UCI-ITS-LI-03-12

Freight Transportation Electronic Marketplaces: A Survey of the Industry and Exploration of Important Research Issues

UCI-ITS-LI-WP-03-12

Srinivas Nandiraju [1]
Amelia C. Regan [2]

[1] Institute of Transportation Studies
University of California, Irvine
Irvine, California 92697-3600, U.S.A., snandira@uci.edu

[2] Department of Computer Science, Department of Civil and Environmental Engineering
and Institute of Transportation Studies, University of California, Irvine
Irvine, California 92697-3600, U.S.A., aregan@uci.edu

August 2003

Institute of Transportation Studies
University of California, Irvine
Irvine, CA 92697-3600, U.S.A.
http://www.its.uci.edu

FREIGHT TRANSPORTATION ELECTRONIC MARKETPLACES: A SURVEY OF THE INDUSTRY AND EXPLORATION OF IMPORTANT RESEARCH ISSUES

Srinivas Nandiraju

Institute of Transportation Studies

University of California, Irvine

Irvine, CA 92697-3600

snandira@uci.edu

Amelia Regan

Department of Computer Science and

Department of Civil & Environmental Engineering

University of California, Irvine

Irvine, CA 92697-3600

acregan@uci.edu

August 1, 2003

Submitted for presentation at the 84th Annual Meeting of the Transportation Research Board, and publication in Transportation Research Record

FREIGHT TRANSPORTATION ELECTRONIC MARKETPLACES: A SURVEY OF THE INDUSTRY AND EXPLORATION OF IMPORTANT RESEARCH ISSUES

Srinivas Nandiraju

and

Amelia Regan

ABSTRACT

B2B e-Commerce facilitates the reduction of supply chain intermediaries and reduces transaction costs. This revolution has spawned a number of online marketplaces for freight transportation service procurement. The paper looks into the operational models of existing electronic freight marketplaces and the strategic behavior of shipper and carriers conducting their business in these market places. A literature survey of market clearing mechanisms models for online freight transportation market places is provided. Models for shipper-carrier strategic interaction are presented for freight transportation procurement. Some of the key research questions for developing methodologies to aid both the shippers and carriers are discussed.

Key Words: Business-to-Business marketplaces, Freight Transportation, Service Procurement, Auctions, and Exchanges.

INTRODUCTION

E-commerce continues to be significant factor in the US economy and forecasts indicate the sector continues to grow. The US business-to-business (B2B) e-commerce market was $823 billion in 2002 and is predicted to grow by $2.4 trillion by the end of 2004 according to some market research firms (Standard and Poor's , 2003). E-procurement, the acquisition of goods and services over the Internet has evolved into an important channel of procuring goods in the supply chain system. A reliable and efficient means of goods transportation is vital for the success of E-procurement. For business to consumer (B2C) e-commerce, express parcel services clearly dominate the market. However, B2B e-commerce relies more heavily on less-than-truckload (LTL) and truckload trucking services. The trucking industry is heavily fragmented, fiercely competitive and operates on low profit margins. Hence it has historically been relatively slow to adopt technologies. The trucking industry hauled more than 9 billion tons of freight in 2003, or 68.9 percent of all freight tonnage transported in the United States. The industry generated revenues totaling $610 billion and according to the American Trucking Associations (ATA) annual Freight Forecast, trucking revenues will likely surpass the $1 trillion mark by 2015 and account for more than eighty seven percent of all freight transportation revenue (ATA 2003). Though the transportation industry has been slow to change, electronic freight intermediaries are beginning to emerge and to make inroads into this market. We should point out, that this is really the second entry of these players into the market. Several hundred such companies emerged between 1999 and 2001 but most of these quickly exited during the so-called dot com bust (Song and Regan, 2001).

The word "online" is synonymous with the Internet and a freight service company having an Internet presence enjoys significant benefits. It serves as a means of advertising, a way to reach new markets, and a way to communicate in real time with supply chain partners. Companies also are able to cut administrative costs as transactions are performed electronically and devote their time to enhancing customer service. In the express parcel industry, UPS, FEDEX and DHL for example, have been able leverage the power of online tools to serve their customers.

Online freight marketplaces are portals where transportation capacity is bought and sold. In the B2B jargon these can be categorized as vertical marketplaces as they deal with transportation specific and sometime other value-added services for transportation management. The marketplaces offer short-term (spot market) and longer-term contracts. The electronic marketplaces can be broadly characterized into the following ways depending on the services they provide. The primary categories are:

- Clearing houses (Bulletin boards)
- Auction houses
- Freight Exchanges

In an online clearinghouse, carriers and shippers post their requirements, and carriers post their unfilled /unutilized capacity. A clearinghouse usually consists of a database of loads (an origin destination pair and an associated time window for pickup or delivery) posted by the shippers or transportation capacity posted by carriers. The agents in these cases, shippers or carriers (or third party logistics providers (3PLs)) peruse the database and initiate negotiations with other players one-on-one. The access to these portals is mostly through the Internet but some sites are also accessible through wireless devices that share EDI and XML based data. Carriers can find the loads using the Internet and web enabled cellular phones or personal digital assistants (PDAs).

In a transportation auction the items being auctioned are either transportation capacity, as in a spot market or transportation demands, as in a large-scale combinatorial or quasi-combinatorial auction for longer-term contracts. The participants are typically shippers, carriers, 3PLs and other forwarding agents. In an exchange, shippers and carriers exchange demands for transportation services for promises to provide transportation capacity. In a transportation exchange, shippers post their demands, carriers their transportation capacity and the online marketplace performs the matchmaking at a competitive price. The exchanges also contribute in the efficient handling of negotiations and the overseeing of the logistical processes of both the shipper and carriers (Song and Regan, 2001). The market places are characterized as public or private depending on whether all interested carriers can participate or if participation is limited to a select few. The road haulage orders are usually spot or short-term deals and long term (or binding contract).

Auction houses and freight exchange marketplaces employ a variety of negotiation capabilities. The capabilities vary with respect to the complexity of the technologies employed. IT complexities involved in these negotiations in decreasing order of complexity are automated online negotiations, manual online negotiations, and manual negotiation over the telephone or by fax. These marketplaces bring about a range of interesting mathematical problems related to the way these negotiations take place (Figliozzi, Mahmassani and Jaillet, 2003, Ihde, 2004).

In the traditional means of procuring transportation service, shippers scout for carriers who can best fit their service criteria at an acceptable rate. Negotiations are held person-to-person between representatives of the shippers and carriers to generate mutually binding contracts. Historically, shippers typically locked up most of their known demands with contracted carriers and looked to spot markets for unforeseen transportation demand or demands that were not fulfilled, despite being under contract.

Online marketplaces offer some advantages over traditional marketplaces. They smooth the complex negotiation process and lower transaction costs. They may lower costs because traditional staff need no longer occupy time with transactional, or contractual negotiations with individual carriers. The shippers lower their freight bills and carriers fill excess capacities. Online marketplaces reduce the complexity of decision making as the agents come together in a marketplace and sell their assets. Shippers and carriers get access to more business opportunities and geographical scope without incurring huge expenses on advertising. Online marketplaces are tools to gather large amounts of data, which can be used by pro-active agents to leverage and improve their service efficiency and lower costs (Goldsby and Eckert 2003). Most importantly they are just a click away from the pulse of the market – making current market clearing prices available in real-time. Despite the merits of online marketplaces some shippers shy away as the marketplaces usually do not assume responsibility for the actual movement of freight. They only try to match the shipper with the best carrier based on the shippers' criteria (the exception is of course 3PLs that own marketplaces or carriers who host private marketplaces). In neutral marketplaces the problem of monitoring the execution and performance of business entities is hard. Some shippers also believe that trust, vital for good relationships, is hard to build without person-to-person negotiations. Unless the marketplaces provide and circulate good, reliable information about the agents in their marketplace, it will be difficult to engender trust to trade and attain the critical mass necessary to make the marketplaces viable.

The purpose of our paper is to look at the current state of online freight marketplaces and study the business models underlying them. We present a literature survey of the market clearing mechanisms from different scientific branches like economics, game theory and operations research and critique their applicability to the freight transportation industry. Our intention is to provide a snapshot of the research in this area.

CURRENT FREIGHT MARKETPLACES

Before the large-scale deregulation of the US for-hire transportation industry, supply chain firms traditionally viewed transportation as an exogenous entity because of government controlled rates. After deregulation, procuring transportation became a complex decision because the carriers were able to offer integrated services as they were driven by competition and a wide variety of firms entering into the market. The carriers became a marketing arm of the shipper and also an integral part of the shipper's logistics network (Stock 1988). This paved a way for the shipper to concentrate on its core competencies and to leverage the expertise of the carriers. Carriers benefited by gaining more access to a traffic base, increased stability of market share and opportunities to diversify into new services. Deregulation was positive for shipper-carrier relationships as it led to more co-ordination and cost effectiveness. The complexity of decisions and to desire to better utilize the core competencies led to the rapid rise of the third party logistics industry (Menon, McGinnis and Ackerman, 1998). 3PLs are firms performing the logistics functionality for the supply chain firms. Firms communicated using EDI but the Internet boom drastically changed the way companies operate and helped improve communication. The first successful exchanges, NTE and DAT, grew out of load posting services that began in the early 1990's using simpler technologies. At the same time as these original logistics e-commerce sites were developing, e-procurement in manufacturing industries was taking giant strides.

Online marketplaces proliferated in the mid 1990's in different configurations and catered to different modes of transportation. Airline and Ocean freight marketplaces like Go Cargo.com (ocean shipping) and Global freight exchange (GFX) came into existence. The major logistics software providers, 3PLs, truckload and LTL service providers plunged into the market with their own marketplaces. The economic boom also brought about many non-asset based companies into the market. Transplace.com, which was formed by six major truckload carriers, led by JB Hunt, and Transportation.com, backed by Yellow Freight, serve the highway market. Transplace.com also focuses on providing a portal through which shippers can tender truckload, LTL, and parcel shipments to carriers under contract. About 1,540 carriers work with Transplace.com. The portal, which reported $700 million in revenue last year, charges shippers for services such as freight booking and transportation. Small package leaders UPS, FEDEX and DHL developed online marketplaces and also formed strategic alliances with other marketplaces.

As things progressed the picture for most of these types of companies was not rosy (those mentioned above are some of those the ones that survived, and even thrived). Most failed to obtain necessary market share or to identify profitable business models. They also failed to develop good relationships with shippers and carriers. Shippers who had long-term contracts with the carriers were wary that these marketplaces would strain their existing relationships. In a just in time (JIT) environment, shippers were more concerned with service parameters and most marketplaces acted as a matching place for loads but did not assume responsibility for the execution of the service. Shippers used online spot markets for their urgent demands, but for time critical freight, contracted carriers were used. Carriers also looked down on these websites as they felt that the price competition would cut into their already lower margins. Due to these difficulties the vast majority of the original online marketplaces shut down and others changed their business models to become ASPs, logistics service providers or formed strategic alliances with other freight industry companies (Coia 2002).

The supply chain software vendors are beginning to include strategic transportation procurement tools in their products. Manugistics Group, Inc. acquired Digital Freight exchange in May 2002 in order to add an online bidding tool to its SRM suite. Invensys Software systems subsidiary, Caps Logistics is on its third release of its transportation procurement tool called BidPro. Schneider Logistics introduced their Combined value Auction (CVA) module in June 2002.

Companies that frowned upon the auctions, which they believed tended to increase price competition and treated the carriers as a commodity formed collaborative models for shippers and carriers. The other main advantage of shipper collaboration is the control of inbound logistics. Elogex sets up collaborative networks, providing shippers with transportation management software and arranging to make shipments visible while in transit through Internet based interfaces. Nistevo's private exchange enables clients to automate their load tendering with a core group of carriers, thus eliminating paperwork and look for backhaul opportunities. Lean logistics combines the transportation needs of shippers in order to obtain economies of scale and scope to lower transportation cost.

The electronic marketplaces have started focusing on helping shippers and carriers automate their long-term contracts. Several companies have developed software tools to automate the development of contracts (for example Logistics.com, now part of Manhattan Associates and Transplace). These companies are helping to run combinatorial or quasi-combinatorial auctions for shippers. Internet-based transportation logistics marketplace Transplace and Associated Warehouse Inc. have announced a strategic alliance to provide integrated warehousing, fulfillment, transportation and logistics services.

Classification of e-Marketplaces

In electronic transportation marketplaces with reverse auction capabilities, the shippers post requests for quotation (RFQ) and the carriers respond by competitively bidding to the load tenders. The exchanges offer a wide range of services, depending on the technology they employ. Shippers can submit their loads either in the public marketplace or a private marketplace. A private marketplace for a shipper consists of its contracted carriers or in-house carriers. In a public marketplace all approved carriers can participate in the exchange. Some online marketplaces usually have a certified base group of carriers. The reliability of the marketplace is increased if all the shippers and carriers have been certified and based on their service records and business credentials. The marketplaces can also be categorized depending on whether they assume responsibility in the overall logistical processes. A neutral marketplace is a place, which offers capabilities for the shippers and carriers to match their demands, and is not involved in the actual execution of the agreements. The marketplaces also offer specific modal or inter-modal services. They can also be differentiated by the geographical scope of their operations.

In spot markets, shippers post individual pieces of business (mostly speculative freight and urgent demands requirements) and carriers can bid and start the communication process with the shipper. Shippers sometimes post hypothetical loads to test the market and gauge the pricing system prevalent in the market. In long term contracting, the shippers enter into long-term contracts with the carriers based on forecasted demand profiles over the period of the contract. In essence, the carriers are contracting to provide service along the contracted lanes (Origin-Destination pairs) at a given price *if* the shipper requires such service and *if* the carrier has the capacity to provide such service. In reverse auction mechanisms, shippers select the carriers who fit their selection criteria and ask for competitive bids. The auctions come in many flavors that vary depending on the information available to the various players. The shippers have the final say in the auction process and are not obliged to assign the contracts to the lowest bidder.

In our presentation of the case studies, we simply point out how the companies differ from the general description provided in the last two paragraphs. Most of the information we provide was obtained from white papers presented on the companies' web sites.

Case studies

FreightMatrix

FreightMatrix is an online provider of transport management services (TMS) and a freight spot marketplace. Spot market freight matching is done using i2 technologies software called Transportation Bid Collaborator (TBC). TBC has built in proprietary heuristics and mixed integer programming based tools to analyze bids. Carriers build their private network and the turnkey software optimizes the network. TBC helps in factoring the probabilities of backhaul and asset utilization. Carriers analyze the shippers' requirements and their operational network and look for synergies. The bidding is dependant on the number of lanes, service levels and types, the number of carriers participating in the auctions, and number of rounds for bidding (single or multiple). The marketplace facilitates the creation of online trading communities in a neutral and anonymous environment. The shippers can create a private marketplace with core carriers or participate in the portal's public marketplace. FreightMatrix's spot matching pricing is internal and is deemed as fair. They also provide routines for network planning to minimize transportation costs while maintaining service levels and for transportation planning for strategic decisions on locations, inventory stock policies and distribution strategies.

Freight-traders

Freight-traders, a UK based online marketplace, is a subsidiary of Mars Inc. a multi-national company and operates in Europe. They provide services for online design and management of freight tenders. The marketplace has about 2250 shippers and carriers working with them.

Leanlogistics

LeanLogistics provides transportation management services (TMS) for carriers and shippers with real time planning, execution and visibility. Transportation management services have capabilities to award contracts network based (long term contracts) and lane wise (spot contracts). Leanlogistics also provides value added services like CMM (continuous move management) that looks at the network and plans for continuous and closed loop moves.

logistics.com

Logistics.com offers services to all modes and combinatorial transportation service procurement software. They help the carriers with carrier management tools to identify consolidation, domiciling opportunities for drivers and lowering costs. Domiciling refers to the process of getting truckload drivers back to their homes after several weeks on the road.

Nistevo

Nistevo facilitates shipper collaboration by consolidating loads into full truckloads. The collaboration can be extended to repositioning of trucks for future loads and warehouse management. It provides a hosted software service that enables shippers, carriers to plan, execute, and settle their inbound and outbound transportation demands. It has more than 1400 carriers in the network and supports all modes including intermodal freight. Nistevo software tools help create private, semi-private network, share capacity, reduce shipment cycle time and cost of other logistic handling, collaborative logistic network.

NTE

NTE provides software tools for private freight exchange and neutral auction houses for shippers. The software tools help the carriers to participate in the shipper's freight exchange and auctions. NTE started in 1994 as a phone in service and moved to Internet in 1995. NTE offers transportation management services and also takes financial responsibility for the transactions between the carriers and shippers. It caters to nationwide truckload services.

SUMIT CVA

This portal offers a suite of logistical functions for shipment planning, carrier selection, rate negotiation and freight auditing. It also enables shippers and carriers to view the functioning of these supply chain processes at every stage. SUMIT CVA uses the NEX combined value trading framework developed at Caltech (Ledyard et. al 2002). CVA is a multi-round auction configuration with dynamic bid revisions and service lane combinations based on the shipper's requirements. SUMIT CVA allows the efficient matching of carrier capacity with shipper demands by allowing carriers to bid on bundles of lane combinations and grouping of loads that reflect the best use of their transportation network. The system has been used to process bids from around $5 million to $130 million, mainly in truckload and intermodal markets. Carriers are able to enter their rates, create packages and conditional bids, review service requirements and analyze bid results. (Cotrill 2003)

Transcore

In February 2001, TransCore, a global B2B and business-to-government (B2G) transportation technology provider, acquired DAT Services and its e-marketplace, DATconexus, now renamed Transcore Exchange. A neutral marketplace, TransCore runs an indigenous public network of consists of 18,000 participants. DAT was one of the original load matching services. DAT companies had penetrated the truck stop market with a variety of services.

Transplace

Transplace was formed in 2000 through the merger of existing logistics business units of Covenant Transport, Inc., J.B. Hunt Transport Services, Inc., M.S. Carriers, Inc., Swift Transportation Co., U.S. Xpress Enterprises, Inc., and Werner Enterprises, Inc. Its formation was led by J.H. Hunt logistics. Transplace uses its trademarked Dense Network EfficiencySM (DNE) platform a combined network across hundreds of shippers, thousands of carriers and multiple modes to obtain collaboration among the different entities in this highly fragmented transportation industry. DNE has a core optimization engine for better matching and asset utilization. It has a base of more than 3000 carriers with freight transactions worth more than $2 billion in 2002. Transplace also provides 3PL services, transportation management services, brokerage and carrier bid optimization services.

MARKET CLEARING MECHANISMS

Song and Regan (2001) provided a broad overview of emerging freight transportation intermediaries. Figliozzi, Mahmassani and Jaillet (2003) provide a framework for transportation auction analysis. They tackle the carrier problem in these reverse auctions and mention about the dynamic, stochastic and the complexity of the problem. The analysis of the problem is at the heart of many different branches of science and all these connections are laid out in brief. Simulation of the auction marketplace with demands occurring with a Poisson distribution and under a

Vickery second price auction method are performed and analyzed. The analysis looks takes a complex problem, but do not actually suggest a bidding framework for the carriers for use in the auctions taking place in the present online transportation marketplace.

Ihde (2004) presents a new auction mechanism called "Dynamic Alliance auctions" for spot market matching. The mechanism uses a package wise bidding for spot markets. He proposes that for the carriers better capacity utilization is achieved by forming complementary trips and round trips. He develops the mechanism for an auction mechanism in which the different shippers demands are collected, aggregated and suitable match to form complementary trips. Analytical results are presented for the equilibrium division of freight payment to the carriers by the shippers and the range of efficiency of the auction. Experimental evidence is provided based on the simulations done using the data from Daimler Chryslers virtual trucking enterprise "Fleetboard".

Online Negotiations

For both shippers and carriers, negotiations may be one-to-one or one-to-many. A trucking company dispatcher managing a large fleet may be simultaneously involved in a number of such negotiations to get the right price for his or her transportation capacity. Carrier operations thus evolve in a highly dynamic environment, where little is known with certainty regarding future demands, travel times, waiting delays at customer locations, and precise positions of loaded and empty vehicles at later moments in time. Service is tailored for each customer and the timely assignment of vehicles to profitable demands is of the outmost importance. The price is dependent not only on the complementary backhaul opportunities but also on the dynamic and temporal characteristics of the carriers' fleet. The onus now is to find a set of strategies that will help the carrier to get the best price for its services. This problem is similar to the yield or revenue management in airline operations.

In these negotiations, pricing of transportation service is of vital importance, but other attributes like service characteristics and good business relationships also come into play. An electronic marketplace setting the pricing must use algorithms, which are competitive and simulate the off-line market conditions. Pricing should be fair and take into considerations such as differentiated service packages, seasonality and volatility of demand / supply, and the underlying business rules and restrictions. Online marketplaces such as NTE, DigitalFreight and Transplace have their own pricing algorithms.

In the online marketplace negotiations, the main problem of the carriers is to decide on what loads to bid for and the price he has to charge for the loads. For pricing the load under consideration, the carriers need to calculate the marginal utility of the load to have an idea of the price for the transportation service.

Auctions

According to McAfee and McMillan's (1987) definition, an auction is "a market institution with an explicit set of rules determining resource allocation and prices on the basis of bids from the market participants." Auctions are increasingly becoming a viable means of economic trade (or negotiation protocols) especially when exactly the seller does not know the value of the good. The advances in technology have also made the process of conducting auctions a lot easier. The rapid growth of electronic market places, especially popular sites like eBay have made auctions a widely accepted form of market clearing. Our research examines the emerging marketplaces in the freight industry and tries to draw some light on the auction mechanisms and the competitive bidding aspects. Multi-attribute auctions relate to items that can be differentiated on several non-price attributes such as quality, delivery date etc. Transportation auctions are multi-attribute auctions in the context that bidding items (a 'lane') have other non-price attributes for e.g. service quality and time windows for delivery.

An auction is characterized by its bidding rules, market clearing rules and the information revelation policy. Market clearing rules specify the allocation of items to bidders and what the bidders payment. Information revelation policy determines the process of disclosing the information externality during the course of the auction. In general the auction protocols can be categorized mainly in two forms depending on whether the current bid price and other bidders know the bidder identity at every round. In the case where this happens we refer to the auction as open while otherwise the auction is closed.

The most famous types of open auctions are i) English auctions ii) Dutch auctions. The best-known closed auctions are the i) First price auctions ii) Second price Vickery auctions. Combinatorial auctions are those in which multiple items are put out to bid simultaneously and in which bidders can bid on combinations of these items. These are considered especially useful when the bidder has non-additive preferences among the goods being auctioned. In the transportation industry, the items put out to bid are lanes, with specified demands. The problem of selecting the winners in such an auction is referred to as the winner determination problem.

In an English auction, the bidders are free to raise their prices until they reach their valuation. In the end only the highest bidders remain and if the bid is at or higher than the seller's reserve price, then the item is awarded. In the descending price or Dutch auction, the auctioneer begins by asking a certain price and gradually lowers it until some bidder agrees to pay the current asking price. In the first-price sealed bid auctions, the bidder with the highest bid receives the object at a price equal to the amount of the highest bid. The second-price sealed bid auction is similar except that the winning bidder has to pay an amount equal to the second highest bid. In double auctions buyers make bids and sellers makes asks and the item is traded when the current bid for the item is higher than the current ask. If the auctioneer has more objects to sell, traditionally these are sold in a series of single object auctions or as a whole in a single auction. The second-price sealed bid auction is also called Vickery auction. Freight-traders.com uses Vickery auction for their closed bid auction.

The outcomes of the auctions are influenced by the strategic behavior of the bidders and the sellers, the presence of asymmetries and independence of the private information. Each bidder has a private valuation of the objects that they are bidding for based on their valuation of the utility of the object. This information can either be dependent on either some knowledge about the valuations of other bidders or completely independent of other bidders. Symmetry in an auction implies that all the private valuations are drawn from the same common probability distribution whereas asymmetry implies that each bidder has a different probability distribution from which he chooses his valuation. See Milgrom, (2004) and Vijay Krishna, (2002) for good general references about auction theory.

In combinatorial auctions using the Vickery-Clarke-Groves (VCG) scheme is the dominant strategy for agents to report their true valuations (Milgrom, 2004). The auctioneer solves the WDP for optimal allocation and solves a set of winner determination problems for optimal allocation excluding a single agent each time. The payment a bidder or an agent has to make is the difference in "welfare" of the other bidders without him and the welfare of the others when he is included in the allocation. VCG auctions are impractical to implement when the number of bidders are large.

The valuation problem in combinatorial auctions is hard as there are an exponential number of packages to consider. iBundle (Parkes 2000a) is an iterative combinatorial auction solves this problem to an extent. In the initial phase all the prices set to zero and in the bidder evaluation phase, given a current set of package prices each agent determines the set of packages that are within a bid increment of epsilon of maximizing utility. The winner determination is a primal allocation using the winner determination problem to maximize his revenue. The pricing phase (dual pricing) determines the package prices and is reported back to the bidders. The bidders evaluate the package prices and resubmit their bids. The bidders at this stage can generate different packages and submit a bid for them. The fundamental assumption in iBundle is that the bidders employ myopic best response where only utility maximizing packages are submitted.

Ledyard et al. (2002) conducted a multi-round combinatorial reverse auction for the procurement of contracts of serving over eight hundred lanes (delivery routes) for Sears Logistics Services. Elmaghraby and Keskinocak, (2003) report the use of multi-round combinatorial auction for long term contracting at Home Depot. Logistics.com, Accesstransporta.com (Canada), Translogistica.com (UK) have reported the use of combinatorial auction methods for long term contracting. Song and Regan (2003a, 2003b, 2004) develop optimization based bidding strategies for carriers bidding in these auctions.

Auction Models

Two of the most basic and widely applied auction models are private value auctions and common value auctions. In the private value model, each bidder knows his true valuation, but not other bidders' valuation (Vickery, 1961). In a pure common value model the true value is the same for each bidder but each bidder's estimation of the value is different.

Single Independent Private Values (SIPV)

The assumptions for SIPV model are:

- Single object for sale
- Bidders risk neutral
- Bidders valuation is i.i.d on some interval according to a continuous cumulative distribution function *F*. Each bidder knows his exact valuation.
- All N bidders have the same continuous cumulative distribution function *F*.
- Bidders know there realization but they do not know what other bidders valuation is, but do know that they have the same *F*. (*F* is common knowledge)
- Bidders are not restricted by budgetary constraints
- The item is not put up for resale.

In SIPV model, the descending auction is strategically similar to the first price sealed bid auction (Vickery, 1961). With the private values model, in an ascending auction, it is clearly a dominant strategy to stay in the bidding until the price reaches your value, that is, until you are indifferent between winning and not winning. In the second price sealed bid private value auction it is optimal for the bidder to report his true value, no matter what other players do. In fact "truth telling" is a dominant strategy (and leads to Nash Equilibrium). Hence an ascending auction is strategically similar to a second price sealed bid auction. This equivalence is called the "revenue equivalence principle" in the auction literature.

Proposition I: SIPV model is applicable to spot market freight matching and not for long term contracting.

In these models the situation is also called symmetric because all the bidders have a common value distribution *F*. The model in general can be applied to spot markets. This is especially true for carriers that have satisfied a forward move to a destination and want a backhaul move back to the origin. The assumption that bidders are independent is typically strong, but valid as the business is cut throat and in economic terms close to perfect competition. The common distribution F is valid, as the direct cost of moving a load from between an origin-destination pair is similar across carriers. The independence assumption is safe as the valuation depends on the trucks forwarding destination and deadheading involved. The cost of providing backhaul services varies across carriers because of deadheading or waiting for the load or for a repositioning time. The consequences for the shippers are that because of "revenue equivalence" the expected value of the winning price is the same across the first price open bid auction and the second price closed bid auction. For carriers in a second price closed bid auction, it is weakly dominant strategy to bid their true valuation.

The Single Independent Private Value Auction (SIPV) does not take into account the time constraints of the auction that might be critical, because of bid sniping, a common occurrence on eBay and Amazon auctions. Bid sniping is the practice of entering a time-constrained auction at the last minute, hoping to be the final bidder. This behavior has been observed in some spot markets for transportation services. Ihde (2004) uses an SIPV model for developing bidding strategies for bidding in dynamic alliance auctions and proves the existence of asymmetric Nash equilibria in special cases. He also develops analytically shippers' expected payoffs and proves that it is safe from collusion, bid sniping. Experimental results are provided.

In the markets for long term contracts, however, the SIPV does not apply because of the inherent nature of transportation capacity dependence on forming complementary or round trips. In these auctions package bidding is a more viable form of bidding (Caplice, Sheffi, 1996).

Common Values auctions (CVA)

In Common value auctions, all the bidders assign the same value but do not exactly know what the true value is. In these auctions, the *ex post* value is the same to all but is unknown to any particular bidder. In the common value models a key feature is the "winner's curse", that is, the winner generally ends up paying more than the actual value of the prize.

Proposition II: CVA model applicable to long-term freight transportation procurement.

Long term contracting is a strategic decision and CVA assumption is not an unreasonable assumption because the value of the contract is same to all the carriers. Exact valuation is hard to find due the inherent dynamism and uncertainty in demand, fleet management and other unforeseen events. Carriers valuation will be based on the information signal received to them depending on the strength of their prediction of future events. Ledyard et al. (2002) model the auction for Sears Logistics based on the common value paradigm.

RESEARCH ISSUES AND QUESTIONS

Electronic marketplaces give rise to many interesting problems for transportation researchers and transportation professionals. The examination of the applicability of various auction mechanisms in different transportation services (Truckload, LTL, rail etc.) is of significant interest. The auctions mechanisms for multi-attribute transportation procurement (price, quality etc.) have not been well developed. In order to evaluate different offers for an item with different attribute levels we need to draw resources from multiattribute utility theory to provide a tradeoff across these different attributes. Bidding languages for freight transportation help the carriers efficiently communicate their bids. The impact of bid semantics on the design and efficiency of auction mechanisms needs to be clearly understood. Another important issue, both for carriers bidding in spot markets and in auctions for long-term contracts is how to incorporate information about previous auctions into future behavior. The incumbent carrier base has more information about shippers' behavior and demand distribution. This leads to information asymmetry across carriers.

Spot Freight Matching

In a carrier bidding problems, the decision to bid on the combination of lanes to serve and the price to charge is a strategic decision. The carriers' profits depend on the price parameters and fleet management (operational problem). The selection of the loads to bid depends the fleet management characteristics for the current and future time horizon. The evaluation process also has to take into consideration the kind of service in question (truck load, LTL etc.). The carriers are also involved multi-lateral negotiations or multiple auctions or procuring using traditional means for the same transportation capacity. From a carrier's perspective, the yield management problem in electronic marketplaces is choosing the electronic auctions to participate, setting the bid prices depending on the auction format and deciding how low they can bid. In multi-round auctions, the questions of interest would be the minimum bid increments and the bid stopping rules.

Long term Contracting

Combinatorial auctions seem to be the preferred auction methodology in practice and literature. The development of optimal means for solving winner determination problems and for bidding is also important. For combinatorial auctions of lanes, both the winner determination problem (WDP) and the carrier's bidding problem are NP hard problems. Though small scale WDPs are solvable, many assumptions are made. The biggest of these is that the demands offered by the shippers are correct when in fact these can be highly stochastic. Similarly, the carriers assume that they can safely predict their future capacities – this too is an unreasonable assumption. In the future, means to incorporate stochasticity in the offering, bidding and winner selection processes should be developed. These problems offer rich opportunities for researchers. The development of iterative combinatorial auction mechanisms to reduce the burden of the shippers' allocation problems and the carriers' bid construction problems are an interesting topic of research. In some cases the shipper must resort to using approximation algorithms to solve the large scale WDP and ensuring fair allocations in such cases is very important. Song, Regan and Nandiraju (2004) and Song, Nandiraju and Regan (2004) compare various heuristics for the winner determination problem in combinatorial auctions and the bid analysis problem in unit or non-combinatorial auctions.

Collaboration Strategies

Collaboration issues raise important questions for fair cost allocations between shippers and carriers to ensure the cohesive element in their relationships. Nistevo, Elogex provides practical examples of shipper collaboration in transportation procurement. Song and Regan (2004) explores auction based post contract collaboration strategies for smaller carriers. Game theory offers the best way to model the interactions between the shipper- to- shipper and shippers - to - carrier relationships. Another interesting aspect is that the relationships can be modeled using either cooperative or non-cooperative game theory.

CONCLUSIONS

In this paper we have discussed the state of existing electronic transportation markets. The method of doing business departs significantly from traditional procurement and hence it will take some time to get accepted. The Internet boom has seen a splurge of electronic marketplaces in the late 90's, but now a trend of consolidation and forming strategic alliances with other logistical companies is under way which will help to provide tangible values to the shippers and the carriers. The success of the online marketplaces depends on whether they can attract the critical mass for desired transaction efficiency and provide value added services to improve the logistical processes. On-line transportation markets will also emerge to concentrate on the niche markets like serving the metal industry (e.g. Eflatbeds.com), frozen food, and natural gas sectors.

Single Independent Private Value (SIPV) model is useful for spot markets for carriers looking for backhauls. The Common Value Auction (CVA) model offers more help to model long term contracting for freight transportation procurement. The consequences of these findings are that the results developed in classic auction literature will be a helpful benchmark to apply and aid shippers and carriers in transportation auctions.

From a shipper's perspective, research is needed on the format and rules of the auction, the information revelation policies to the carriers and the business constraints that he should consider. The shippers need auction mechanisms that are truth-revealing, incentive based and robust to future disruptions. The auction mechanisms designs have to deal with stochasticity arising out of the uncertainties in demand, network performance and carrier operations.

Carrier fleet management is a complex task and bidding in online marketplaces brings in additional complexities. The dynamics involved in bidding strategies, negotiations and utilizing the information revelation in stochastic, dynamic bidding environments needs a deeper understanding to develop methodologies to aid the carriers.

REFERENCES

1. American Trucking Association, 2003.
2. Caplice, C. and Sheffi, Y., Optimization Based Procurement for Transportation Services, Journal of Business Logistics, Vol.24, No. 2, pp. 109-128, 2003.
3. Coia, A., Evolving transportation exchanges, World trade, Vol. 15, No. 7, pp. 22-23, July 2002. ·
4. Cotrill, K., Freight on the block, Traffic World, pp. 1-4, May 2003.
5. Elmaghraby, W., and Keskinocak, P., Combinatorial Auctions in Procurement, The Practice of Supply Chain Management, C. Billington, T. Harrison, H. Lee, J. Neale (editors), Kluwer Academic Publishers, 2003.
6. Figliozzi, M. A., Mahmassani, H. S., Jaillet, P., A framework for the study of Carrier strategies in an auction based transportation marketplace, Transportation Research Board, Journal of the Transportation Research Board, Vol. 1854, pp. 162-170, 2003.
7. Goldsby, T., J., Eckert J., A., Electronic transportation marketplaces: a transaction cost perspective, Industrial Marketing management Vol. 32 pp.187-198, 2003.
8. Ihde, T., Dynamic Alliance Auctions - A mechanism for Internet-based transportation markets, Physica – Verlag, Hedelberg, 2004.
9. Ledyard, J.O., Olson, M., Porter, D., Swanson, J. and Torma, D., The First Use of a Combined Value Auction for Transportation Services, Interfaces, Vol. 32, No. 5, pp. 4-12, 2002.
10. McAfee R. P., and McMillan, J., "Auctions and bidding" Journal of Economic Literature, Vol. 25, pp.699-738, June 1987.
11. Mele, Jim , By the numbers, Fleet Owner, July, 2000.
12. Menon., M. K., McGinnis. M. A., Ackerman K., B., Selection criteria for providers of 3PL services: A exploratory study, Journal of business logistics, Vol. 19, No.1, pp. 121-137,1998.
13. Milgrom, P., Putting auction theory to work, Cambridge University Press, Cambridge, 2004.
14. Parkes, D.C. and Ungar, L.H., Iterative Combinatorial Auctions: Theory and Practice, Proc. 17th National Conference on Artificial Intelligence (AAAI-00), pp. 74-81. 2000a.
15. Song, J., and Regan, A.C., Transition or Transformation? Emerging Freight Transportation Intermediaries, Transportation Research Record, Journal of the Transportation Research Board, Vol.1763, pp. 1-5, 2001.
16. Song, J and Regan, A.C., Combinatorial Auctions for Transportation Service procurement: The carrier perspective, Transportation Research Board, Journal of the Transportation Research Board, Vol. 1833, pp. 40-46,2003a.
17. Song, J and Regan, A.C., Combinatorial Auctions for Transportation Service procurement: An Examination of Carrier Bidding Policies, Proceedings of the 10th International Conference on Travel Behavior Research, Lucerne, August, 2003b.
18. Song, J and Regan, A.C., Approximation Algorithms for the Bid Valuation and structuring problem in combinatorial auctions for the procurement of freight Transportation contracts, Proceedings of the 83rd Annual Meeting of Transportation Research Board, Washington D.C., 2004.
19. Song, J., and Regan, A.C., An Auction Based Collaborative Carrier Network, Proceedings of the 83rd Annual Meeting of Transportation Research Board, Washington D.C., 2004.
20. Song, J., and Regan, A.C., and Nandiraju, S, A Bid Analysis Model with Business Constraints for Transportation Procurement Auctions, UC Irvine Institute of Transportation Studies Working paper, UCI-ITS-LI-WP-04-1, 2004

21. Song, J., and Nandiraju, S and Regan, A.C., Optimization Based Techniques for Solving Large-Scale Combinatorial Auctions for Transportation Contract Procurement, UC Irvine Institute of Transportation Studies Working Paper, UCI-ITS-LI-WP-04-2, 2004.

22. Standard and Poor, Industry Survey: Transportation Commercial, 2003.

23. Stock, J., R., The Maturing Of Transportation: And Expanded Role For Freight Carriers, Journal of Business Logistics, Vol. 9, No.2, pp. 15-18, 1988.

24. Vickrey, W., Counterspeculation, Auctions and Competitive Sealed Tenders, Journal of Finance, Vol. 16, pp. 8-37, 1961.

25. Vijay Krishna, Auction theory, Academic Press, San Diego, 2002.