A Survey Report for

CmpE 296U – Web-Based Application System and Tools

on

Online Auction Protocols and Systems over the Internet

By

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Abstract

Electronic auctioning is key in understanding the electronic commerce and its success in transforming the marketplace. Electronic auctioning is opening new avenues for businesses to become efficient and to cater to large and small consumer base. Also, business transaction like consumer-to-consumer has attained wider market by virtue of the property of Internet. Some of the toughest and frustrating part of the purchasing process - negotiation, is moving from human agent to software agent and participating in the auctions round the clock on users behalf in an open multi-agent distributed environment.

This survey report is research study on electronic auctioning process, systems and protocols.

Chapter 1 gives a brief introduction to auctioning and defines terms related to auctioning. It also explains the types of auction and auctioning mechanisms.

Chapter 2 explains several auction protocols for single ended and double ended auctions. It also lists an application of auctioning in resource and task allocation for a shop-floor control in large computer-controlled manufacturing systems.

Chapter 3 deals with the Michigan Autobot auction server.

Chapter 4 discusses some of the attacks on the security of auction protocols.

Chapter 5 compares and analyzes several existing electronic commerce systems and the protocols discussed in chapter 2.

Chapter 6 concludes the report with references.

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1. Introduction

Electronic Commerce is already considered to be a multi-billion dollar industry, and agent-mediated electronic commerce is revolutionizing Internet commerce even more. The industry has rapidly spawned areas like newsletters, auction software providers, and specialized search engines. Additionally, their use in online retail, automated auctions are also found at the core of systems for market-based resource allocation.

In fact, businesses are finding creative ways of conducting customer interaction using innovative techniques. For example, search engines now sell the top positions of their search lists to content providers. This helps businesses to favorably get attention of search engine users by topping the search list [1]

Electronic auctions represent a more general approach to price determination of any product or service, admitting a range of negotiation protocols for pricing the item or services.

Though electronic auction house is rapidly changing the buying/selling landscape by generating new services, it is not always the same as the traditional markets composed of human agents. In fact, the challenges it poses to the electronic marketplace in terms of fairness, privacy, security, speculation, manipulation, price war requires us to carefully evaluate the auction types, protocols, agents, servers associated with such systems.

1.1 Terminologies

Auction: Auctions enable the exchange of goods and services much as the stock exchanges manage the buying and selling of securities. But since auctions have a wide scope and a short lifetime, the opportunistic behavior needed for successful interaction requires agents to both participate in and manage auctions.

Auctions could involve consumer-to-consumer, consumer-to-business, or business-to-business transactions.

Agent: Agents in online auctions are software entities that have been given autonomy and intelligence by the user to carry out specified tasks with little or no human supervision. Agents must be continuously watching the online marketplace to the appearance of products that we might wish to buy. This relieves the buyer (customer) from searching the market to find suppliers who might be interested in bidding. Agents are fed with the data about our interests, the value we attach to items, and what we are willing to pay or trade. In short, they facilitate the connection of potential buyers and sellers. The buyer agents negotiate transactions with the seller agents [3].

These software agents thus are personalized, continuously running and semi-autonomous. For example, a company could use software agents to monitor the quantity and usage patterns of paper within the company, launch a buying agent when supplies become low. These buying agents automatically collect information on products and vendors that may fill the need, evaluate the offerings, and decide the product and vendor, and pursue closing the transaction.

Bidder: Bidder is a potential buyer in the market place.

Auctioneer: Auctioneer is one who is auctioning on behalf of the seller to sell goods or securities to the bidders. Auctioneer gets a small percentage of the sell-price.

1.2 Need for Online Auction

Traditional auctioning is advantageous in many ways because the bidder must be present at the site of the auction. Further, this auctioning style does not involve many people at the site and hence auctioning can not be carried out on a grand scale. This is because the auctioning is done locally and not publicized.

On the other hand, electronic marketplace is easy, fast, and inexpensive. The sellers can advertise their products (to be sold), it’s features and price online to many people to know and become interested in their products. In addition to these features, online auctioning helps to conceal the buyer’s identity and give them privacy. Online auctioning helps people to carry out transactions in the comforts of their desktop computer. The transaction parties may be physically located anywhere since in electronic commerce transactions, an electronic network connects them. Searching for a particular product online is also easy and fast.

1.3 How Does a Transaction Occur

In the first stage, the agents help in connecting the buyers and sellers. Next, these agents negotiate a mutually acceptable contract and exchange the goods or services between the seller and the buyer. Then the transaction ends.

Unlike Business-to-Consumer trading, Business-to-Business trading needs an automated negotiation to carry out transactions. Software agents take this responsibility for much of this negotiation. These software agents monitor other trade agents continuously, watching for potential opportunities. Further, they may enter into negotiation with many potential trade partners at once, reach an acceptable deal and set up a contract.

1.4 Types of Auctions

There are two categories of auctions [8]:

- Single-Sided Auctions

In Single-Sided auction mechanism, bidders are uniformly of type buyer or uniformly of type seller. The following are some of the auction types under this [6, 12] -

  - English Auction: This type of auction is also known as First-Price, Open-Cry auction in which the auctioneer asks progressively for higher bids and closes when no one is willing to exceed the current bid making the highest bidder the winning buyer of the item under bid.

  - Dutch Auction: In this auction type, the auctioneer begins at a high price and incrementally lowers it until some bidder signals acceptance to buy at the current price and the auction terminates.

  - First Price Sealed Bid Auction: In this type of auction, each buyer submits only one bid in a sealed envelope and the highest bid wins the auction.

  - Vickrey Auction: Here simultaneous sealed bids are made. The winner is the buyer with the highest bid, but only pays the second highest bid.

- Double-Sided Auctions

This auction mechanism admits multiple buyers and sellers at once. As an example, consider the Continuous Double Auction (CDA) – a general model for commodity and stock markets that initiates trades as soon as matches are detected. Another mechanism is the clearing-house or call market wherein the markets aggregate bids over time and clear at scheduled intervals.

The auction types for Single-Sided auction can also be considered for Double-Sided auction.

Each auction type has advantages depending on the response time, privacy, avoidance of speculation, fairness, sale price and so on. Currently, eBay and Onsale Inc. use English auction.

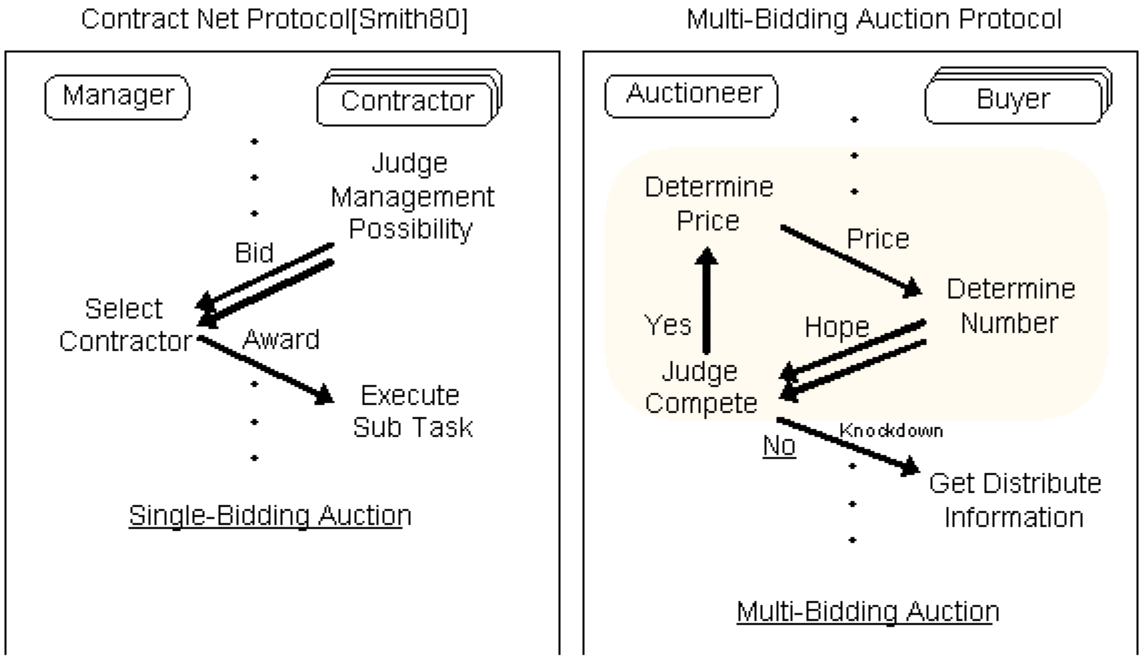

Figure 1: Types of Auction Protocols [14]

1.5 Choosing Auction Mechanism

As mentioned in chapter 1, there are five major types of auctions: Dutch auction, English auction, and FPSB auction, and Vickrey auction. The reason for the choice of one over the other depends on the application. Some systems even allow users to select the type of auctioning (AutoBot). English and Vickrey auctions are mechanisms based on dominant strategies. A dominant strategy is one, which yields a (expected) payoff that is higher than the other strategies, whatever the behaviors of the players and the state of the world [XX]. This has some advantages to the applications – like it promotes truth revealing from the bidders. An English auction is robust and can be executed quickly compared to Vickrey auction. This is because the information revealed during the auction ensures that bidders will move closer to their reservation prices [12].

1.6 Kinds of Auction Protocols

Single-Dimension Auctions: This auction has one preference for both sellers and buyers i.e., best price is preferred by all [12].
Multi-Dimensional Auctions: This auction has different preference weightings for sellers and buyers i.e., for fixed prices, different buyers will prefer different service

providers. This implies that the service provider, which can make the best offer is not necessarily the one that matches the buyer’s needs [12].

1.7 Characteristics of Auction Protocols

The auction protocols used in auctioning should have some characteristics so that the auction-construct developed is very efficient. For this, the auction protocols in e-commerce have to be defined to have the following properties for the transactions. These properties are [10]:

- Security: Protocols need to be designed in way that no passive or active attacks by an intruder or any unpredictable termination of transactions, or corruption of data on the network can cause damage to either party involved in the trade (transaction). Cryptographic protocols designed should not make the transaction vulnerable to security attacks.

- Privacy: It is desired that the auction protocols be designed in a way that protects the privacy of the parties. The details of the transaction should not be exposed to any third party unless so desired.

- Anonymity: Protocols should also be designed in such a way that nobody should recognize the true identity of the customer, or else be able to create a profile of the customer’s transactions and dealings.

- Atomicity: Transactions need to be secured in a way that when a transaction takes place, it should either come to a completion, or terminate (in case of some error) without any incomplete transaction.

- Low Cost: The cost of the transaction should be kept as minimal as possible.

All these factors are to be considered important and one cannot be traded-off with the other.

1.8 Need for Negotiation Agents

In online auctions, autonomous agents operate in open distributed systems comprising multiple problem solvers with competing objectives. In such cases, agents manage the interdependencies by interacting with other agents to procure services. The agents on user’s behalf will then decide the terms and conditions. Thus negotiation is key to the successful multi-agent system. Agents may be involved in many negotiation scenarios. It is hard to construct one generic protocol to fit all mechanisms and scenarios. Given that the transaction is internet-based, makes the number of agents in the process huge. And factors like cooperation or competitive strategy, familiarity among agents by earlier encounters must also be considered in modeling the other parties' behavior. To successfully participate in bidding, bidding agents must try to respond based on such internal model. This kind of response must consider extreme negotiating situations like when the other agent is using an unforeseen protocol [12].

2. Auction Protocols

2.1 ADEPT Project Auction Protocol

It is a first-price, open-cry auction protocol for multi-dimensional auctions [12].

2.1.1 Service-Seeking Agent (SS)

This is a buying agent and the preferences of this agent is described by a quasi-linear utility function u(s) – p. A continuous and differentiable function with the quality of service agreed, du(s) / ds > 0. The SS-agents spending on the service is restricted by some real number p_0. Here the service is a pair (p, s) where p is a real number and s is a vector of real number s = (s1, s2,…,sn) where s1=q is a measurement of the quality of the same service.

2.1.2 Cost-Structure of Service Providers (SP)

The cost to a SP-agent or a selling agent from a service s and a price p is expressed as continuous and differential function C_i (s) + p with dC_i / ds_i < 0.

It is assumed here that SP-agents preferences move in opposite directions to those of SS-agents. However, this is not a restrictive assumption. Such variables can be excluded from analysis.

2.1.3 The Protocol

1. Initiation: The process begins with an announcement from the SS agent consisting of the list { FPOC, u_B(s), p_0, m_i, T, X }

Where FPOC : type of auction

u_B(s) : buyer's declared utility function

p_0 : maximum amount the buyer is willing to pay

m_i : minimal acceptance level of offers

T : maximal time buyer will wait for a new offer before accepting existing one

X : percentage figure by which a new offer has to exceed the last offer in order to be considered.

2. Auction: SP-agents submit offers s wherein s > m_i for consideration by SS-agent.
   An offer will be accepted by SS-agent if it exceeds the last offer by X percentage and nT is not elapsed. The acceptable offer is made public by the SS-agent with the identity of SP-agent.

3. Termination: The auction terminates T seconds after the last acceptable offer was made.

2.1.4 ADEPT Project Pre-Auction Protocol

If an SS-agent cannot initiate FPOC or appropriately starts one-to-one negotiation, pre-auction protocol can be used to remove inefficiencies. The protocol is described here:

I. Initiation: An SP-agent approached by an SS-agent announces a "pre-auction protocol" to the other sp-agents.

II. Pre-Auction: SP-agents compete using an English auction, with the difference that the maximum price is taken as $(1 – A).P_0$ where A is small and the winning bid is S and the winning SP-agent has index i.

III. Negotiations: Here "i" makes a take-it-or-leave-it offer to SS-agent of service S for a price of P_0. All other SP-agent do not negotiate with the SS-agent.

IV. Insurance: "i" then pays the other sp-agents, $A. P_0/n$ for their cooperation.

2.2 Double Auction Protocol

2.2.1 Persistent Shout Double Auction for Bargaining Agents

Agents that communicate simply by bidding to buy or offering to sell a good at a given price are Bargaining agents. Here, trading can be done automatically on behalf of individuals and organizations [9].

The Persistent Shout Double auction is one form of continuous double auction used in real world trading, wherein, in this set up, a trader may make a bid or offer at any time. But once a bid or offer is made, it persists until the trader chooses to alter it or remove it, or it is accepted. In agent-based computational economics, bargaining agents can yield insights into how simple human markets converge on equilibrium price, and place a lower bound on the intelligence necessary for the economic activity.

The persistent shout double auction is equivalent to all agents shouting what they are currently willing to trade for in each round.

Eg., FastParts provides a persistent shout double auction for buying and selling overstocked electronic components. Buyers and sellers revise their bids according to the trading activity. When a bid and an offer meet the price, the entry is deleted and trading takes place.

2.2.2 Double Auction Market

The behavior of agents in a double auction marketplace depends on the supply and demand of the good under auction. This implies that higher the value of a good, lower it's demand and vice-versa. The point of intersection of supply and demand curves is the point of trade at the equilibrium price and the equilibrium quantity as shown in Fig. 2 [9].

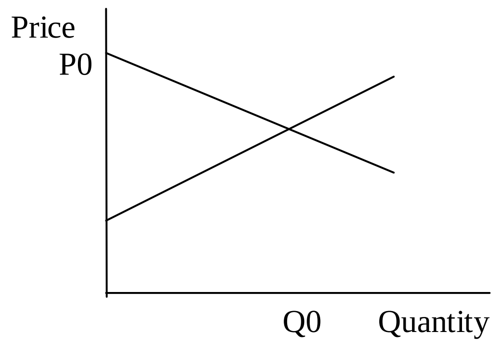

Figure 2: Supply and Demand

2.2.3 Auction Scenario

In this type of auctioning, there are agents for both buying and selling commodity goods. Each agent is given a trading period, it's own limit price - buying price should not exceed this price for a buyer and, it should not sell for less than this limit price for a seller. The agents make a bid/offer by adhering to these rules of trade pricing. The trading continues until all agents have bought/sold or are no longer willing to adjust their bid/offer. All the agents are reinitialized with an intention to buy or sell a good.

2.2.4 The Algorithm

The following agent algorithm describes how to adjust the bid/offer an agent makes in response to the market dynamics. It is assumed that the market has both buying and selling agents[9].

Each seller agent has a profit margin P that determines the price at which it is buying or selling a good relative to its limit price, L. It is required that for a seller, P should lie in the range [0, infinity], with L(1+P) being the minimum price to sell the good. If an agent makes an offer, it will offer to sell its good at say, price p. It will accept any bid if it is at or above this price p and will reject other bids.

For a buyer, the profit margin P must lie in the range [-1, 0], with p being the maximum price willing to pay for the good. This maximum price is then given by L(1+P). The buyer agent will accept any offer at a price p or below, and will reject other offers. The value p is the current valuation the agent places on the good.

To start with, each agent is assigned a random profit margin in the appropriate range. Each agent monitors bids, offers and trades in the marketplace, and uses it's algorithm to modify its profit margin so as to maximize profit. If the profit margin is set too low, a high profit is not made as in the case of setting the profit margin high. But setting the profit margin too high by the agent is also a set back wherein there is a risk that the trade may never happen. Hence an intelligent target profit margin setting would be to study the market activity to find the balance, and to respond to changes in the marketplace if a new balance is appropriate.

This algorithm runs for every round in the market and the current market activity is determined to set the target profit margin in this round's first phase. In the second phase, a learning rule is used to determine how much profit margin is altered towards the target.

2.3 Condition Purchase Order (CPO) Protocol

This is a buyer driven system in which a buyer places a CPO on a public server. Potential suppliers can then browse these CPOs on a public server and bind any that they wish. By binding, suppliers are effectively signing a contract [5].

Players of the Protocol include Buyer, Seller(s), Arbiter, and Server. Protocols make use of a public key certificate for authorization purposes.

The structure of a CPO includes an CPO ID, Arbiter ID, Server ID, Goods, Price, StartDate, EndDate, Terms, Buyers Bond certificates, Checksum. The CPO must bear the digital signature of both the arbiter and the server.

2.3.1 Steps to post a CPO

1. Getting Arbiter's approval: Arbiter's approval is required to deal with the players and for acting as an arbiter. A variation of this protocol could be that buyer wants to add bidding to CPO. This requires to be approved by Arbiter as well.

2. Posting the CPO to the Server: Server checks authenticity and issues a receipt after posting buyer's CPO.

3. Browsing the CPOs: Potential Seller and server interact and then server confirms the seller's bonding certificate. Server opens access to CPO to the seller.

4. Binding the CPO: Seller offers to bind the CPO, sends along with it an authentication key previously given by server back to server for binding. If it is

bidding variation, when time expires, server sends all bids to arbiter to select the best bid. The winning and losing bids are all notified.

5. Delivery of the CPO: This is a simple exchange of in the presence of arbiter.

2.4 Secure Auction Protocol

This protocol is for a fully automated electronic auction between anonymous customers and a merchant (seller) whose identity is known to the public. This protocol takes care of all the features needed in a protocol such as security, atomicity, privacy, as mentioned in Section 1.7. It can also be applied to non-electronic goods also [10].

2.4.1 Auction Scenario

The auction involves a set of customers and a single merchant who wants to sell the product for the highest bid. The customers can bid within the bidding round cut-off time. The merchant computes the highest bid among the collected ones and if no higher bid is done when compared to the previous bid-round, the product is sold to the highest bidder in the previous round. But if a higher bid has been made, all customers are notified about the new high bid and another round of bidding starts. This simplifies the negotiation process for customers by getting to know the intelligent bid.

In this system, it is assumed that only the third parties know the identities of the customers. The third parties issue pseudo-identities to the customer. These third parties act as collection agencies in case the customer (highest bidder) refuses to buy the product in auction. For this, the merchant approaches the third party with the highest bid and collects the payment.

2.4.2 Auction Protocol

The auctioning stages are that at first the merchant (seller) advertises the product by broadcasting its price, features, and it's other details. These messages are sent with an encrypted key and there is no room for confusion with the sale of other products. The merchant also signs these messages so that the customers know it is from a particular merchant. In the next stage, the interested customers respond to the advertisement by sending their pseudo-identity, which is the customer's public key and the name of the third-party that issued the public key, the price offered, payment encrypted with key and the signed value of the price offered.

The merchant now checks against his/her third-party directory to confirm that the customer's public key is indeed issued by the third-party. Further, since the customer offered price message is secured by the merchant's public key, only the merchant can read it. The merchant acknowledges the receipt of the bid in the next message.

Now, if the bidding round has timed-out, the merchant broadcasts the maximum price (can also hike the price) offered, by again signing this message. Hiking the maximum price also helps in case of ties between the bidders.

Next, if there is no higher bid, the product to be sold is advertised for the highest price quoted. This message is again signed by the merchant for valid identity of the merchant to the customers.

Finally, the highest bidder responds with the decryption key for the payment. For this, the bid-winner encloses the old notice for reference and a signed copy of the decryption key so that the merchant sees the message is from the actual bid-winner. The merchant then acknowledges the payment and sends the signed product encryption key.

2.5 Multi-Agent Contracting Negotiation Protocol

The architecture is for a multi-agent negotiation system called Multi Agent Negotiation Testbed (MAGNET). It provides an integrated support for complex agent interactions, such as automated contracting in different types of markets, as well as other types of negotiation protocols. This approach helps prevent fraud and discourage counter speculation in the negotiation process. The idea centers around three main components: the exchange, the market, and the session [2].

2.5.1 Architectural requirements needed to support Contract Negotiation

Support for complex multi-agent negotiation: Most of the protocols in agent-based auctioning involve time limits to receive the bids, process response, etc. To support this, the market should maintain the state of each transaction. It is intended that the architecture provide a common time reference to all parties involved in the time-sensitive negotiation.

Protection against fraud and misrepresentation: Since the market is always prone to agents taking undue advantage of other agents in case of an opportunity, the architecture supporting the negotiation must protect against such behaviors of agents. The architecture must also have the ability to validate non-performance and assess negotiated decommitment penalties.

Discouragement of counter speculation: The protocol design if improperly designed will allow the agents to falsely estimate and misinterpret the setting of bid price. The architecture should take into account these market behaviors.

2.5.2 Auction Scenario

This protocol can be assumed as a three-step process. The auction scenario can be described as the session (means by which market services are delivered to the participating agents) being initialized by a customer agent. The customer-agent then issues a call-for-bids, the suppliers reply with bids and the customer may accept the bid by sending the bid-accept message or reject it.

2.5.3 Contract Negotiation Protocol

This protocol observes a time-bound bid acceptance or rejection along with time-based decommitment penalty. The following are the steps followed by the protocol to communicate a transaction.

Initiating a bid: The customer enters into negotiation with the agents by developing a list of subtasks chosen from market conditions. The call-for-bid message from the customer includes a bid deadline, or the time frame for the supplier to respond to the bid, the time at which the customer will start considering the bids, the earliest time at which the bid acceptance will be sent, and the penalty functions for each subtask.

This call-for-bid message is then sent to the market session for it to be visible to all the suppliers who are registered with the market. All other messages sent are private and they can be verified to be so before they are sent.

Bidding: Once the supplier agent gets the call-for-bid from the customer, it may choose to respond with a bid within the time frame allocated to it and according to the catalog of services provided by the market agent. If the supplier is not interested in the bid, it may even choose not to send a response bid and the customer would understand that the supplier passively rejected the bid. Each supplier can also send multiple bids for a call-for-bid from the customer, each being a different cost and in a different time window.

The bid message from the supplier to the customer should include the cost to the customer, the time window, and the estimated duration of the work for the whole subtask combination. Along with these, it should also include the bid-accept deadline and the penalty function for the customer in case the latter decides to decommit after it has committed itself and given the supplier the task.

Bid acceptance: The customer after receiving the bid from the supplier can in turn opt not to acknowledge the bid and also opt to choose among the bids. The customer then has to either accept the whole bid, or a subset of the bids or totally reject them. This makes the system not to have an open-ended negotiation. If no acceptable set of bids together would cover every subtask to the satisfaction of the customer, then the customer can avoid the negotiation because it knows how the supplier could break down the costs of the accepted subtasks when it becomes necessary for the customer to accept a subset of the original bid combination.

Further, a bid-accept message is sent through the market session, which will then validate, verify and time-stamp it before forwarding it to the customer. Similar to the supplier rejection, the customer also can reject the bid passively by not sending any bid-accept message to the supplier. If either of the agents is not satisfied by some of the terms, they exchange decommitment messages for those terms. Included in a decommitment message will also be an acknowledgement of the penalty that the agent will be paying as a result of decommitment.

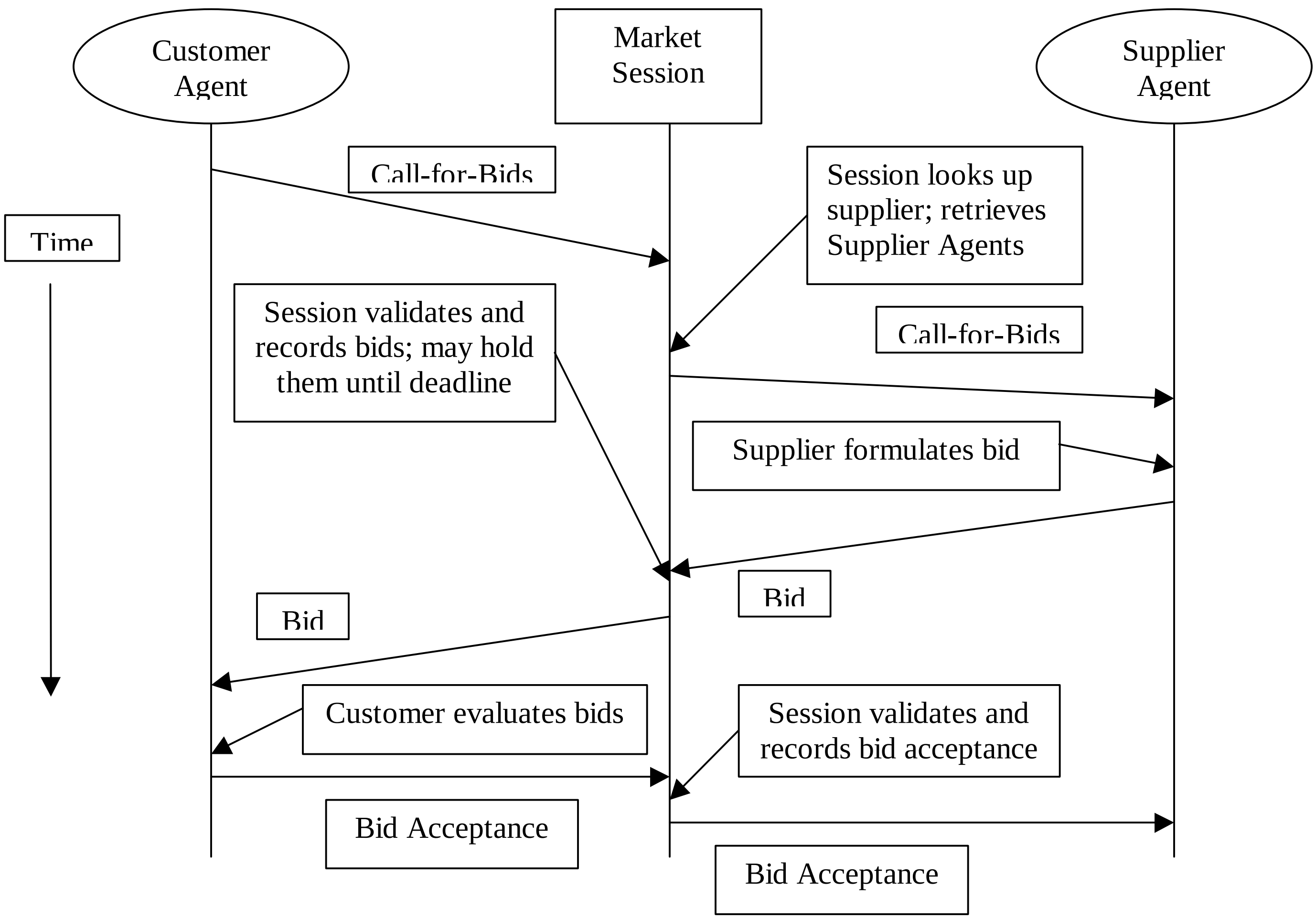

Figure 3: Session-Mediated Negotiation [2]

2.6 Auction-Based Control Scheme of Large Computer-Controlled Manufacturing Systems (LCMSs)

As mentioned in Chapter 1, Auctioning can be applied to improve the efficiency of many complex computer-based systems. As an example, “Shop Floor Control" and "Production Control and Scheduling" have long been recognized as complex activities and are difficult to manage. The interconnection between the shop floor, purchasing, and distribution is the key to an organization's productivity, profitability, and even survival, especially as the pace of business accelerates and product manufacturing and assembly become more complicated [11].

To be successful, shop floor leaders must manage the shop so that it interfaces smoothly with other company operations. They cannot simply apply traditional practices to the existing system. There is significant need for new techniques to successfully manage the task and resource allocation of LCMSs. This involves managing myriad of things starting from the release of orders to the shop floor so that they are completed on time to manage the production queues efficiently. It is important to note that the system must accommodate machine breakdowns, material shortages, or other unforeseen events.

Modernization will turn the manufacturing systems even larger and larger and hence would require computer-based shop-floor control scheme (to control increasing number of machines) to achieve high reliability, fault tolerance, extendibility, reconfigurability, and adaptability. The traditional control scheme is hierarchical, wherein it follows master/slave relationship between adjacent levels and control flows in a top-down manner. This system has limitations with regard to maintenance, extendibility, and flexibility. The auction-based job control scheme has no such master/slave relationships and allows local entities of the system to make decisions based on the information exchanged amongst each other. This independence has several advantages including fault-tolerance, system modularity, and reduced software complexity. This idea of decentralized control for the shop-floor using auctioning is discussed in detail in the following sections based on [1].

2.6.1 Overview of Auction-based Control Scheme

Under an auction-based scheme, a work-piece, upon arrival to the system, broadcasts its processing needs (tool requirement and processing time) to the machines on the floor. The work-piece then joins the input queue and awaits bids from the machines. On the basis of variety of factors, each machine entity that is interested in processing this work-piece constructs a bid and submits it to the work-piece. There are some criteria for machines to become eligible for the bid; for example, availability of certain tools with that machine is one such criterion. The machine constructs a bid based on the processing time for the parts in its input queue, the remaining processing time of the part currently being processed, and the penalty associated with borrowing any tools from the central tool crib. After a predetermined deadline, the work-piece evaluates the bids it has received. The work-piece then selects the machine with the most attractive bid as the winner of the auction. The objective of the control scheme is to maximize throughput - average time in the system is thus a primary performance measure. The work-piece is then transported to the machine that won the auction. After undergoing processing at the machine, the work-piece subsequently leaves the system. Thus the task allocation to machines is achieved through the auctioning mechanism. [1] also considers the availability of cutting-tools on the shop-floor and such resource management in building auction-based schemes unlike previous researchers. The Auction protocol discussed in 2.6.2 handles cutting-tool availability, negotiation between machine and tool carrier entities, and inter-machine negotiation of cutting-tools.

2.6.2 Auction Protocol and Procedures

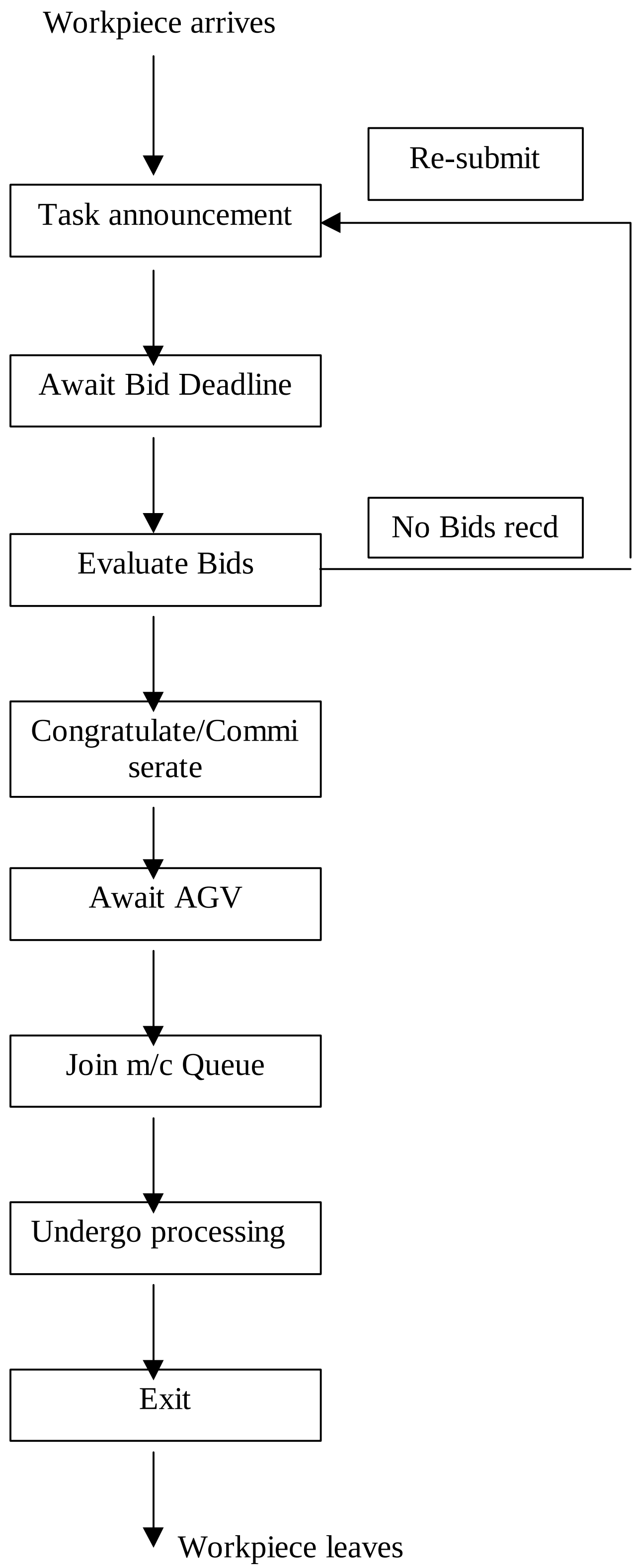

Figure 4: Workpiece Control Protocol

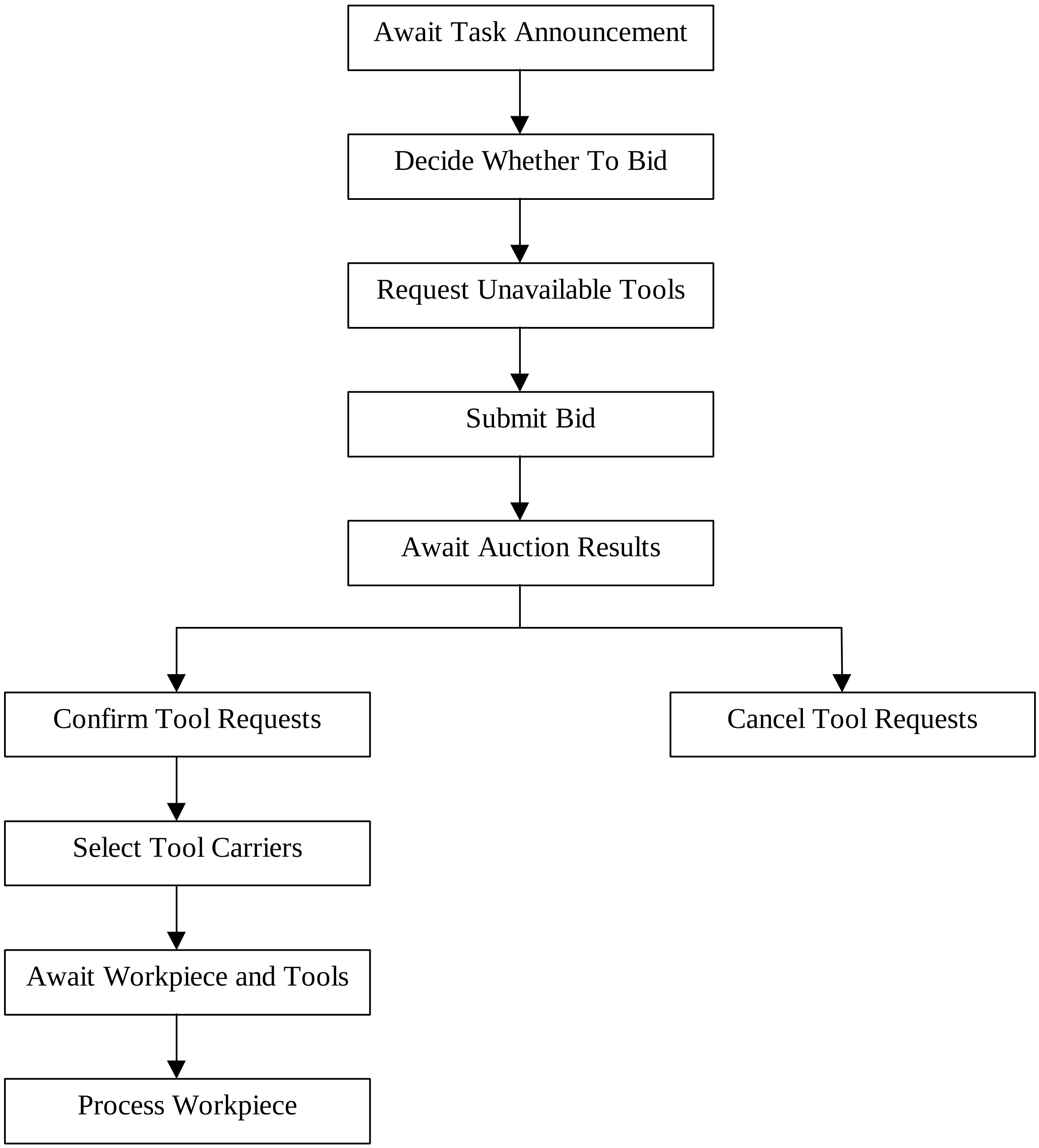

Figure 5: Machine Control Protocol

3. Auction Servers

3.1 AuctionBot

Michigan Internet AuctionBot is a price-negotiated platform (server) and is a standardized agent interface to online auctions. It supports both human and software agents [13].

AuctionBot manages a large number of simultaneous auctions. The registered users can track their bids in multiple auctions and check the automatic accounting of their final transactions. They are also notified of price quotes and clears through email.

3.1.1 AuctionBot Architecture and Working

The basic interface consists of two distinct portions – the web interface for humans and the TCP/IP interface for the software agents. The right side of Fig.6 shows the auctioneer processes and scheduler. The interface and the auctioneer programs update information in a common database [13].

A human user specifies a bid via a sequence of web forms and submits it to a bid-submission program. This program inserts the user's bid into the database and returns a confirmation about the bid submission to the user. To keep the interface responsive, the submission program does only a cursory verification of this bid. When a full verification is done, the auctioneer program examines all the bids in the auction.

The scheduler, which is a daemon process monitors the database for auctions that have events to process or bids to verify. It then forks the appropriate auction program for it. The auctioneer loads the auction parameters and the set of current bids from the database. The auctioneer validates bids as necessary, and may do one clear and/or one price quote each time it is run.

Since the interface between the interface and scheduler is asynchronous, if the latter goes offline or falls behind in its tasks, the interface continues to operate and vice-versa. All the data is time-stamped to ensure that when an auction event occurs, it does so with the set of bids that were active at the time the event was supposed to happen.

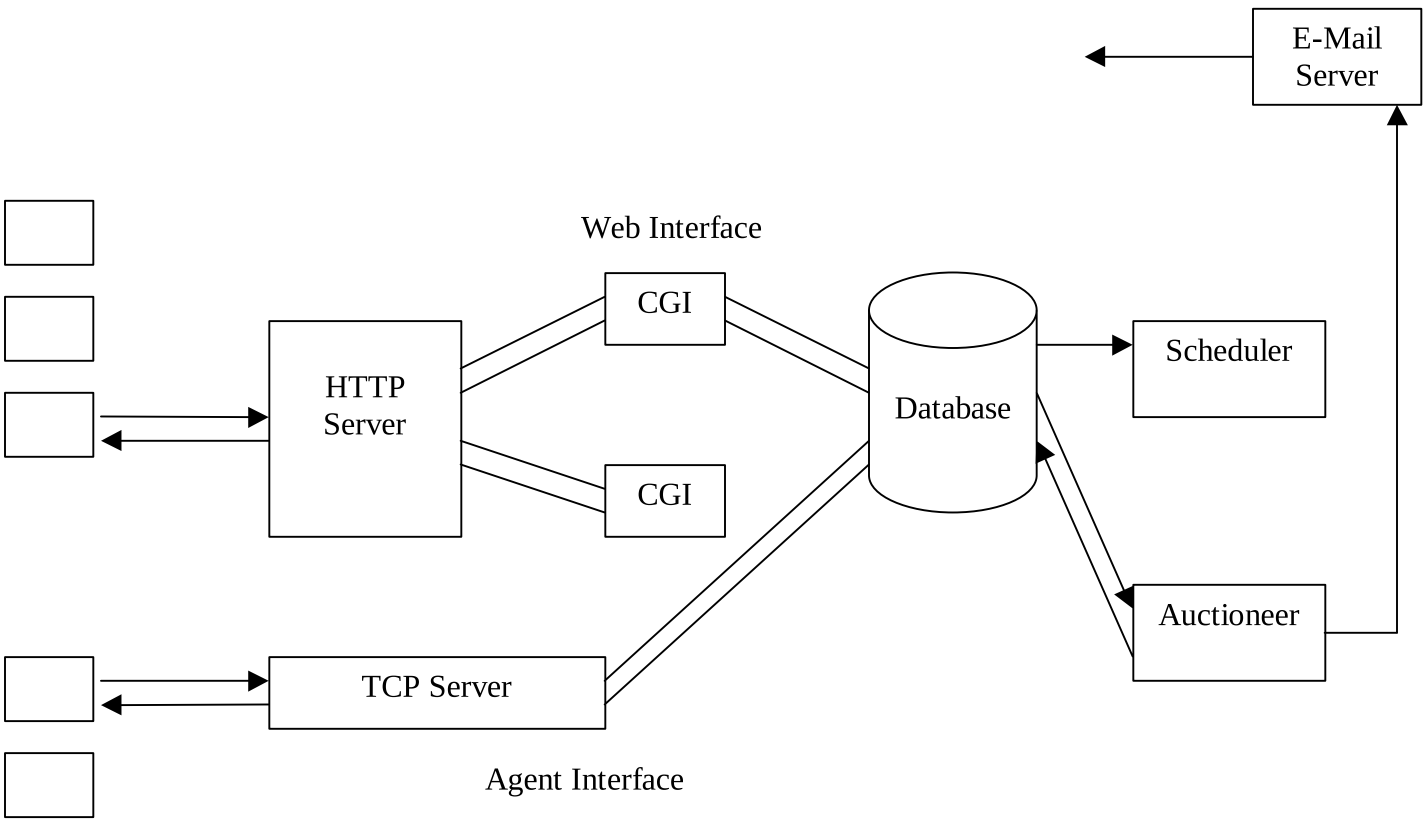

Figure 6: AuctionBot Architecture

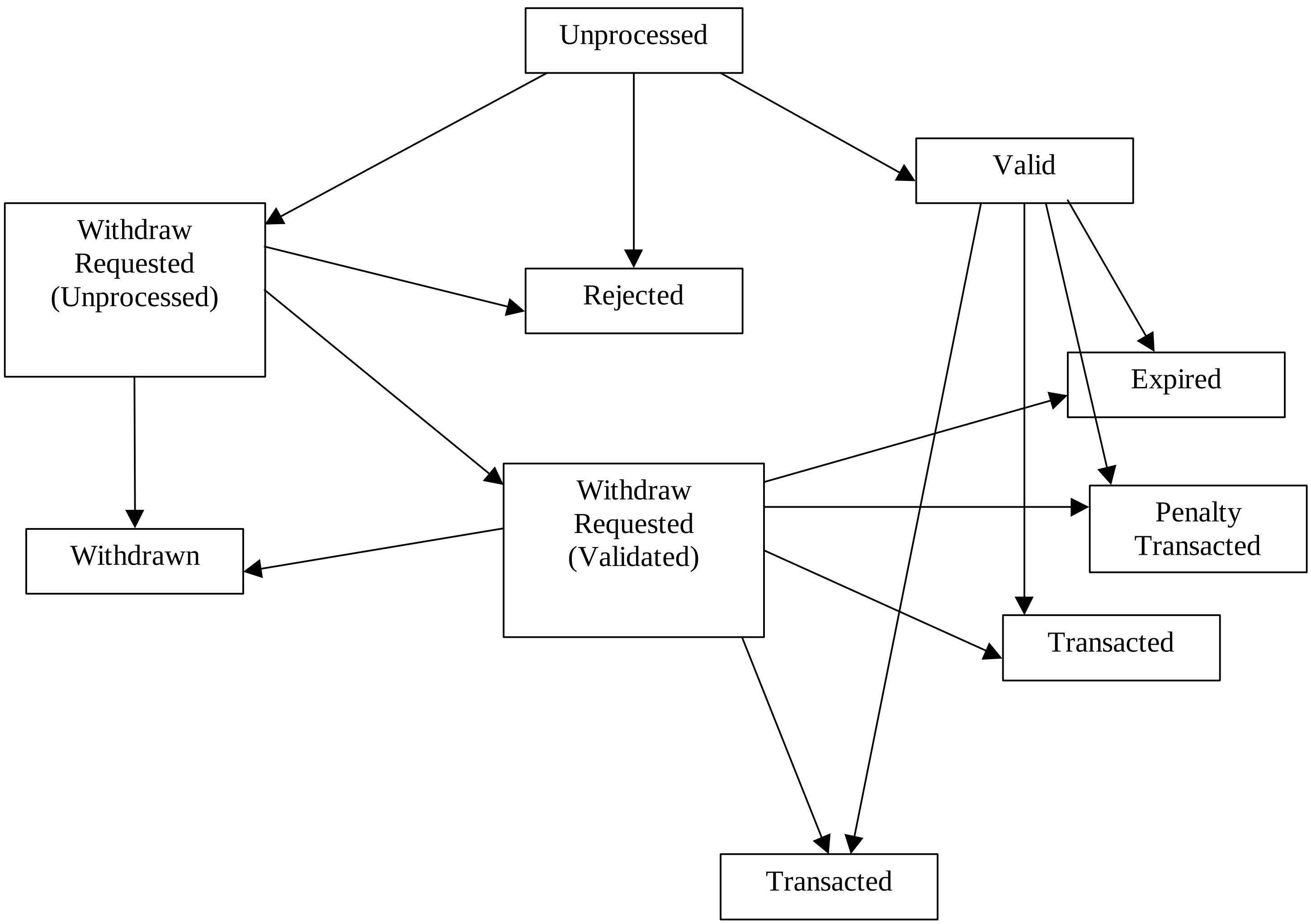

Figure 7: State Transitions of Bids

4. Security Threats to Negotiation Protocols

Many types of attacks on an online commerce system can be carried out. They are broadly classified as [5]:

1. Black-box attack
2. End-Run attack
3. Direct attack

The system strength can be measured by testing against such attacks.

4.1.1 Black-box Attack

A black-box attack on a system includes [5]:

1. Seller Collusion: Nothing can prevent sellers from colluding amongst themselves. A classic example of this attack happened in the recent US bandwidth auctions. The companies in this auction competed for licenses in different cities and states. The bidders were not supposed to communicate to each other the destinations they were bidding for. Apparently, one of the bidders submitted a surprisingly low bid and the last few digits of amount bidded were identical to the telephone code of the area it was after. This was well deciphered by other bidders, and the sell-price was substantially lower than was originally anticipated. Software agents are unlikely to make such executions and the short time interactions on the electronic marketplace makes it even harder for agents to collude in this manner [12].

2. Jurisdiction Problems: A buyer may post an auction whose eventual seller is in another country, with third parties (server and arbiters) in still other countries. This kind of situation is easy to handle by masking based on IP addresses.

3. Delivery Failure: The would-be seller may refuse to deliver upon the agreed goods to the buyer or vice-versa. Bond certificates help in such cases but must be carefully reviewed to avoid making the failure profitable to either party.

4.1.2 End-Run Attacks

This kind of attacks bypasses the system and strikes at the core assumptions of the electronic commerce system [5].

1. False Certificates: Attackers can produce false certificates and enter a false purchase order (in CPO protocol) and disrupt the auction.
2. Hard-to-Interpret Conditions: Participants like buyers when setting terms for their deal primarily do this type of attack. The buyer may put dual-interpreted conditions into the CPO (in CPO protocol). Arbiter’s role is to weed out such confusing conditions and make the terms clear and simple.

3. Key Companies: Protocols that use keys to authorize must have measures in place to handle situations when user's private key is stolen as an example.
4. Repudiation: If a user bounded a CPO (in CPO protocol) and later wishes to back off by claiming that his key was compromised, such cases must be proved using other records like phone records.

4.1.3 Direct Attacks

A direct attack is an attack on the protocols and algorithms within the system itself [5].

1. Forged Bonding Certificates: This would defeat the signature scheme. This kind of attack must be identified and guarded from future attacks.

2. Forged Arbiter Acceptance: Buyer may forge arbiter's acceptance and try to post a CPO (in CPO protocol). The digital signatures checking will catch such attacks unless the signature scheme itself is compromised.

3. Forged Post of a CPO (in CPO protocol): An attacker may forge a CPO already posted. The posting protocols on the server side must prevent such attacks.

4. Forged binding of a CPO(in CPO protocol): Server should prevent such forged binding by binding using a binding key only with the knowledge of user's private key.

5. Learning CPO (in CPO protocol) in Advance: An attacker may poll arbiter to learn ahead about a CPO in process. Such attacks may include even bonding agencies. To prevent such attacks, the entire message passing amongst agents must be encrypted under the respective parties' public keys. Using random numbers in the communication would improve the security as well.

5. Comparison and Analysis

5.1 Today's Agent-Mediated Electronic Commerce Systems and its Analysis

Shopping for a product or service took a new meaning with the advent of television and now lately internet is revolutionizing it. Online marketplace is opening a broad range of alternatives and issues to all participants. Several agent-mediated online systems have been identified in this section to understand and compare amongst each system [6].

Buying process can be categorized broadly into the following stages [6]:
1. Need Identification: Here buyer identifies an unmet need.

2. Product Brokering: Here buyer evaluates product alternatives and creates a "considered set" of products.

3. Merchant Brokering: In this stage, buyer evaluates merchant alternatives using the previous stage "considered set". The evaluation includes price, warranty, quality of service, delivery time, etc.

4. Negotiation: buyer and seller interact to settle on the terms of the transaction and complete the purchase.

5. Purchase and Delivery: This is to hand off money (payment options as per terms) and receive delivery of goods or services.

6. Product Service and Evaluation: This is a post-purchase stage relating to customer service, satisfaction of the overall buying process.

It is apparent that though stages of buying process have been identified as 1 through 6 above, it by no means is a complete representation of complex buying process. It is just a simplified model and in reality we can expect overlaps and iterations among these stages.

Today's electronic market systems use agent technology and aims to assist the customers in different stages of the buying process. The following lists such six agent systems [6]:

1. PersonaLogic (www.personalogic.com)
   This system assists buyers in product brokering. Once consumers identify a need, they can narrow down the products that best meets their need using this system. The user will enter required product features, which gets processed by a constraint satisfaction engine. The user can enter hard constraints and soft constraints. The system returns a list of products, which satisfies the input constraints.

2. Firefly
   This system assists buyers in product brokering as well.

3. Bargain Finder
   Bargain Finder helps in merchant brokering unlike PersonaLogic and Firefly. This helps in online price comparison of a specific product. This system had some problems with merchants blocking their price because they didn't think they should compete on the price alone. However, small merchants who wanted exposure well utilized the system.

4. Jango
   Jango helps in merchant brokering just like Bargain Finder but tackles the merchant blocking issue. This system mimics the requests to merchants for price quote as if it is a real customer request thus making it convenient to compare prices online.

5. EBay (www.ebay.com); OnSale(www.onsale.com)
   These websites offer services to customers to advertise their products or trades. They provide customers a common umbrella for negotiation even though they are far apart. But negotiations in the purchase/trade should be carried out by human participants.

6. AuctionBot
   Unlike the sites in listing 5, Auctionbot helps consumers in the negotiation process. This is a general purpose Internet auction server. Users create new auctions to sell products by selecting from variety of auction types. Users also input parameters (bidding price, method of resolving bidding ties, etc.) through the system API and spawn autonomous agents to compete in the AutoBot marketplace.

7. Kasbah
   Kasbah is a consumer-to-consumer online transaction system, which helps user in negotiation stage of the buying process. Users create agents to buy or sell goods. Kasbah agents seek out potential buyers or sellers in the marketplace and negotiate on owner's behalf. While creating agents, users specify constraints such as initial bidding price, lowest (or highest) acceptable price, deadline for the completion of transaction, and other restrictions. Once the buying agents and selling agents match, the negotiation protocol for buying agent will offer its bid to selling agent. Based on this, selling agent accepts or rejects the bid. Kasbah provides buyers with three negotiation strategies: anxious, cool-headed, and frugal - corresponding to a linear, quadratic, or exponential function respectively for increasing its bid for a product over time. Similar strategies are supported for seller agents as well.
   Also, Kasbah system incorporates a trust and reputation mechanism called "Better Business Bureau". On completion of transaction, both parties can rate the deal. This rating gets accumulated in Kasbah system and is used to determine the reputation of the agents. It can be used against future negotiations with those agents if reputation falls below certain threshold.

8. Tete-a-Tete (http://ecommerce.media.mit.edu/tete-a-tete/)
   This is integrative negotiation approach to online shopping. Unlike previous negotiation brokering systems, this system provides product brokering, merchant

brokering, and negotiation brokering all together. Tete-a-Tete's consumer-owned shopping agents and merchant-owned sales agents cooperatively negotiate across multiple terms of transaction including warranties, delivery times, service, return policies, loan options etc. Product features and merchant feature are part of the negotiation. This helps shoppers determine what to buy and where to buy from simultaneously. This helps in searching specialized product configuration and solves certain what-ifs(what if merchant can't overnight and User need the product as early as possible) by exploring alternatives. Tete-a-Tete is XML based negotiation protocol system.

5.2 Comparison of the Discussed Negotiation Protocols

Table 1: Comparison of Negotiation Protocols

	ADEPT Protocol	ADEPT Pre-Auction Protocol	CPO Protocol
Auction Mechanism Supported	FOPC (buyer initiated)	FOPC (seller initiated)	Sealed bidding
Response time and Convergence	Quick because there is time limit in the cost function	Quick as it involves Take-it-or-leave-it offer	Slow because it involves third parties and checks
Applicability to large set of services	Ye s, because it is a multi-dimensional system	Yes, it is efficient especially in one-to-one negotiation or when fine details are being finalized with one seller and buyer.	No, system doesn't support multi-variable utility function. However, a variation would make it broader to services.
Robustness	Yes, it is based on modified English auction	Yes, it is based on modified English auction	Negotiation mechanism is not discussed. More general protocol
Auction Type	Buyer-driven	Seller-driven	Buyer-Driven
Fulfilling contract	No mechanism	No mechanism	Yes, bond certificates
Security Attacks	No mechanism	No mechanism	Encryption and digital signatures are part of the negotiation process
Anonymity	No	No	Yes, involve server and arbiter

Miscellaneous	Delays sometimes play significant role in bargaining especially one-to-one but there is no incentive to wait in this protocol. Very useful if deadlines are set to complete transactions.	Slightly costly because of Insurance "A" for all SP-agents. But it is a trade-off against the inefficiencies of long direct negotiation.	Costly because of involving arbiter and server. Also, complex process to set up the CPO because involves interactions among multiple agents in an order. Buyer kind of picks up the advertisement cost by posting the CPO.

Table 2: Comparison of Auction Protocols

	Double Auction Protocol	**Secure Auction Protocol**	**Multi-Agent Contracting Protocol**
Auction Mechanism	English Auction	FPSB	Sealed bid
Auction type	Many-to-many	Customer-to-customer	Buyer driven one-to-many
Security	No such mechanism	Yes, uses encrypted messages	Yes, system itself ensures security and java/corba implemented
Privacy	Yes, automated agents can mask private data	Yes, uses cryptography	Yes, involves proxy server which maintains privacy
Anonymity	No, delivery involves no mediator	Yes, uses merchant as third party	Yes, session involves users dealing with exchange but delivery mechanism of contract service leaves open anonymity!
Transaction Cost	Less as there is no third party involved	Must pay merchant cost.	Overhead session cost to the exchange

6. Conclusion

Electronic auctioning helps to offer wide variety of services to consumers that were never thought of earlier. This helps consumers in making a better choice by balancing all personalized factors such as price, quality of service, delivery time, availability, location etc. before agreeing upon a deal with specific vendors. This in turn makes businesses to beef up information system resources and drive them to electronic commerce than ever before.

Agent-mediated negotiation will empower users to negotiate custom products at near retail prices from suppliers and help them to build better bargaining power by cooperating (coalition) with other similar agents in the marketplace across the regions.

The security is still a prime factor for electronic retailers. In addition, how effectively the transactions handled by their software agents can be controlled in time-critical applications like stock purchasing is an important factor. However, this becomes trivial in the trading on simple goods like music, books, etc.

As seen in Chapter 2, the auction protocols that negotiate on user's behalf for a best price but also offered negotiations based on other parameters like quality of service, delivery restrictions etc. This kind of bargaining requires knowledge based software agents. Currently, standards don't exist for negotiating protocols. This poses some challenges to all agents to successfully participate in variety of auctions.

Electronic auctioning, especially business-to-business will provide efficiency to companies and help streamline their manufacturing systems if deployed.

Thus agent-driven electronic auctioning is one the key drivers which could make the Internet commerce ubiquitous.

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