Algorithmic Mechanism Design

Coordination of Carriers in Retail Logistics

Goal

- Efficient coordination of carriers at low transaction costs.

Problem

- BGL survey among more than 500 transport companies, 18% of them have an average waiting time of more than two hours and 51% have an average waiting time between one to two hours at each warehouse.
- Uncoordinated planning of carriers as a main reason.
- Current time slot management systems (FCFS) fall short of expectations. High prices and low adoption rates.

State of the Art

- Substantial research on vehicle routing problems for carriers.
- Application of cooperative game theory under complete information.
- Information sharing about waiting times as a possible remedy.
- Traditional mechanism design suggests Vickrey-Clarke-Groves (VCG).
- Algorithmic mechanism design and the MIDR principle.
- Bidder-optimal core-selecting mechanisms as alternative.

Challenges

- Development of economic mechanisms where carriers express their preferences for various routes and respective time slots and the mechanism assigns time slots to carriers.
- Even if participants were truthful, the coordination problem involves a number of hard computational problems.
  - Multi-depot vehicle routing problems with uncertain service times or time-dependent routing problems.
  - Multiple knapsack problems of the central coordinator.
- Manipulation leads to high transaction costs for bidders. Economic mechanisms should avoid strategic manipulation and set incentives for truthful bidding.
- VCG induces dominant strategies, but is not applicable with suboptimal solutions.
- We plan to develop new or extend existing approximation mechanisms for the coordination of carriers at loading docks.
- Various related problems in MS/OR:
  - Tactical capacity and workforce planning problems under uncertainty

Available Data

We have received data from one of the leading German time-slot management systems in the retail industry.

Projects

- Coordination via auction mechanisms
- Coordination without monetary transfers (matching)

Selected References
