CONCLUSION AND FUTURE DIRECTIONS

This paper explored how Software Agents are helping consumers combat information overload and expedite specific stages of their on-line buying process. Today's first-generation agent-mediated electronic commerce systems are already creating new markets (e.g., low-cost consumer-to-consumer and refurbished goods) and beginning to reduce transaction costs in a variety of business tasks. However, we still have a long way to go before software agents transform how businesses conduct business. This change will occur as Software Agent technologies mature to better manage ambiguous content, personalized preferences, complex goals, changing environments, and disconnected parties. The greatest changes may occur, however, once standards are adopted and evolved to unambiguously and universally define goods and services, consumer and merchant profiles, value-added services, secure payment mechanisms, inter-business electronic forms, etc.

During this next-generation of agent-mediated electronic commerce, agents will enhance customer satisfaction and streamline business-to-business transactions, reducing transaction costs at every stage of the supply chain. At some critical threshold, new types of transactions will emerge in the form of dynamic relationships among previously unknown parties. At the speed of bits, agents will strategically form and reform coalitions to bid on contracts and leverage economies of scale – in essence, creating dynamic business partnerships that exist only as long as necessary. It is in this third-generation of agent-mediated electronic commerce where companies will be at their most agile and marketplaces will approach perfect efficiency.

SERVICES OF A BROKER IN ELECTRONIC COMMERCE TRANSACTIONS

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ABSTRACT

Current Web-based electronic commerce systems are lacking in efficient electronic brokerage. However, brokerage plays an important role in many electronic commerce transactions. Over the past few years significant research has been done in the area of electronic commerce, based on distributed object technology. Distributed object systems provide a key to building interoperable applications that can execute on a range of platforms. This new generation of electronic commerce systems is still in its early stages. This paper discusses the design and implementation of a CORBA-based electronic broker. The electronic broker is part of a research project called OFFER, which is trying to establish an object framework for business-to-business electronic commerce. The electronic broker supports search in underlying electronic catalogs and it provides a centralized marketplace with the possibility to use auction mechanisms to buy or sell goods.

INTRODUCTION

MOTIVATION

Electronic commerce on the Internet introduces a new marketspace, making it possible for large numbers of companies to participate. This addition to the electronic marketspace is a melee of smaller companies, each one relatively unknown and together offering a bewildering array of products. The vast amount of information available about products and services in electronic catalogs is difficult, if not impossible, to search. Electronic brokers are needed to provide secure means of exchanging information quickly and effectively between consumers and providers (Cunningham, et al 1997). These brokering agents will provide value-added services such as matchmaking, negotiating and monitoring transactions. This paper describes an electronic broker built on distributed object technology. The e-broker is part of a larger project developing an object framework for business-to-business commerce, called OFFER (Object Framework For Electronic Requisitioning). The e-broker in OFFER assists the user in two main ways during a market transaction. First, it helps search in many, often unknown e-catalogs of suppliers; second, it provides auction mechanisms to support price negotiation between buyers and sellers. The components of the framework are implemented in Java and use OMG's CORBA as a distribution infrastructure.

BROKERS IN ELECTRONIC COMMERCE

Electronic commerce offers several advantages over traditional ways of doing business. Organizations usually see electronic commerce as a way of reducing costs and offering better services. Cost reduction is gained through lowered transaction processing costs and the discovery of better offers than were previously found. Technology can be used in new ways to offer original and innovative services, which would not have been possible otherwise. It can be enhanced by electronic negotiation, contracting and ultimately collaborative specification work. In non-brokered commerce, customers contact suppliers directly, searching for offers and/or conducting one-to-one negotiations. Non-brokered commerce often happens in very small markets, transparent markets, or in markets with monopoly/monopsony structures.

A broker is a party, which mediates between buyers and sellers in a marketplace. Brokers typically provide services that may include searching for a suitable business partner, negotiating the terms of the deal providing letters of credit and/or

banking/payment services, and ensuring delivery of goods. Brokers are often useful when a marketspace has a large number of buyers and sellers, when search costs are relatively high, or when trust services are necessary. Current electronic commerce applications, such as those on the World Wide Web, primarily support information collection. There is little or no support for brokerage. However, sophisticated mediators can make the exchange of information between consumers and providers of services cheaper and better. Electronic brokers aim to find the best conditions for their clients (consumers and providers) and they help to overcome the limitations of direct negotiations between customers and suppliers.

STATE-OF-THE-PRACTICE

This section covers current electronic commerce systems, and highlights some areas where an electronic broker would be useful: search functionality, and negotiation functionality. It also provides a short review of distributed object technology in electronic commerce.

ELECTRONIC COMMERCE ON THE WORLD WIDE WEB

The past few years have seen several major information technologies come together to produce viable electronic commerce systems. Currently electronic commerce is mainly supported by EDI and electronic catalogs. EDI has been in use for over 20 years, mostly running on proprietary networks between two businesses (Sokol 1995). A newer rising technology, made possible by the Internet and WWW, is the electronic catalog. There is no standard definition for the electronic catalog, and the functionality is rapidly evolving, but at a minimum an electronic catalog should support listings of products and/or services, price information and transactions (Segev, et al 1995). Electronic catalogs are especially adept at using database and WWW technology to provide sophisticated search and retrieval functionality. However, current systems have some major shortcomings (Lindeman and Runge 1997): They are lacking in permanent IT support across all transaction phases, instruments for the negotiation of electronic contracts and standards for interoperability.

SERVICES OF AN ELECTRONIC BROKER

For many items, there is often simply too much data on the Web to complete a full search economically (Schmid 1997). Here a broker can search the databases of underlying electronic catalogs and return the results to the requisitioner. Andersen Consulting's Bargainfinder (http://bf.cstar.ac.com/bf/) and Netbot's Jango (http://jango.exite.com) are well-known examples of such intermediaries. Unfortunately, current Web-based technology makes it very difficult to establish e-brokerage for such searches. Web sites format their CGI requests and HTML outputs in vastly different and often changing ways, each of which must be processed differently. Writing and maintaining a program that keeps track of the various queries and parses the resulting HTML files individually is a cumbersome task (Schwarzhoff 1997). This lack of interoperability standards between e-commerce applications leads to high costs for the e-broker. Procuring from sixty heterogeneous suppliers requires sixty different accommodations. There are no widely adopted interface standards for e-commerce systems. Additionally, HTTP is an inefficient and stateless protocol, which is poorly suited to the multi-step commercial transactions we need in e-commerce. Another function a broker should support is negotiation. Currently, most electronic catalogs support only fixed prices; any bargaining must be done person-to-person via e-mail or the telephone.

E-COMMERCE BASED ON DISTRIBUTED OBJECT TECHNOLOGY

The combination of distributed object computing and the ubiquity of the WWW can serve as a basis for powerful commercial applications. Distributed object standards (such as OMG's CORBA or Microsoft's DCOM) provide interoperability of objects across networks in a heterogeneous environment (Orfali and Harkey 1997). OMG's CORBA supports high-level language bindings, as it separates an interface from its imple-mentation and provides language-neutral data types. It supports polymorphic messaging as well as run-time metadata for describing all interfaces known to the system. So many domain experts (Tenenbaum, et al 1997) claim that an object-oriented architectural framework for Internet commerce will solve many problems of current e-commerce systems. Object frameworks provide collections of cooperating components. They are almost complete applications designed to be reused in a number of applications (Pree 1997). Various commercial examples show the widespread use of this concept.

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There are a number of approaches to develop object frameworks for electronic commerce. OMG's Electronic Commerce Domain Task Force (ECDTF) tries to standardize the needed facilities. OSM (Open Service Markets) (McConnell, et al 1997), an EU ACTS project, is developing tools to enable an open electronic trading market based on the OMG Object Management Architecture (OMA). A similar approach called eCo was proposed by the CommerceNet consortium (Tenenbaum et al, 1997). These projects deal with a variety of topics ranging from payment, certificates, and e-catalogs to brokerage.

The current draft of the ECDTF Reference Model (http://www.osm.net/ec-dtf/index.htm) gives a good overview of the ongoing efforts. The architecture is composed in three principal groups, namely low level electronic commerce services including payment, certificate, profile and selection services; commerce facilities supporting contract, service management and related desktop facilities; and finally, market infrastructure facilities covering catalogue, brokerage and agency facility (see Figure 1). The Reference Model helps to identify the planned and future Electronic Commerce Domain Facilities of the OMG OMA. The work provides an overall framework of required electronic commerce components, but it is still in its early stages. So far the efforts concentrated mainly on the low level electronic commerce services.

ELECTRONIC BROKERAGE IN OFFER

So far electronic brokerage is one of the weak links in electronic commerce. This work focuses on the services of the electronic broker in an e-commerce framework called OFFER. OFFER is a research prototype of a reusable object framework for business-to-business commerce. We investigate the roles, processes and functions in electronic commerce and the components necessary to support them. The project should provide knowledge about the functionality of the required software components, their granularity and the interaction between them. OFFER is implemented in Java and uses CORBA as a distribution mechanism. The interfaces of these services are described in OMG's Interface Definition Language (IDL).

BROKER-ASSISTED SEARCH IN ELECTRONIC CATALOGS

This section outlines the workings of a broker-assisted search using the OFFER framework. Suppliers offer an e-catalog to the customer; suppliers can also register with the e-broker. Hence, a customer can search for a service either directly in the e-catalog of a supplier or can use the e-broker to search in all the e-catalogs of all the suppliers, which are registered with this broker. We specify a standard IDL interface for the e-catalogs of a supplier and for the e-broker. Each supplier is responsible for implementing this interface; the implementations can be in any CORBA-compliant language such as C++, Java or Smalltalk. The e-broker provides a search() operation, which allows a customer to find a service with the e-broker. The e-broker supports also an operation, which allows clients to receive information about the suppliers that are registered with the e-broker.

An important requirement is the possibility for new e-catalogs, to register with the e-broker. The broker can either maintain its own database of registered e-catalogs or it can use the services of an Object Trader. The Trading Object Service became a CORBA standard in mid-1996. It defines

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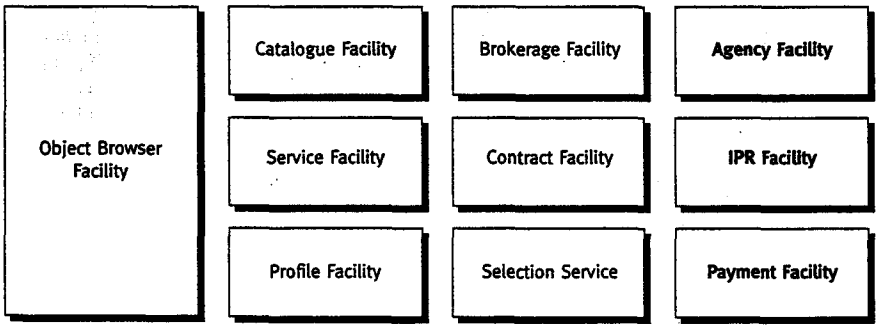

Figure 1 OMG ECDTF Reference Model

several functional interfaces to register (export) or unregister (withdraw) services with the trader. In our case the e-catalogs act as exporters, advertising a service offer (consisting of name, location and several other properties) with the trader. The electronic broker queries a list of references to actually available e-catalogs. The references can be used afterwards to send a search() message to these electronic catalogs and evaluate the results.

There are several advantages of using the CORBA-based approach over existing CGI-based implementations. CORBA 2.0 provides IIOP, an efficient state-supporting protocol on the Internet. As mentioned above, CORBA separates the interface from the implementation. Thus, a CORBA-based e-catalog can change its implementation without requiring the e-broker to rewrite its interface. This is an advantage over current client/server systems, in which the API is often tightly bound to the implementation and therefore very sensitive to changes. However, also with this CORBA-based approach all suppliers of a certain market have to agree on a predefined interface standard for their e-catalogs, in order to gain high-level interoperability.

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BROKER-ASSISTED NEGOTIATION

An e-broker provides a centralized market place, where many buyers and suppliers can meet. Hence, an e-broker is well-situated for offering various kinds of negotiation mechanisms to buyers and sellers. Unfortunately, there do not exist solid bargaining algorithms. Bargaining strategies between a buyer and seller are extremely complex. They frequently evolve over time, and often require shrewd judgements about how much information to reveal, when to lie, how many issues to involve, and which sequence of counterproposals to use. It's a fuzzy science at best, and efforts to either program strategies into software agents (Chavez and Maes 1996), or to have agents learn good strategies (Dworman, et al 1996 and Oliver 1996) are not robust enough for commercial applications. Hence, automated negotiation is still in its infancy, in extremely controlled conditions at research laboratories.

In order to achieve solid negotiation support within the OFFER electronic broker, we replace the buyer/seller negotiating session with an economic mechanism: the auction. The strategy issue collapses into the single dimension of bid

Auction	Rules	Outcome	Optimal Bidder Strategy
Sealed Auctions			
First priced sealed bid	Bidders submit a single sealed bid before deadline	Winner is highest bid at bid price	Shade bid a bit below true willingness to pay
Vickrey	Bidders submit a single sealed bid before deadline	Winner is highest bid at second highest price	Truthtelling
Sealed double auction	Bidders and sellers submit a single sealed bid before deadline	Auctioneer determines a single market-clearing price and matches buyer and sellers	Truthtelling
Open Auctions			
Dutch	Auctioneer calls out descending price; bidder calls out a bid	Winner is first bidder to call out, at price bid	Shade bid a bit below true willingness to pay
English	Bidders successively raise bids for item until single bidder remains	Winner is last bidder remaining, at price of second-highest bidder (same as Vickrey)	Bid up until true willingness to pay, then drop out of auction

Table 1 Auction Rules, Winners, and Optimal Strategies

formulation. The software agents can now afford to be "dumb": they need only know the auction rules and submit a bid. In the Vickrey auction, truthtelling is the dominant strategy, and hence optimal bid formulation is extremely simple. For many other auction types, optimal bidding strategies are only slightly more complex. This approach removes the "cleverness" from the software agents and puts it in the market mechanisms instead. In addition, an auction also solves the ontology problem (the item is successfully described at the outset and cannot change during the course of the auction). Table 1 shows the rules, outcomes, and optimal bidder strategies for some major auction formats. For more rigorous discussion, see (Milgrom 1982 and Vickrey 1961). Each type of auction has special advantages and is suited for special needs. It is important

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to handle these mechanisms flexible and provide easy adaptability. This is achieved through abstract coupling of the e-broker class with the auction class in the framework. So, depending on the special kind of auction, the application changes its behavior. A sealed auction object has a publicly announced deadline, and will make no information about the current bids available to any future bidders until the auction is over. An open auction object will make information about current bids available to any future bidders.

CONCLUDING REMARKS

The OFFER prototype is a very good testbed for components in an electronic commerce framework. Currently we focus on electronic contracting and non-repudiation of commercial transactions. We investigate the services of an electronic notary in OFFER and experiment with new software component models. OFFER is developed at the Fisher Center for Management and Information Technology at U. C. Berkeley. Information around the project can be found at: http://haas.berkeley.edu/~cmit/OFFER/

JUST A MINUTE?

BY MARCUS DE FERRANTI, BAND-X, BRITAIN*

"Companies recognise that transmission capacity will become a commodity – useful, scarce, and eventually as tradable as coffee or copper."
Quote from "The Death of Distance" published September 1997

The development of a clearing house or exchange for telecoms bandwidth has been anticipated by industry experts for some years, yet few predicted its timing or exact nature. Band-X has made such a market a reality, and the number of participants is growing fast. What are the hurdles that had to be overcome, and how does it operate?

WHY A MARKET IN BANDWIDTH?

An "over-the-counter" market in international bandwidth has existed for many years. In this informal market, carriers with excess capacity on a given route simply telephoned around their industry contacts and sought to strike a deal to dispose of spare capacity or conversely to arrange for the carriage of excess minutes. The chances of successfully finding a counterparty with a matching requirement depended primarily on who you knew. Given that the number of serious international market participants has historically been limited to about what could be comfortably be accommodated in a single rolodex, an over-the-counter market performed reasonably well, and indeed some level of capacity trading via personal contacts will undoubtedly remain a feature of the industry.

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What is changing, of course, is the number of telecom companies in the world, which has escalated at an exponential rate, into the thousands when you include resellers, refilers, callback operators, calling card operators, competitive access providers, ISRs, ISPs and all the other varieties of telecom fauna who make their living in the shadow of the facilities based carriers. The growth rate in the number of telecom market participants shows no signs of slowing. Knowing "everyone" in the industry is no longer possible, leading to the situation in which the buying and selling of bandwidth through informal contacts is time consuming and probably not terribly efficient in the sense of minimising unsold capacity and / or achieving the best prices.