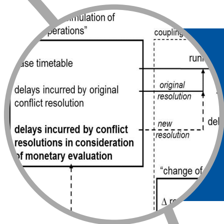
Monetary Evaluation of Dispatching Decisions in Consideration of Mode Choice Models

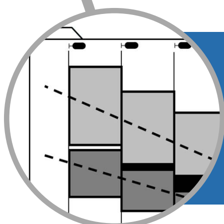
Dipl.-Ing. Marcel Schneider

Institute of Transport Science
RWTH Aachen, Germany

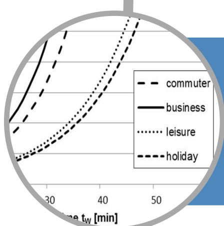
Agenda



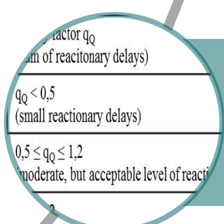
Problem Description and Methodology



Conflict Resolutions in Railway Operations



Mode Choice Model



Monetary Evaluation

Problem Description

- There are two process levels in railway operations research
→ timetable construction and **railway operations**
- Occurring conflicts between trains on the same route are solved according to the trains' **priorities**
- Aim of dispatching is the quickest possible restoration of normal operations
- The chosen dispatching decisions result in **reactionary delays** for minimum one of the involved trains
- These delays are used for an evaluation of railway quality
→ An acceptable sum of waiting times is defined and compared to existing waiting times (quality indicator)
- Limit is based on a survey of experienced dispatchers and only exists for strategic network planning and long planning horizons

→ The consideration of the impact on **end-customers** is missing

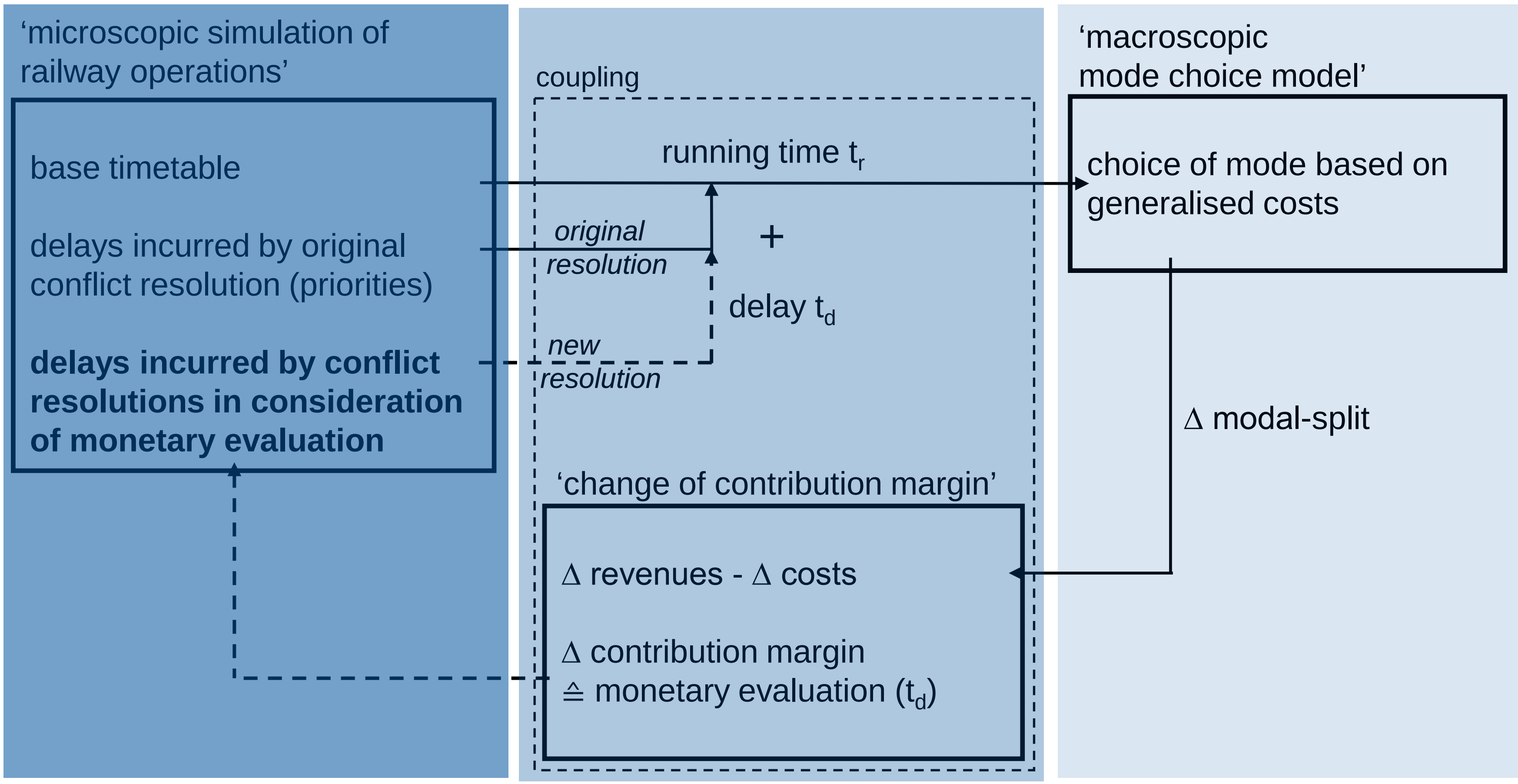
Problem Description

New approach:

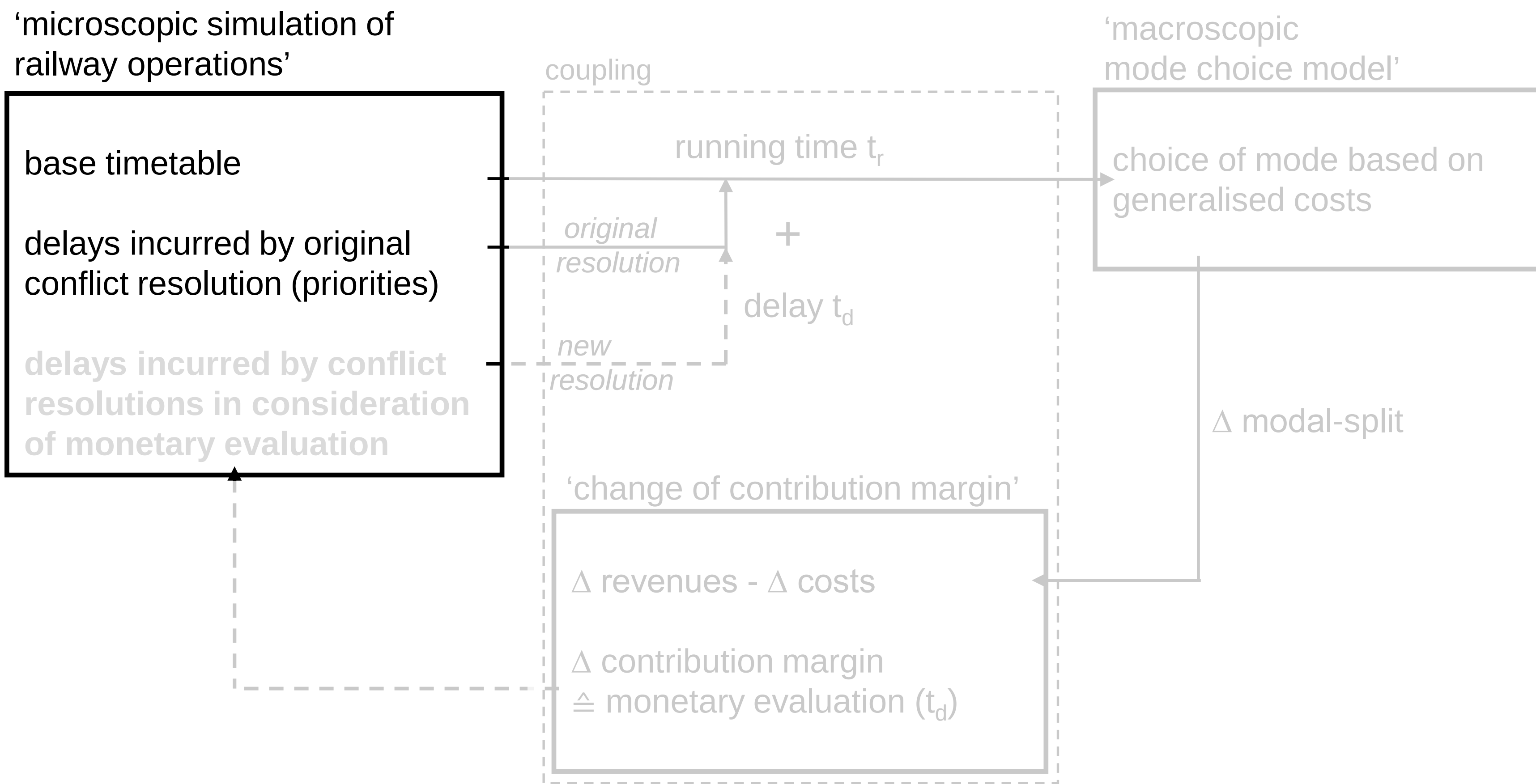
- Switch to single dispatching decisions (short planning horizon) with adaption of future dispatching decisions (long planning horizon)
- Consider the impact of delays on the end-customers expressed by **revenue** changes
- By linking to variable **costs** a **monetary evaluation** of dispatching decisions depending on different train priorities is achieved
- Consider monetary value for following dispatching decisions

→ **Coupling** of railway operations simulation and mode choice models

Methodology



Conflict Resolutions in Railway Operations



Conflict Resolutions in Railway Operations

Microscopic simulation of railway operations with input parameters:

- Infrastructure data (tracks, nodes, signals, paths, speed, overtaking tracks, …)
- train data (commercial type, speed, weight, **priority**, …)
- zero-conflict timetable
- delay characteristics of trains (probability of occurrence, average delay)

- Simulation generates delays based on statistical data for the occurrence and duration of delays of each train (bases on DB guideline 405)
  → saved in a disruptions list

- Occurring conflicts are solved according to train priorities
  (higher priorities are privileged)

Conflict Resolutions in Railway Operations

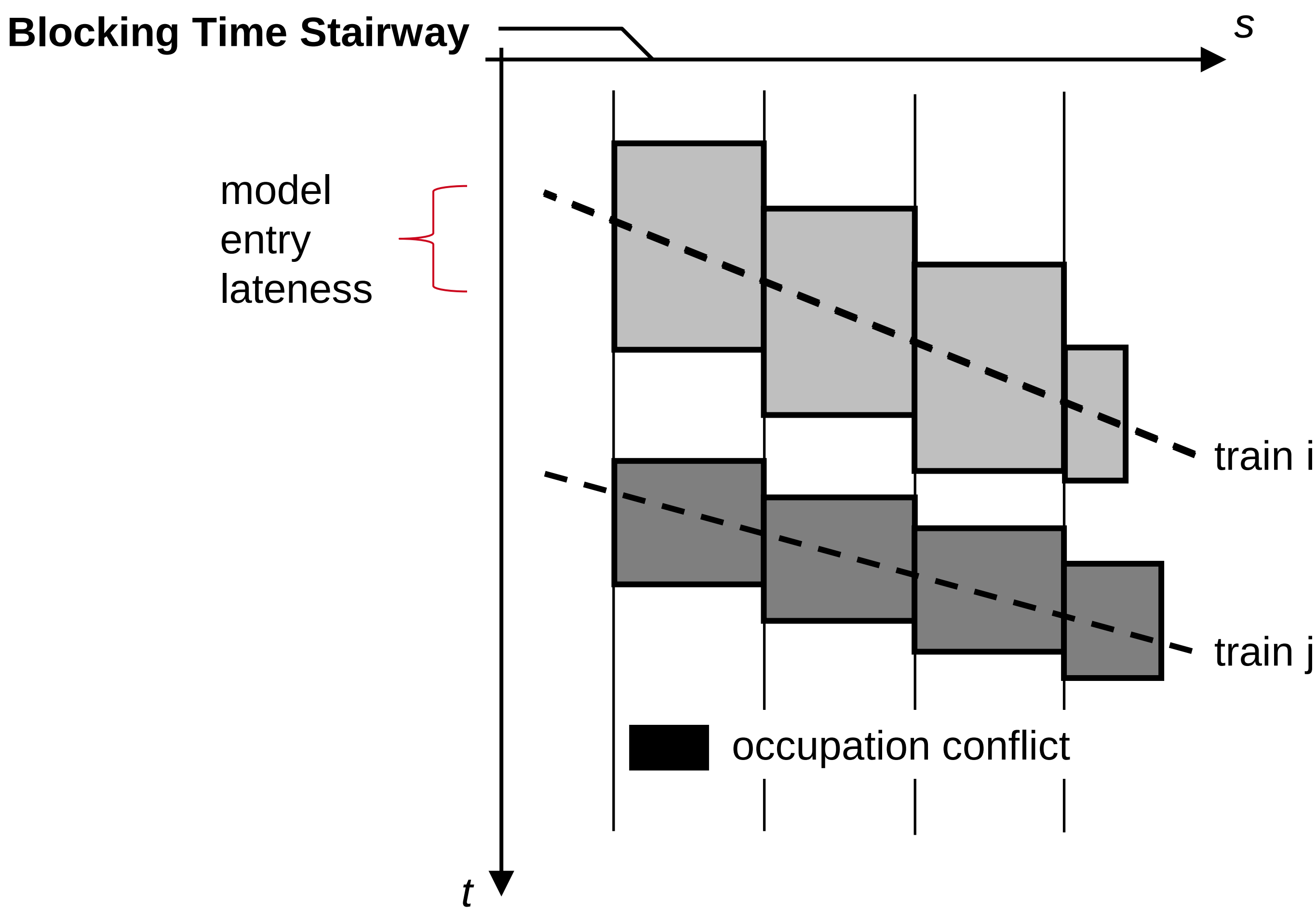
Different types of delays are considered

- model entry lateness
- initial delays
- reactionary delays

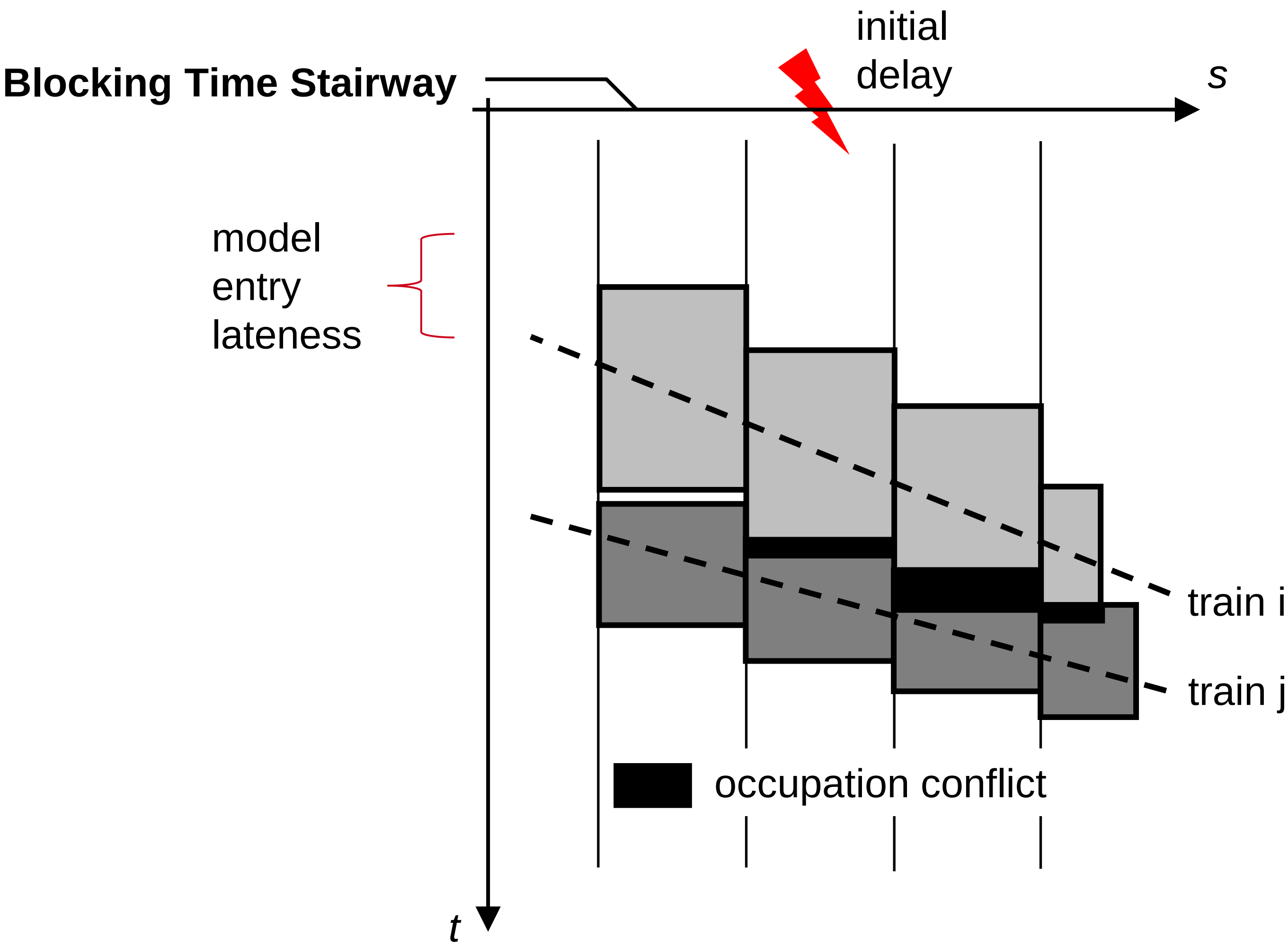
Exact location of delays is crucial

- at the nodes
- on the track (between two nodes)

Conflict Resolutions in Railway Operations



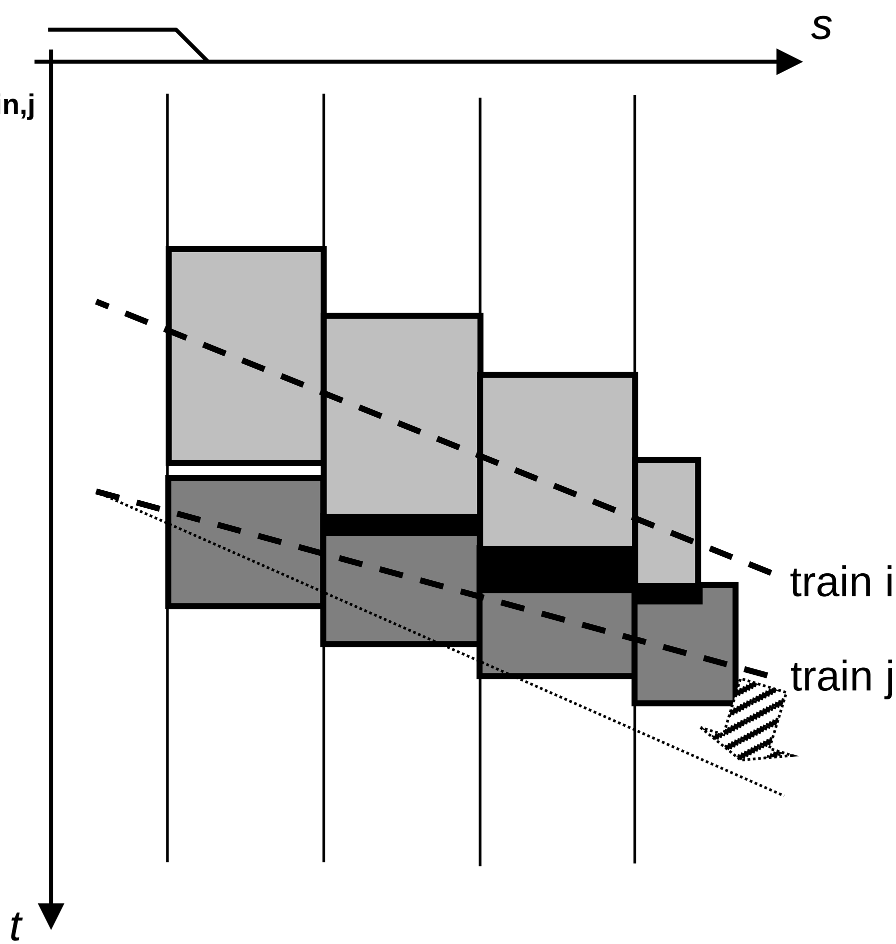
Conflict Resolutions in Railway Operations



Conflict Resolutions in Railway Operations

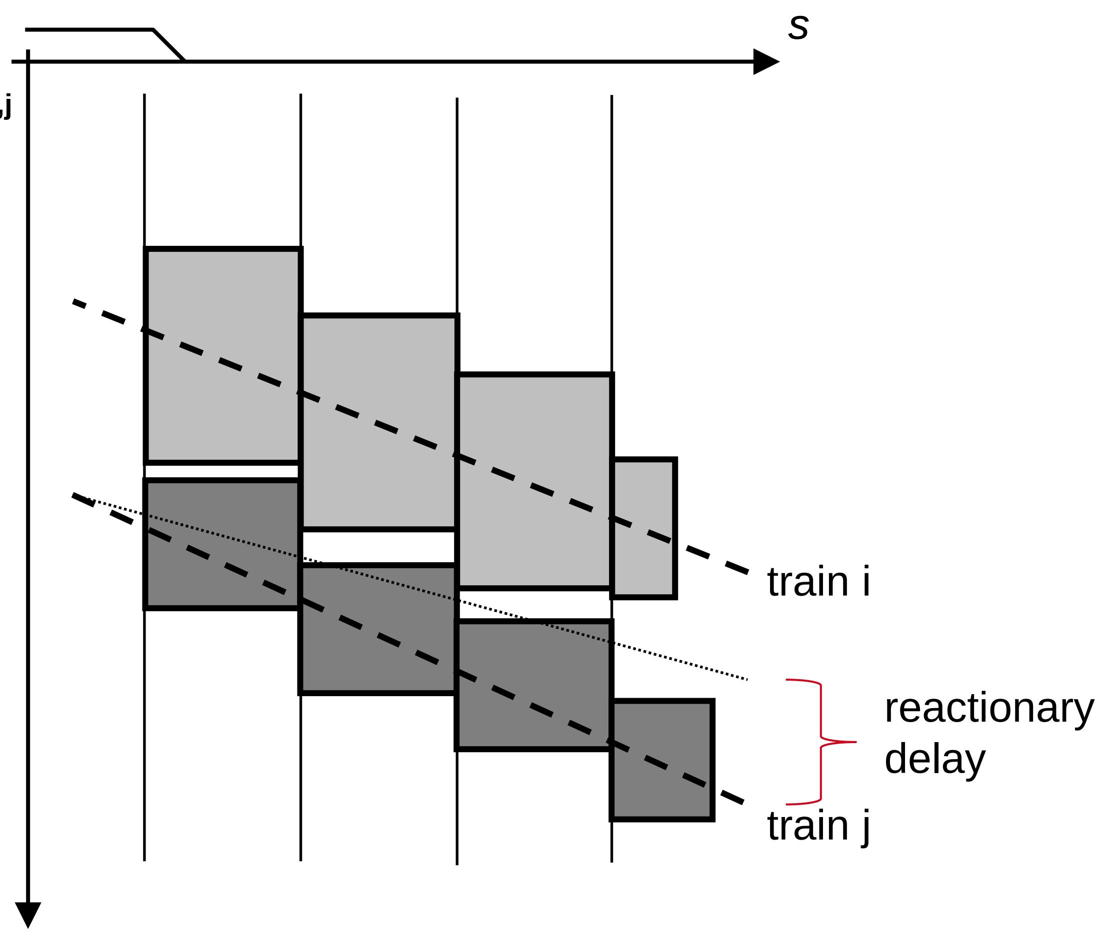
Example: bending

priority$_{train,i}$ > priority$_{train,j}$



Conflict Resolutions in Railway Operations

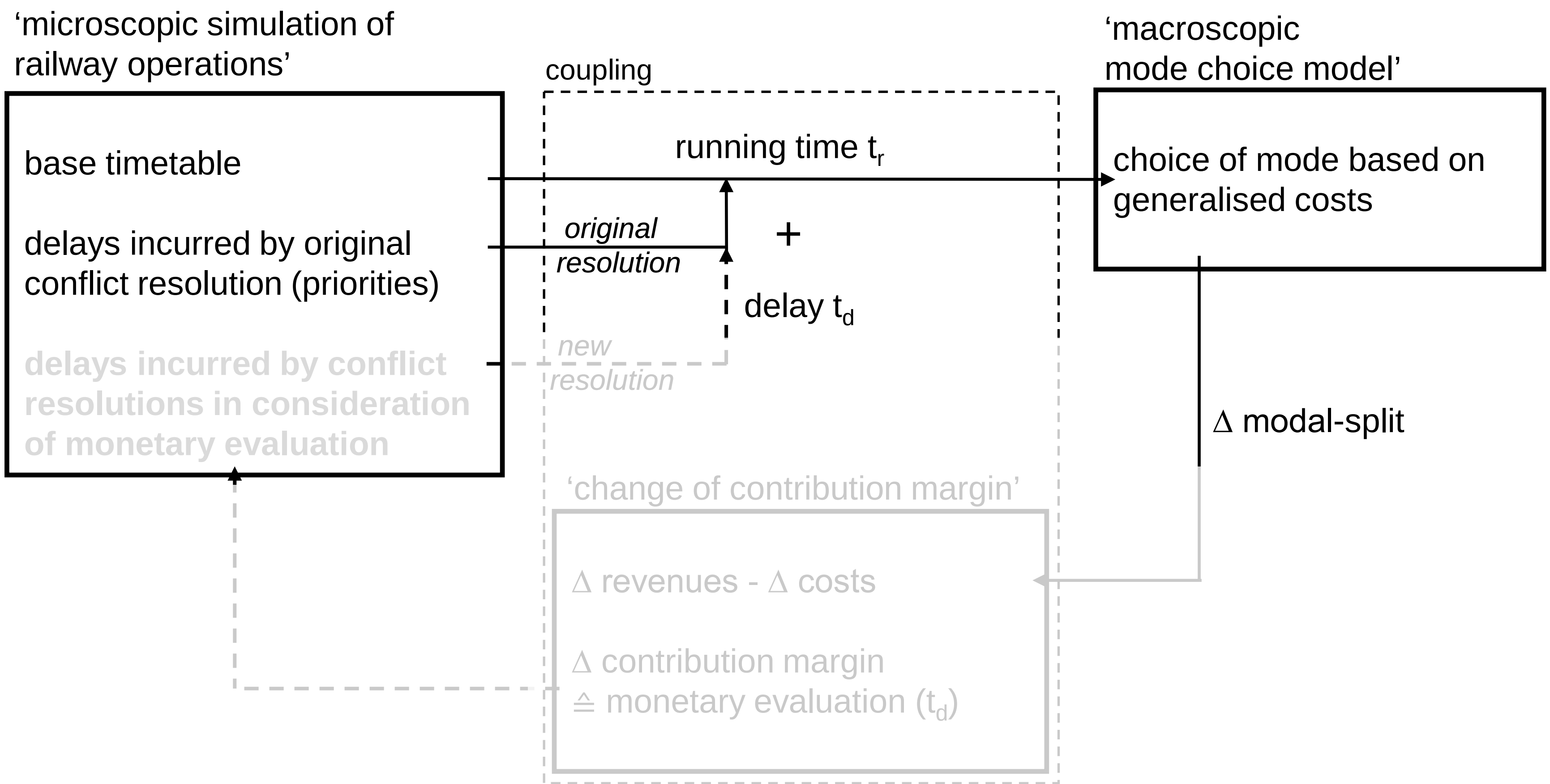
Example: bending
$\text{priority}_{\text{train},i} > \text{priority}_{\text{train},j}$



Other dispatching decisions:

- Shifting
- Longer dwelling time
- Overtaking stop

Conflict Resolutions in Railway Operations



Mode Choice Model

- Calculation of passenger or good demand
  in consideration of competitive transport modes (Modal Split)

- Applied mode choice model for passenger service based on traffic resistances

service parameter 'objective'

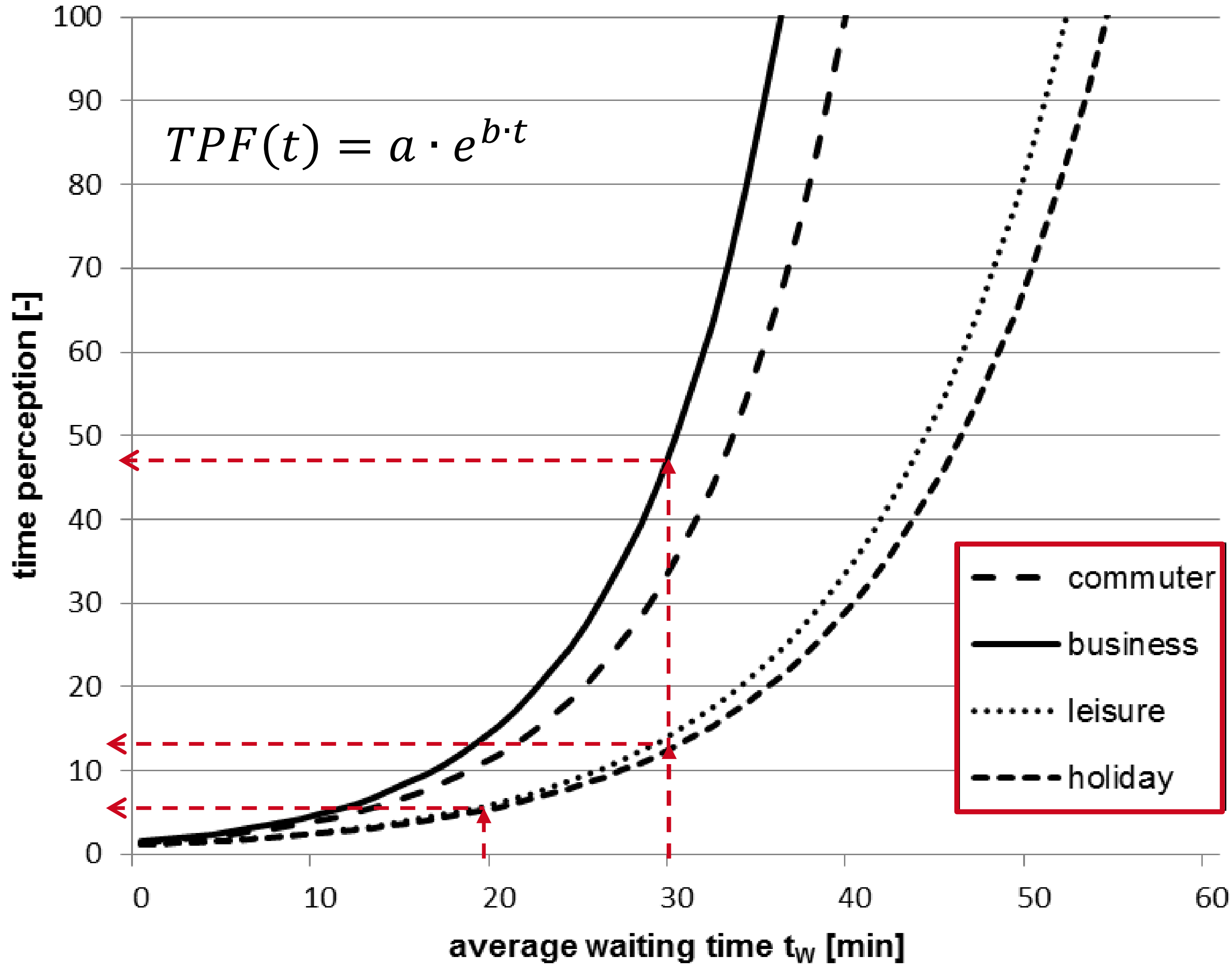
$$r = t \cdot TPF(t)\ [RU]$$

time perception function 'subjective'

- Curve of a time perception function

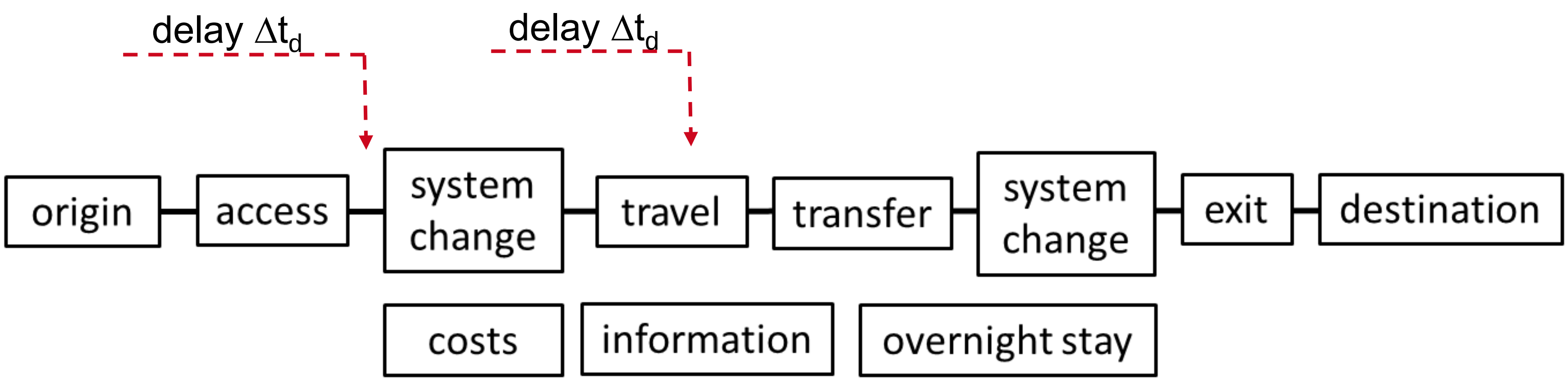
$$TPF(t) = a \cdot e^{b \cdot t}$$

Mode Choice Model – Long-Distance Journey



Mode Choice Model – Long-Distance Journey

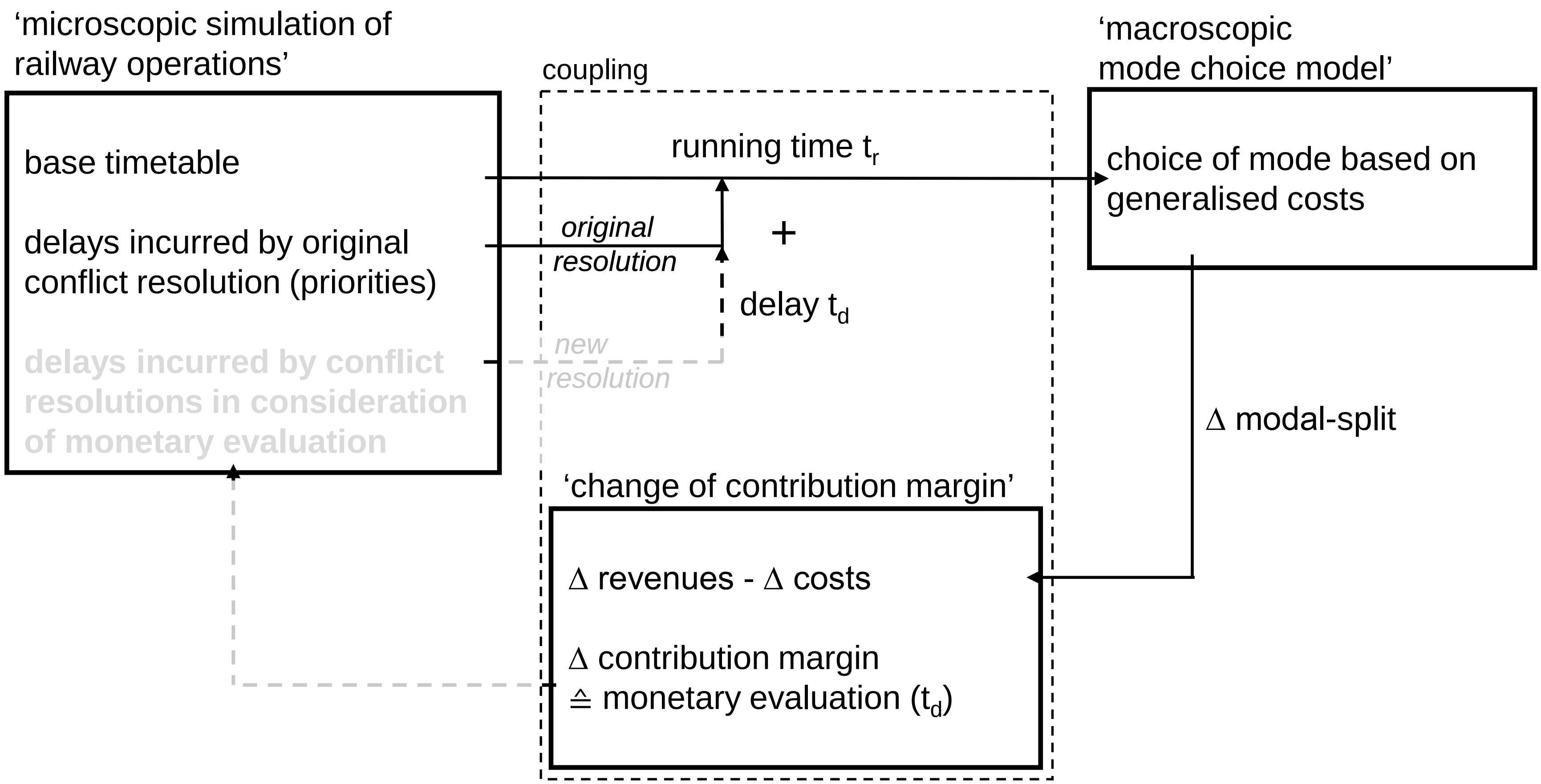
- Each part of the journey is represented by an individual resistance with appropriate perception



- There are different perceptions for waiting times on the platform or inside the train (exact location of delays is crucial)

- Each transport mode has its own chain of resistances

Monetary Evaluation



Monetary Evaluation

- Evaluation of dispatching decisions with appropriate delays depending on the assigned priorities

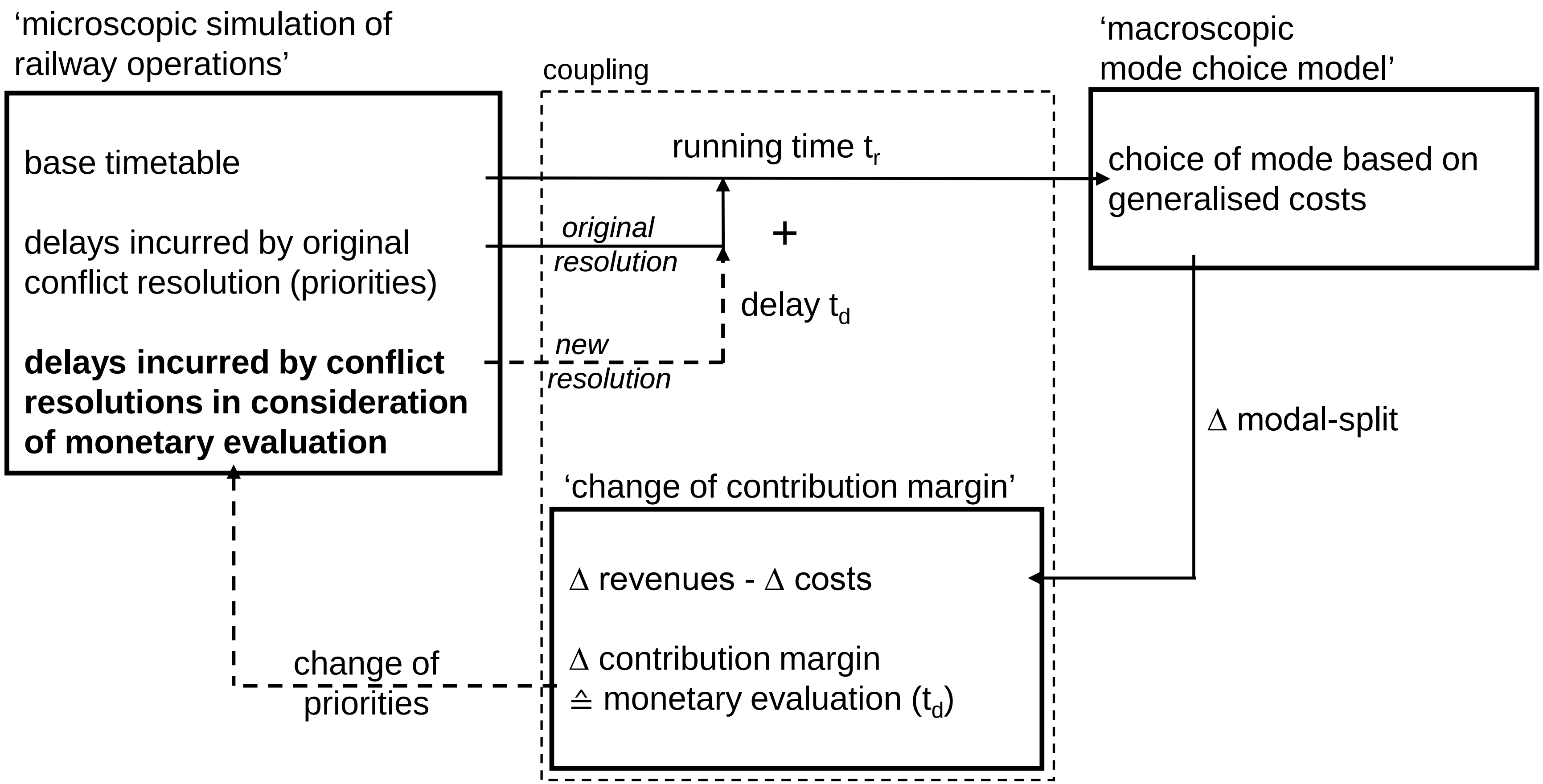
impact on revenues R for each train	impact on costs C for each train
route (number of seats and load factor) number of travellers travel purpose fare **modal-split**	amortisation of vehicle maintenance of vehicle energy consumption train crew **(time-dependent)**

- Evaluation in comparison to the zero-conflict timetable for each train j

$$\Delta CM_j = \Delta R_j - \Delta C_j = \left(R_{tt,j} - R_{cr,j}\right) - \left(C_{tt,j} - C_{cr,j}\right)$$

$$\Delta CM_{cr} = \sum_i \Delta CM_i$$

Monetary Evaluation



→ Optimal allocation of priorities what affects following dispatching decisions

Conclusions

- Coupling of simulation tools in railway operations and mode choice models
- Simulated conflict resolutions based on train priorities
- Resulting waiting times are evaluated by the end-customers
- Linking revenues and variable costs to the contribution margin
- Modification of train priorities leads to a change of the contribution margin as compared to the original timetable conditions

→ Optimal allocation of priorities with appropriate conflict resolutions
and minimised monetary loss