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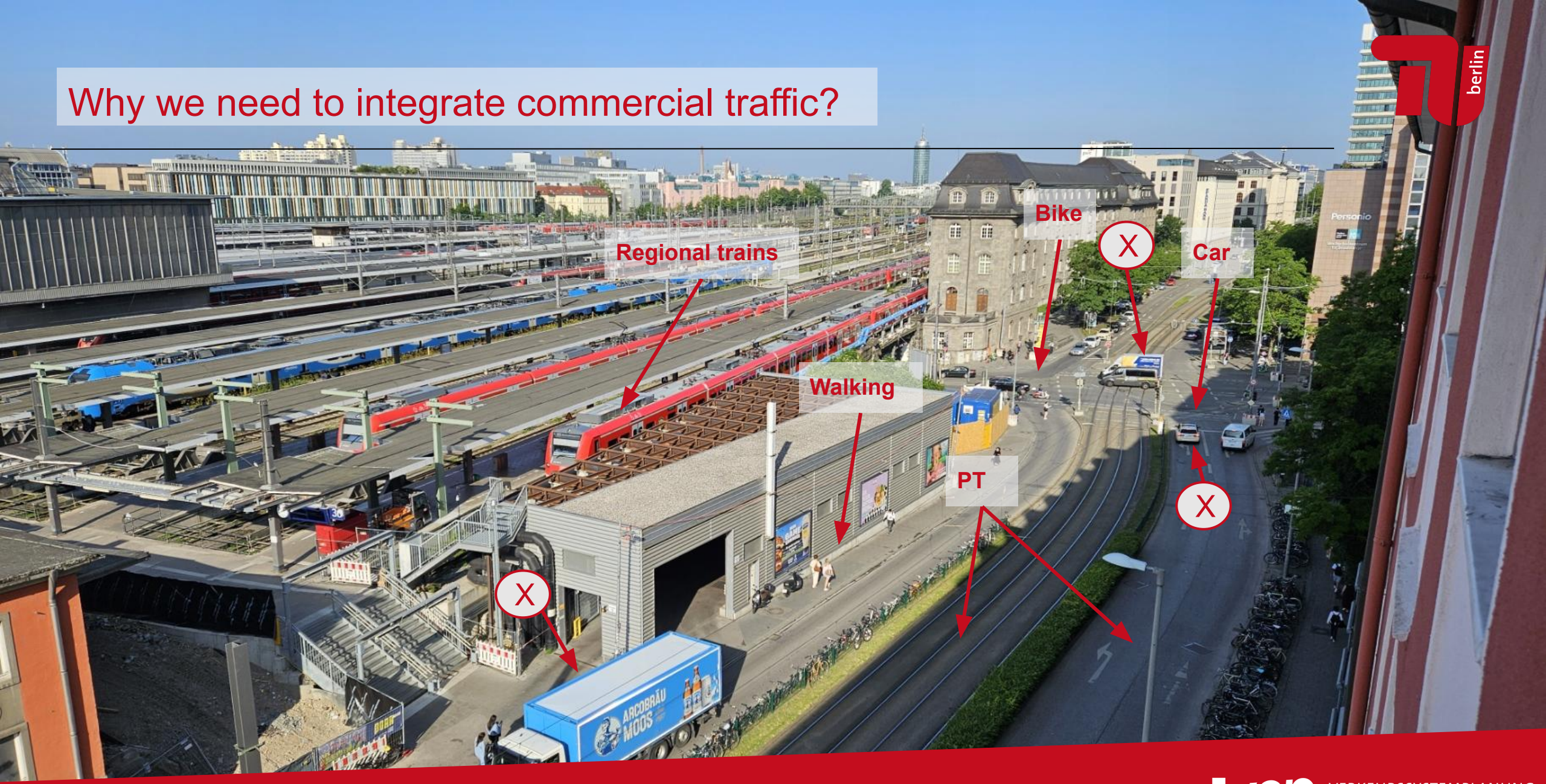
Agent-Based Modelling of the Complete Commercial Traffic: A Case Study for the Ruhr Metropolitan Area

Why we need to integrate commercial traffic?



Extended team for commercial traffic

- Phase 3: Commercial traffic
  - In cooperation with the Bergischen Universität Wuppertal
- Team:

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Ricardo Ewert (TUB)

Gregor Rybczak (TUB)

Prof. Bert Leerkamp (BUW)

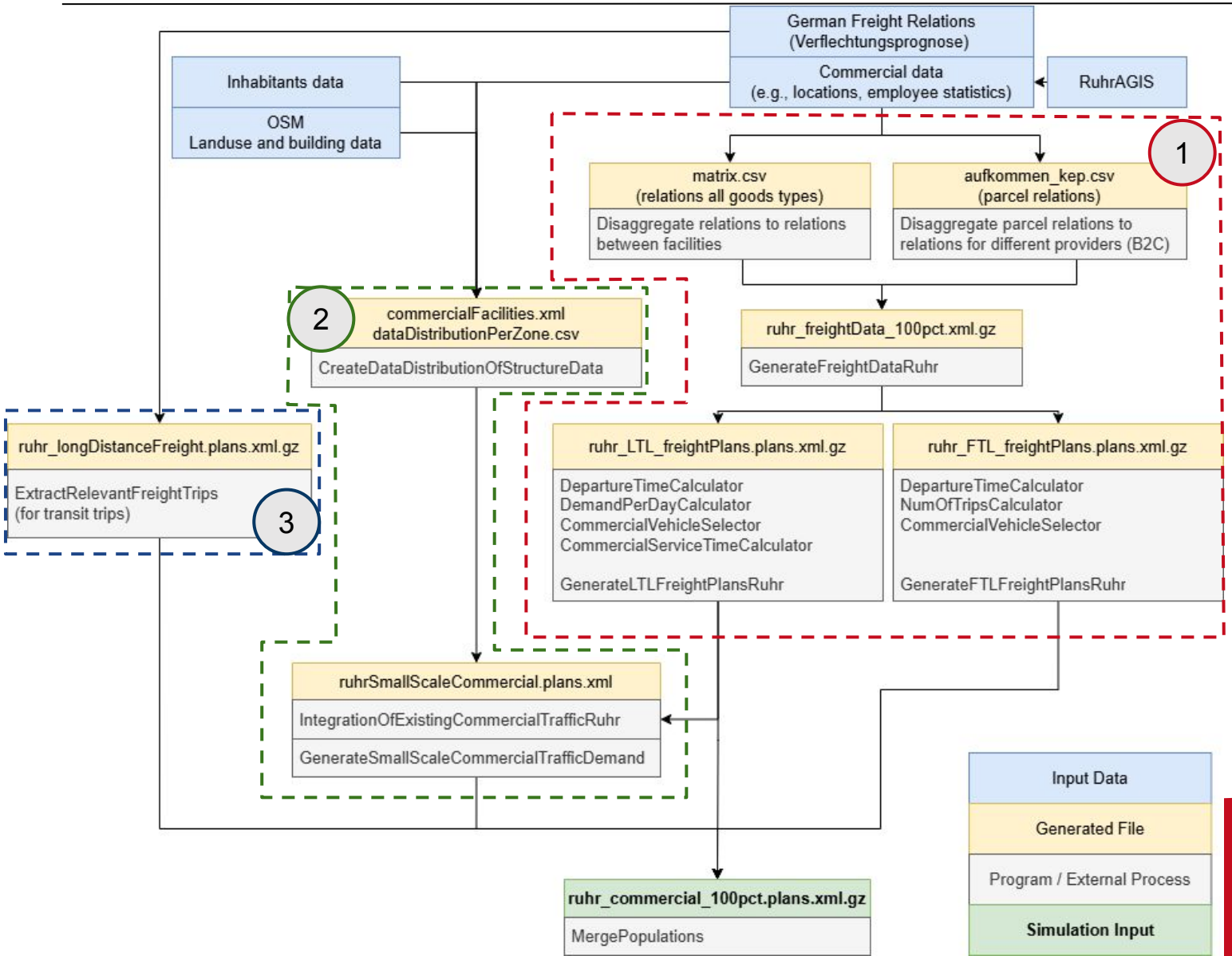
Andre Thiemermann (BUW)

Jan Kuchhäuser (BUW)

Basics - Agent-based traffic model

- **MATSim** (Multi-Agent Transport Simulation)
  - Open source software
- Basic idea:
  - People (agents) follow a **daily schedule**
  - **Daily schedule** consists of activities and trips to the activities
  - **Daily schedules** of the agents are executed in parallel
- Simulation maps an average working day

Overview of implementation



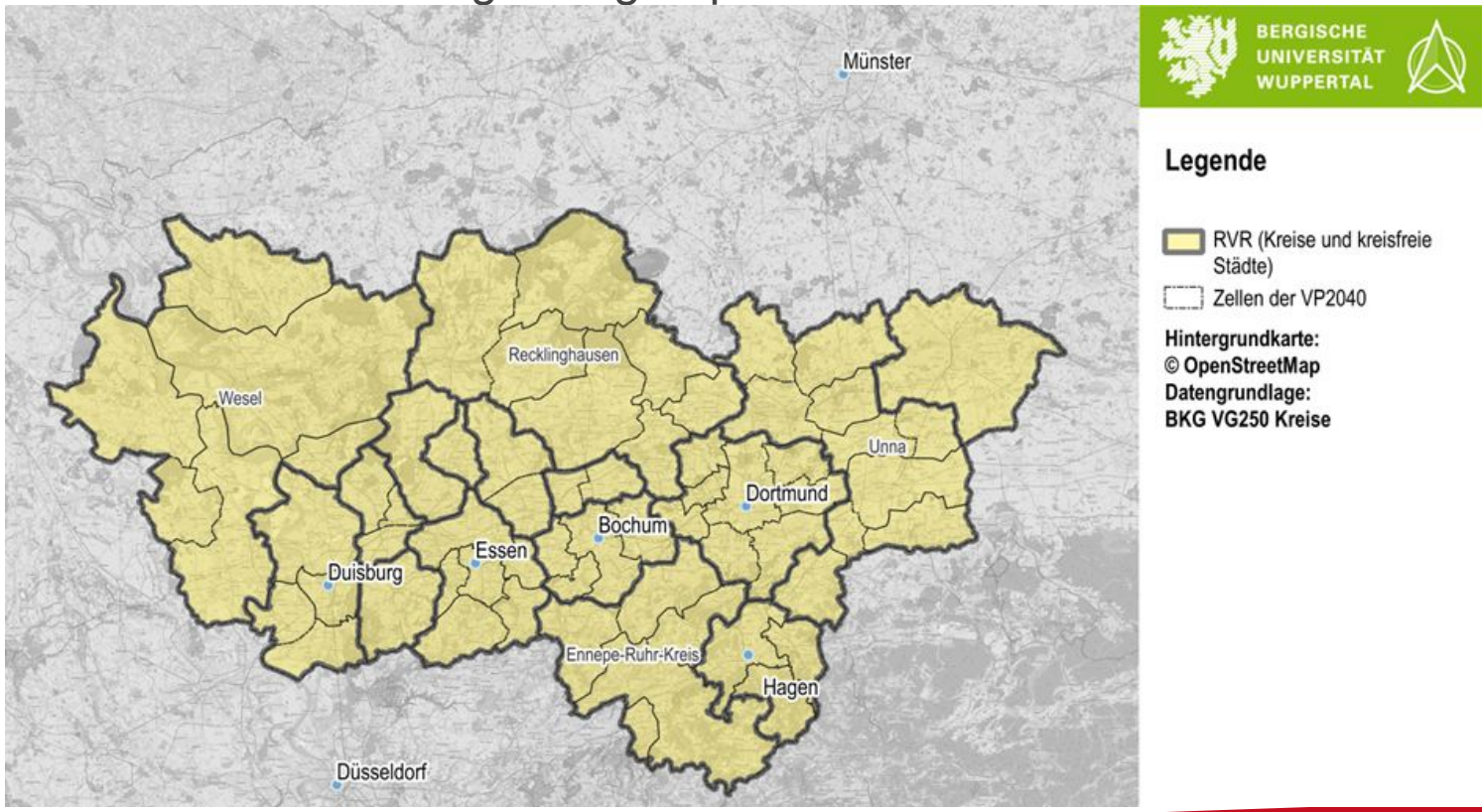
- Divided into 3 processes:
  - 1 Creation of freight transport routes
  - 2 Generation of small-scale commercial traffic
  - 3 Addition of transit freight traffic
- Subsequently, generated agents of the sub-segments are merged

Freight transport tours - disaggregation of freight flows

- Initial data: Forecast provided by the BMV (German Federal Ministry of Transport)
  - Contains annual goods volumes between cells for various goods groups
  - Forecast for 2040 contains smaller cells

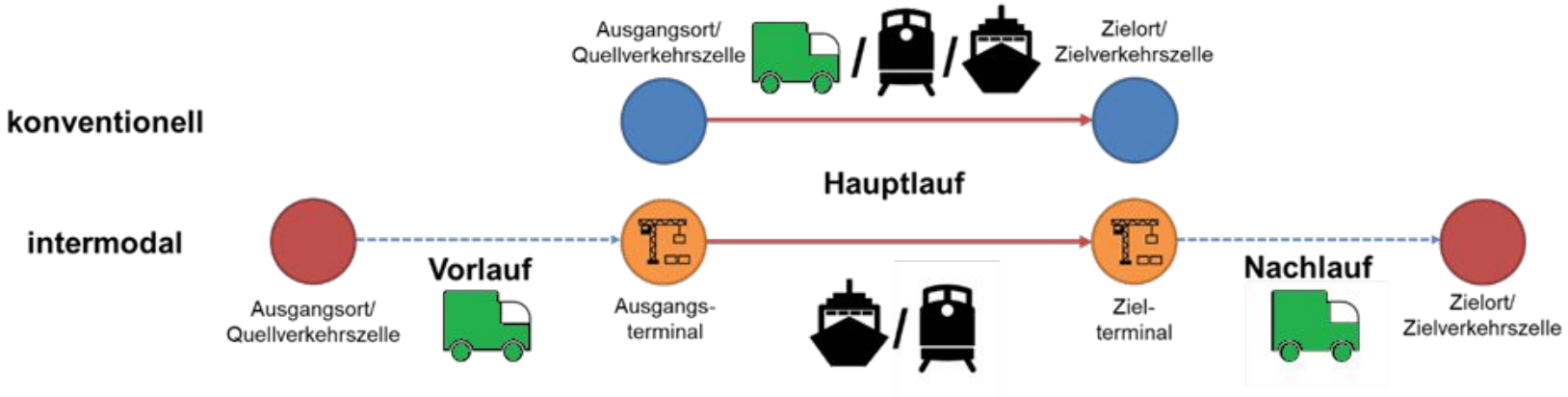
- As the 2040 forecast was announced to be published soon, we use the smaller cells

⇒ Need to disaggregate freight flows and assign them to precise locations



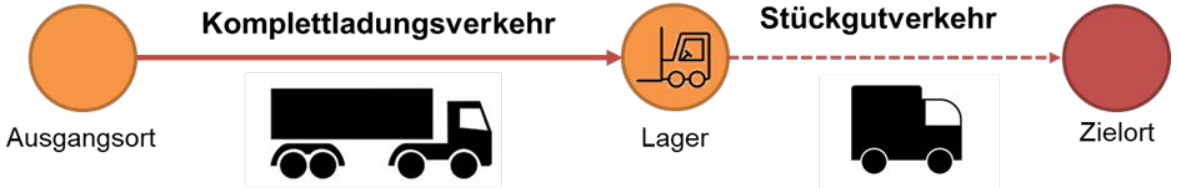
Freight transport tours

- Transport routes included



- Breakdown of the freight groups according to the various cargo transports

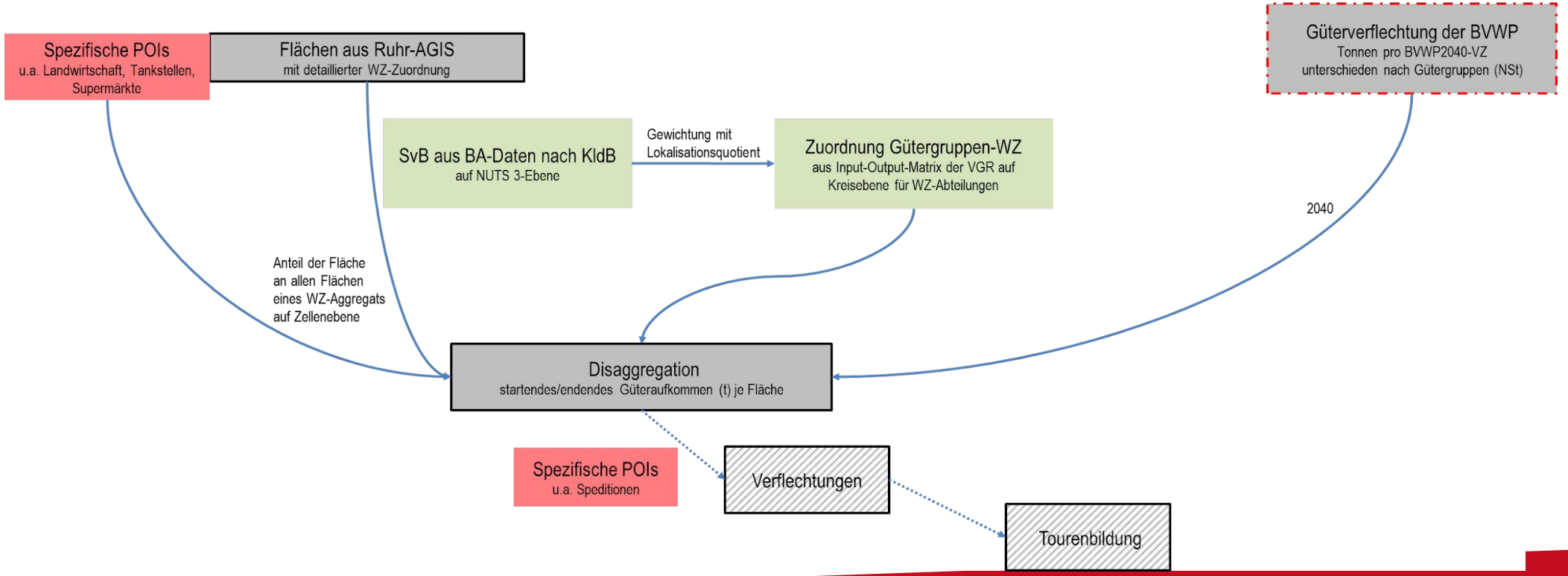
FTL (full-truck-load)



LTL (less-than-truck-load)

Freight transport tours - disaggregation of freight flows

- Methods of disaggregation can vary between freight groups as they are adapted to specific conditions
  - E.g. food, general cargo, hard coal

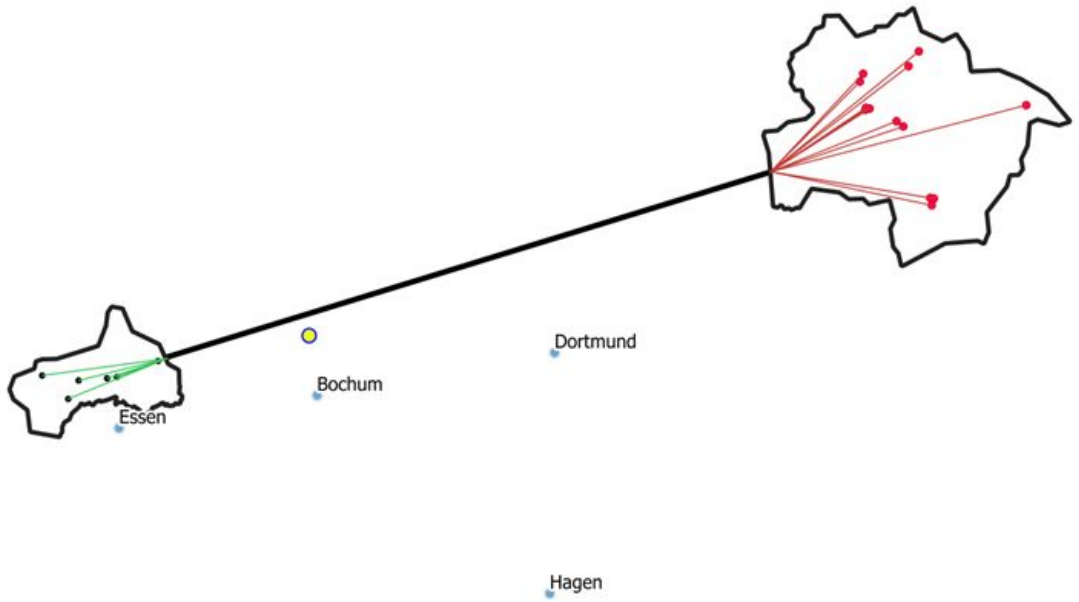


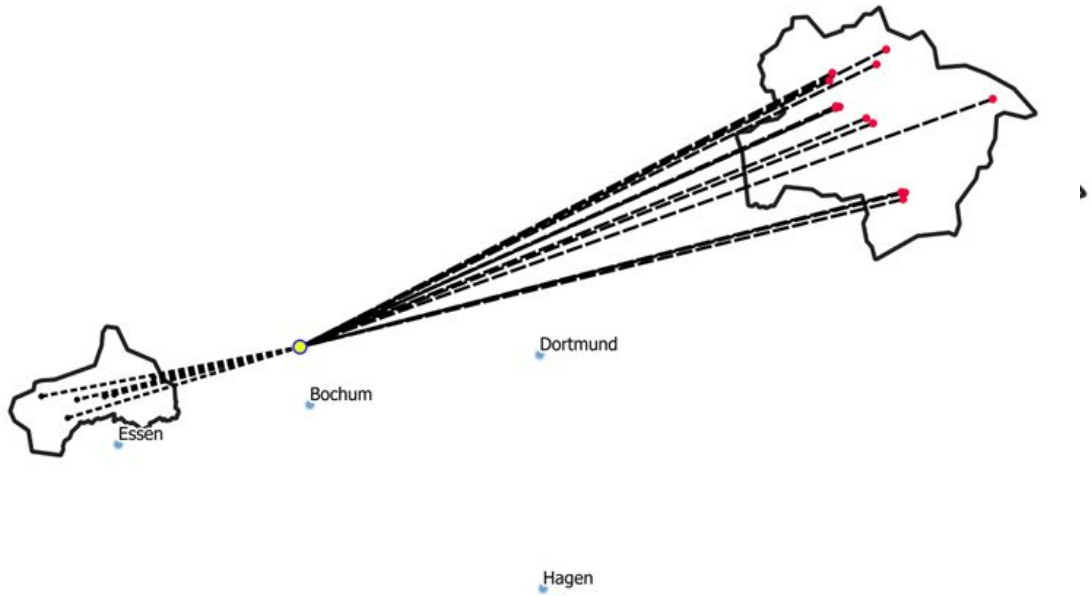
Freight transport tours - disaggregation of freight flows

- Allocation to exact company locations and filtering to relevant flows
  - Unrealistic number of OD-pairs resulting from n to n allocation is reduced by setting minimum volume

Freight transport tours - disaggregation of freight flows

- Example of LTL OD-pairs in food retailing
  - Allocation of the volume to retail companies and routing via company-specific distribution centers in fractional traffic





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Legende

- Verflechtung zur Lagerbelieferung (Komplettladungsverkehr)
- Verflechtung zur Filialbelieferung (Stückgutverkehr)
- bekannter Güterstrom zwischen Verkehrszellen
- mögliche ausgehende Verflechtungen
- mögliche eingehende Verflechtungen
- Gewerbestandorte mit relevantem Quellaufkommen
- Beispiellager
- zu beliefernde Filialen

Hintergrundkarte:
© OpenStreetMap
Datengrundlage:
ruhrAGIS
eigene Recherche

Freight transport tours - disaggregation of freight flows

- Analogous procedure based on the characteristics of the respective freight group in combined transport
- Parcel and waste demand based on households and including the various companies

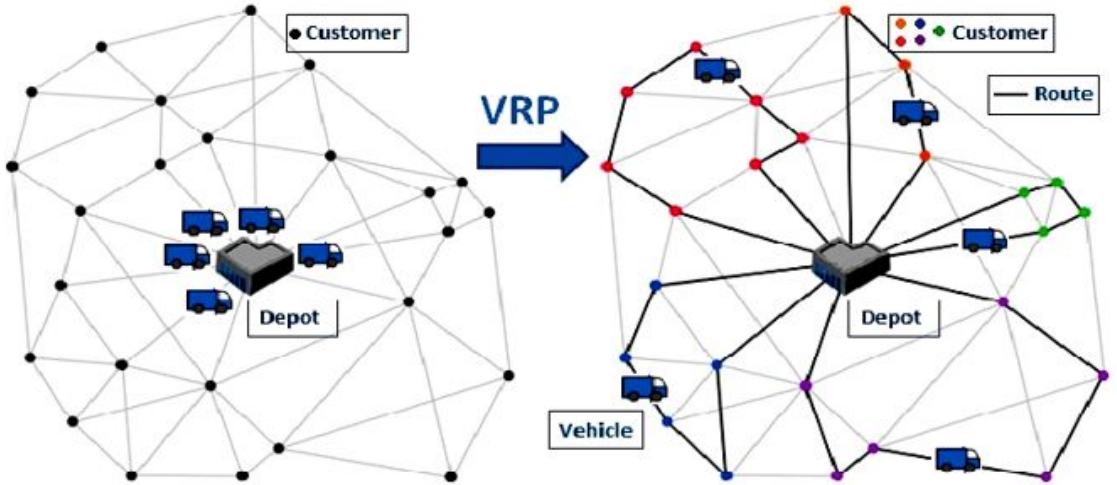
Result of the disaggregation:

- Annual volume of goods in t/a between all commercial companies in the study area
- More precise data basis when using the 2040 forecast

Freight transport tours - generation of daily schedules

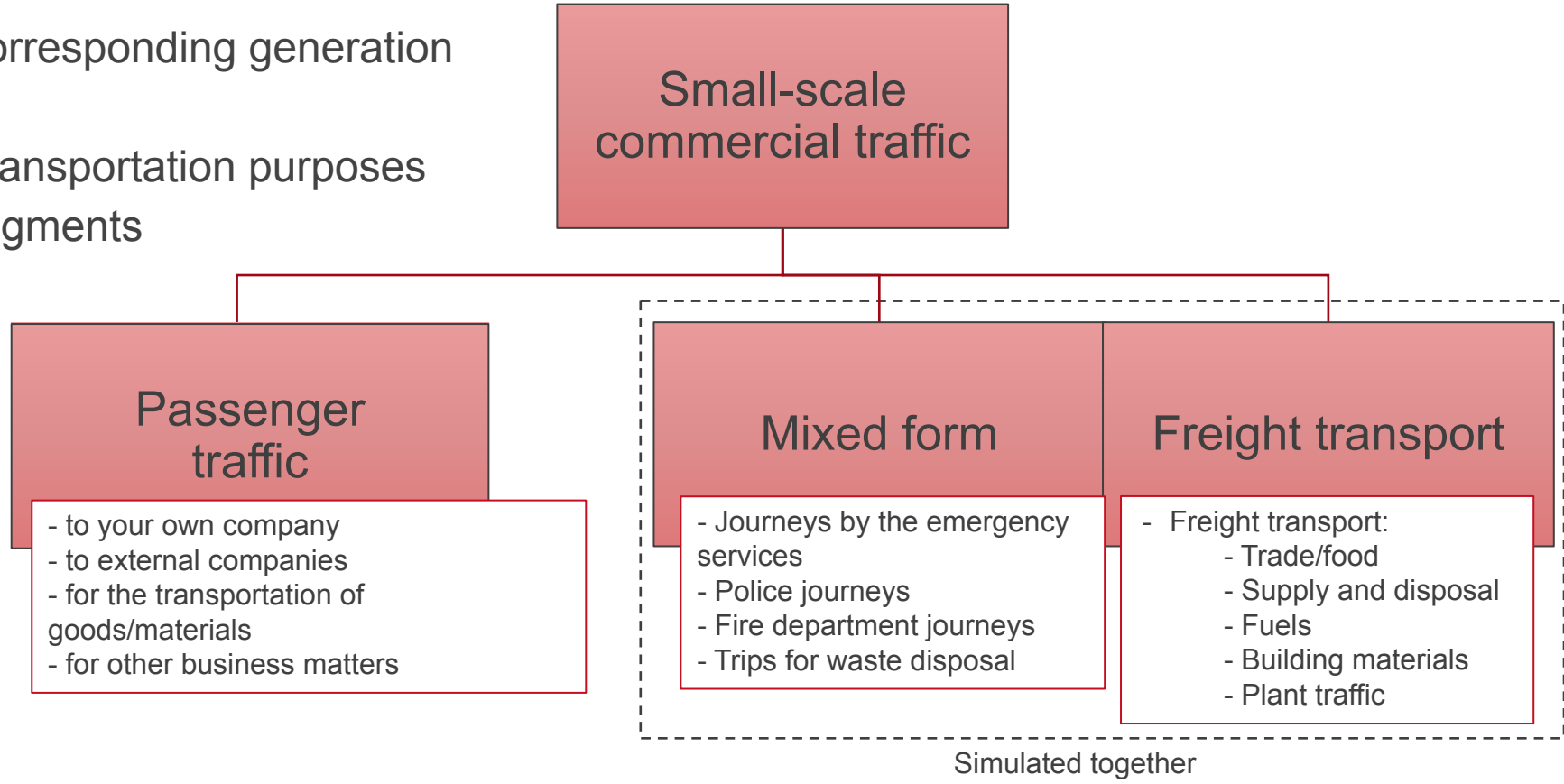
- Calculation of the daily volume of goods
  - Assumption of 260 working days per year (Mon.-Fri.) and an even distribution
- Allocation of plausible vehicle types using the corresponding payload
- FTL tours:
  - Calculation of the number of journeys per day as direct transport
    - for <= 200 km distance, empty return journey
    - for > 200 km distance, parallel empty run
- LTL tours
  - Automatic algorithm for creating and solving various vehicle routing problems (VRPs)
    - Calculation of stop durations
    - Definition of specific time windows

⇒ Daily schedules for representing the freight traffic



Small-scale commercial transport

- Based on structural data and corresponding generation rates for origin/destination
- Demand is "only" assigned to transportation purposes and not to specific economic segments
- Complete methodology see reference or MUM 2023
- Reduction of the volume by relevant LTL transports

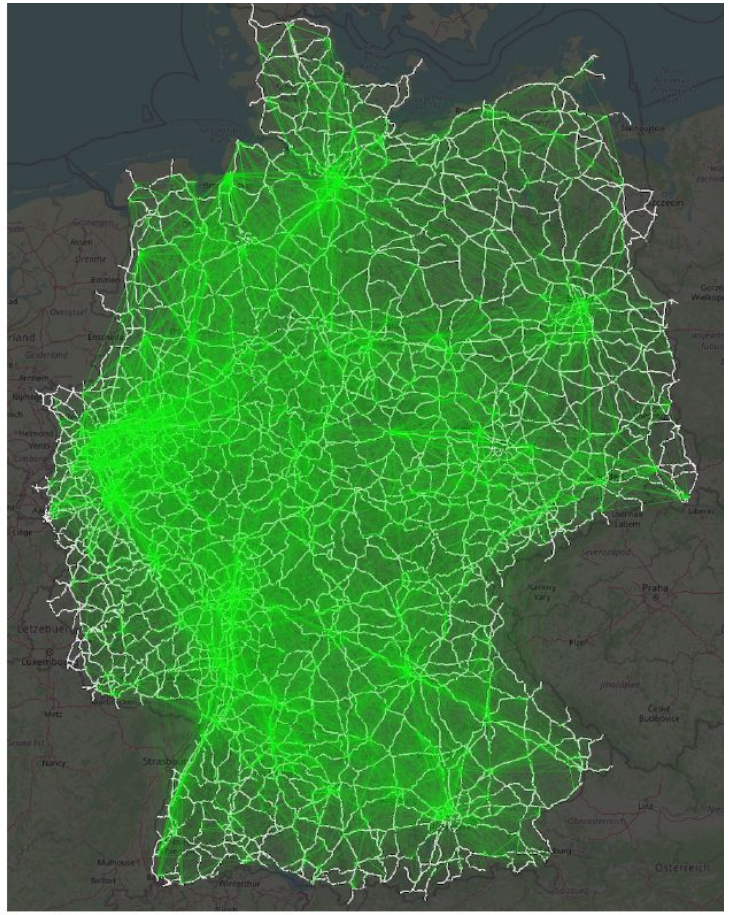


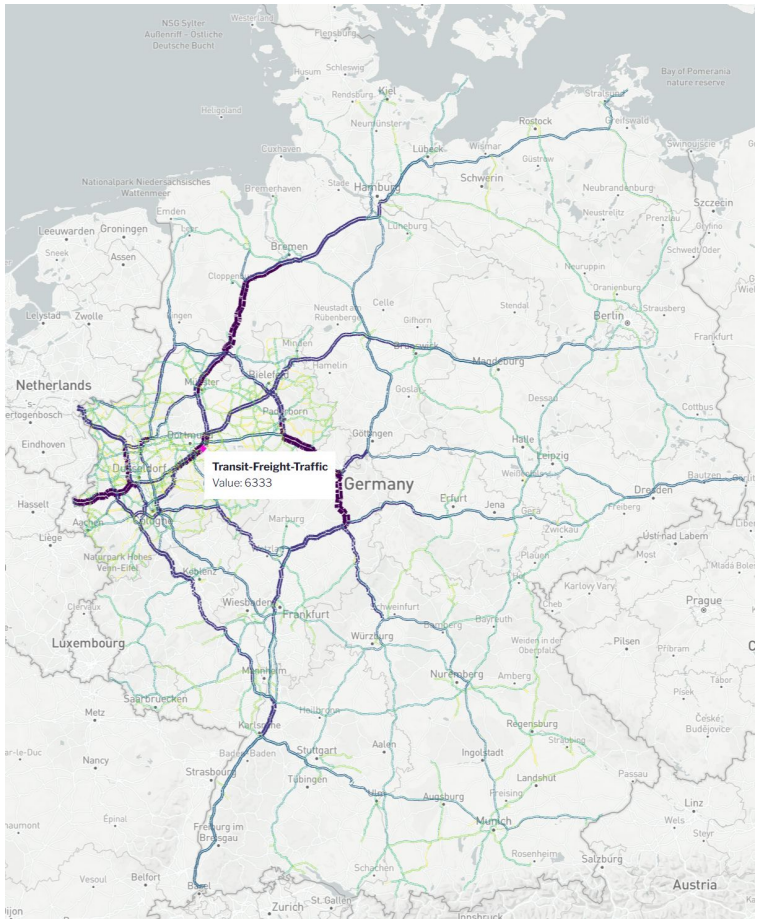
Reference: Ewert R, Nagel K. Agentenbasierte Modellierung des kleinräumigen Wirtschaftsverkehrs. In: Proceedings of Heureka 2024 [Internet]. Forschungsgesellschaft für Straßen-und Verkehrswesen; 2024. Available from: https://verlag.fgsv-datenbanken.de/tagungsbaende?kat=HEUREKA&p=3&tagungsband=2530&_titel=Agentenbasierte+Modellierung+des+kleinräumigen+Wirtschaftsverkehrs

Transit freight traffic

- Identification and extraction of all journeys that cross the Ruhr area without having any activity there

- Implementation as FTL journeys





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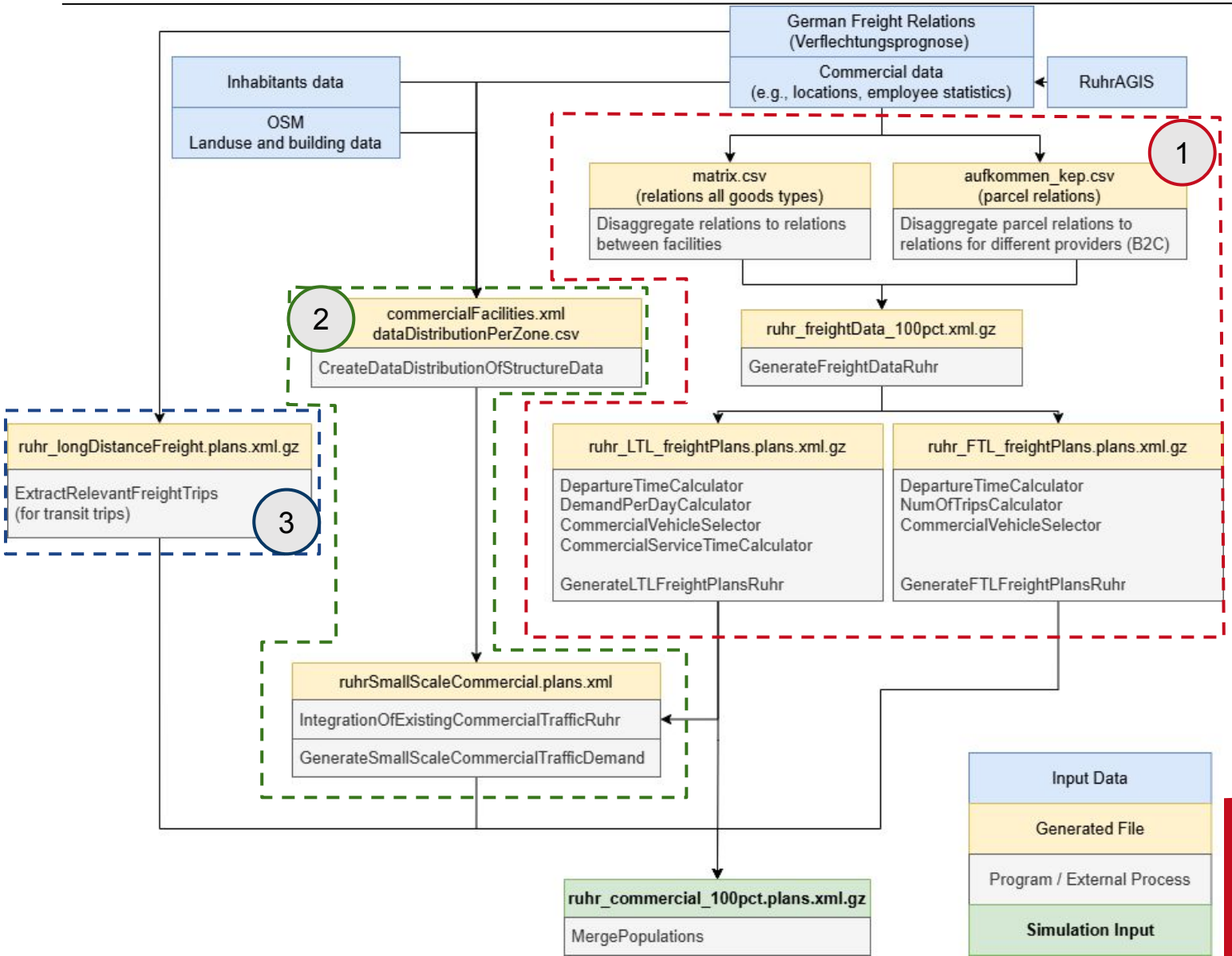

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Ruhr commercial traffic model

Dashboard with relevant results of the commercial traffic model

- Traffic volumes
- Presentation of vehicle routing problems (VRPs)
- etc.

https://vsp.berlin/simwrapper/public/de/metropole-ruhr/dashboards/metropole-ruhr-v2.0.commercialTrafficDashboad/

Outlook

- Wide range of possible use cases (also in connection with the passenger transport model) and potential for future studies
  - Decarbonization; charging infrastructure
  - Resilience of the transport infrastructure
  - Spatial planning in relation to commercial transport

- Potential for further development
  - Integration of specific vehicle fleets
  - Differentiation of goods groups in connection with their transport logistics treatment
  - Utilization of more detailed goods classifications for improved destination selection
  - More precise relations (also through new data; VP2040)

Thank you for your interest

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