Freight Exchanges and Carrier Operations: Issues, Models, and Tools

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Electronic business has already a significant impact on transportation and logistics activities and this impact is expected to continue to grow at a steady pace. The emergence of electronic market places for freight loads (containers, truck loads, etc.), in particular, promises to modify the way carriers and shippers interact and do business. In this paper, we address some of these issues from a carrier point of view.

A market place is a building or any other physical location where many sellers and many buyers meet to trade goods, services, or money, that is to “discover” what is on the market, agree on prices, and strike deals. In an electronic-business environment, these meeting places are virtual (but the transactions are not less real) and are called e-markets, or e-marketplaces or e-exchanges.

Freight exchanges bring together shippers that have loads to move and carriers that look for loads to transport. Shippers have technical and service requirements such as the need for specialized vehicles and due dates. Within these parameters, shippers desire to have their loads moved at the lowest cost possible. Carriers, on the other hand, aim to make a profit out of their operations and thus desire to obtain the highest price possible for each load. The object of shipper - carrier negotiations is thus the price to move a certain load or group of loads, given the quality and service requirements of the shipper.

A carrier has two questions to answer when dealing with freight exchanges: 1) What loads am I interested in? and 2) What bidding strategy to follow for each load or group of loads? To answer these questions, carriers have to refer to their own operating cost and profit.
formulae and to address the relations between the loads on the market and the management of their fleet and personnel. Indeed, at each moment, a carrier has a number of vehicles in the field, moving either loaded towards a receiving customer or empty towards a loading point, a depot or a repositioning location in view of forecast demands. In the same time, other vehicles are waiting at various locations for their next operation. Meanwhile, drivers are subjected to rules and regulations concerning their working periods and the moment they have to return to their respective home bases. Any load accepted, from a “traditional” source or a freight exchange, has to fit into the operations of the carrier and contribute to its profit. The evaluation of the profitability of a load may thus be a quite complex process, involving the planning of the fleet for the current period and a certain time horizon.

Two factors may complicate this process further. First, the combinatorial nature of the carrier operations and, thus, the evaluation problem. Indeed, a combination of loads is often more valuable to a carrier than the individual loads. Thus, the value of a load that replaces a planned empty repositioning movement (while still bringing the vehicle at the desired location and time) is higher to the carrier than the simple revenue of the operation. Second, the fact that freight exchanges might not permit to bid on groups, bundles of loads or that the loads of interest might be on several markets. The bidding strategy of the carrier has to account for these possibilities.

The objective of this paper is to explore a number of important issues and research challenges related to the design of advisors for carriers that integrate freight e-markets into their operations. Advisors are defined as models and methods (plus the appropriate software agents) that aim to assist in 1) combining efficiently the market information and the planning and operations procedures to evaluate and select loads and 2) conducting negotiation on possibly several diverse markets. We aim to explore for each major class of carriers the opportunities for interaction with freight exchanges, discuss challenges associated to the evaluation and selection of loads as well as the control of the negotiation process, point to models and methods that may be used to assist in these decisions, identify promising research directions. We also discuss the strong inter-relations that exist between advisors and e-business in the freight transportation industry, on the one hand, and intelligent transportation systems, on the other hand.

The advisor methodology and complexity greatly depend on the carrier characteristics as well as on the market design and operation rules. We thus first classify carriers, according principally to their type of operation and fleet dimension and identify the main opportunities for interaction with freight e-markets. We focus on long-distance transportation and distinguish between door-to-door, customized services, such as truck-load motor carriers, and consolidation-type carriers such as less-than-truckload motor carriers and container navigation lines. The e-market opportunities for the latter consist essentially in finding loads for the otherwise-empty movements required to reposition vehicles for the next period operations. One may consider, however, the “symmetric” case where the LTL carrier auctions
on the market its spare capacity to interested shippers. This development constitutes a very intriguing and interesting research direction.

Opportunities appear more extensive for door-to-door carriers for which loads on freight exchanges become a complementary source of work to the usual contracts and unplanned demands. It is in this context that the issue of the correct evaluation and selection of loads appears the most sensitive.

Advisors have two main functions: to evaluate and select loads of interest and, then, to conduct negotiations on the appropriate markets. The evaluation-selection function may be performed independently from the planning process of the carrier or be tightly coupled to it. In the former case, a series of orders are passed to the advisor indicating vehicles (together with locations, time periods, and costing information) for which loads have to be found. These systems are best suited to consolidation-type carriers and for small fleets. The independent truck owner-driver is a case in point. Coupled systems appear more appropriate for door-to-door carriers, and time-dependent, stochastic fleet (resource) management models appear the methodology of choice. We will illustrate such a model and examine the algorithmic, data, and computational challenges associated to using it in an e-business context.

How negotiations are conducted depends on the number of markets (one or more), as well as the design and operations of the electronic freight exchanges: the type of market operation - periodic, continuous, etc. -, the type of market clearance mechanism - combinatorial or not -, the market rules - one or several rounds -, and so on. To illustrate, we will compare non-combinatorial continuous and periodic markets with a focus on the interaction with the advisors discussed previously. We will also discuss price modification strategies in various contexts (e.g., the time available between rounds and the price-changing mechanisms).

We will conclude with a discussion on relations between e-market advisors and ITS advanced fleet management systems, as well as a summary of research and development challenges.