A pick-up and delivery problem with hubs and a heterogeneous fleet

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Reference
Grunert T., Sebastian H.-J., Planning Models for long-haul operations of postal and express shipment companies, *European Journal of Operational Research*, Volume 122, 2, 2000, 289-309.

Abstract

The problem to be solved is a variant of the *pickup and delivery problem*. In this problem, a fleet of vehicles must be assigned to a set of demands in such a way that all the demands are met. A demand for delivery is characterized by the quantity to be delivered, the location where the product is picked up and the location where it must be delivered. One must determine an optimal collection of routes covering all the demands, in which the pickup and delivery of a given demand are assigned to the same route and the pickup occurs before the delivery. One must also take into account constraints on the capacities of vehicles and the time windows for pickup and delivery.

In this project we will consider a variant of the problem that has received little attention. It is possible to split a demand for delivery into several demands by introducing potential hubs. For instance, if a product has to be sent from location A to location B, one may replace this demand by a demand from A to H and another from H to B (where H denotes the hub). The delivery of a given product may then "use" several routes, and it may be possible to gather a fairly large quantity at a given hub before delivering the products to an isolated location (for instance). Of course hubs have been used for a long time in the air transportation industry; they help reduce the costs incurred by the airlines.

The classical pickup and delivery problem has been studied for many years and researchers have proposed exact and heuristic methods for solving it. In practice, the problem instances are large, and most of the time, heuristic methods must be used. We are trying to develop new solution approaches for the pickup and delivery problem with hubs. Here are some of the approaches that could be explored:

- A pre-processing approach whereby some demands are split into demands going through a hub. This approach is interesting because solving the transformed problem won't consume a lot of time. On the other hand, it is not easy to choose the locations of the hubs and determine the new time windows;

- A post-optimization approach whereby new hubs are inserted into the existing routes. This approach could produce good results but the associated computing time might be fairly large;

- A global approach based on mathematical programming. This approach might not be realistic, given the size of the problems arising in practice.