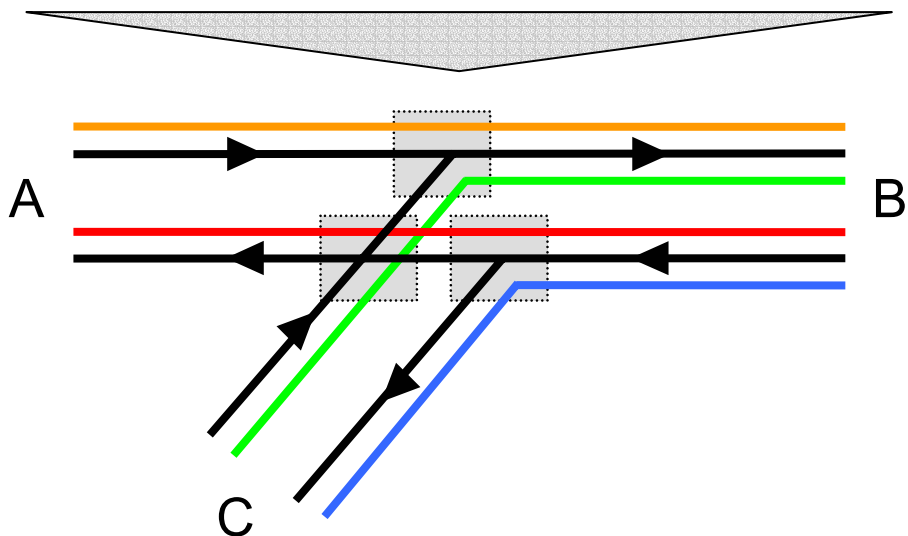
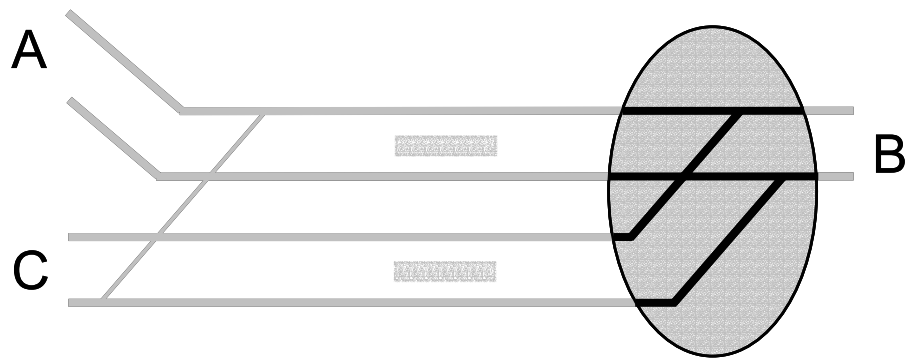
- load-independant



modelling infrastructure and network usage

input data

- infrastructure and flows



- matrix of flows

from \ to	A	B	C
A	—	3	—
B	2	—	4
C	—	1	—

- conflicts between flows

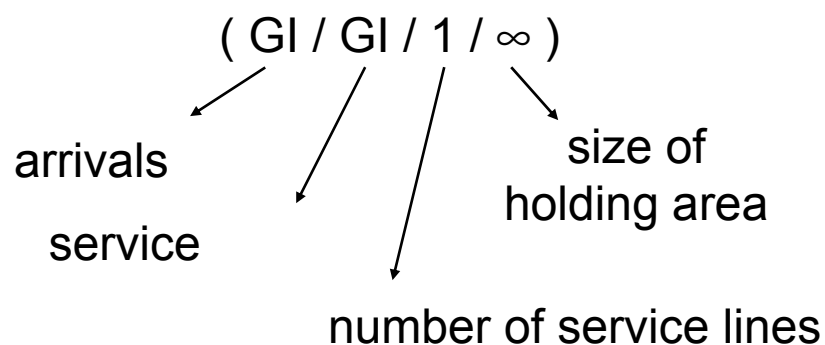
flow	interfering flows
1	2, 3
2	1, 4
3	1
4	2

calculation of waiting times for the switching zone

waiting time for the switching zone

- input data
- number of trains N
- coefficient of variation of the distances between arriving trains
- minimum headway

queuing theory



formula for waiting times

$$\sum_{\text{Züge}} t_w = \frac{N^2 \cdot \bar{z}^2}{Z - N \cdot \bar{z}} \quad t_{w,\text{Zug}} = \sum_{\text{Züge}} t_w / N$$

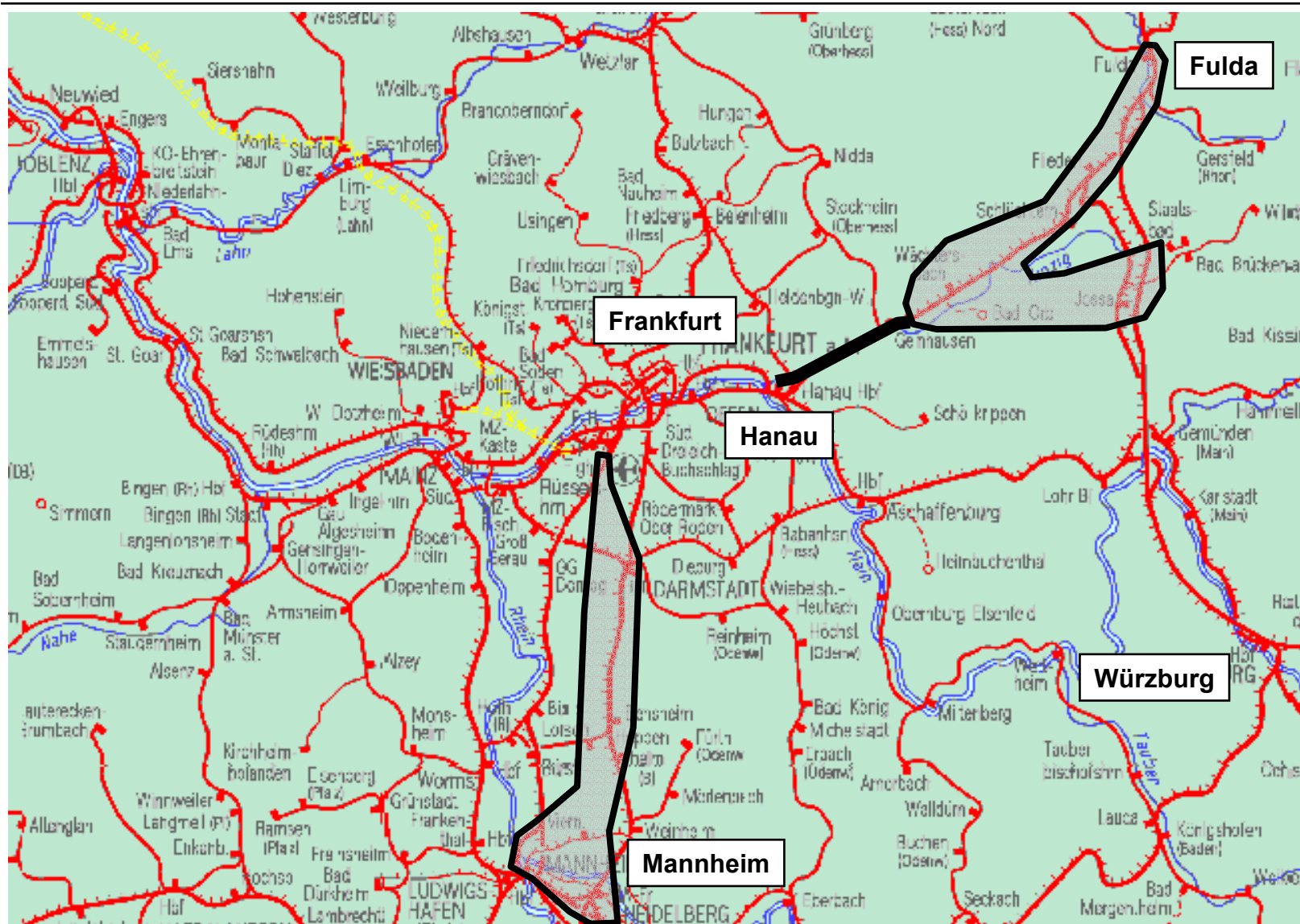
- t_w waiting time
- \bar{z} minimum headway
- N number of trains
- Z length of time segment

equivalent number of trains

$$\prod_j (1 - \rho_j) = 1 - \rho_v \Leftrightarrow n_v = \frac{Z}{\bar{z}} \cdot \left[1 - \prod_j \left(1 - \frac{n_j \cdot \bar{z}}{Z} \right) \right]$$

- ρ occupation of switching zone by flow
- n number of trains of a flow
- j index for interfering flows
- v index for equivalent interfering flow

future new constructions of DB complement the high speed network



the comparison of infrastructure and network utilisation identifies bottlenecks

