Electronic Commerce: a technological perspective

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Electronic Commerce plays an important role in today's business. We here present an overview of the techniques involved in Electronic Commerce, highlighting its advantages as well as challenges, showing how distributed artificial intelligence can be used in this field. We also stress how economic organisations are being affected by this new paradigm leading to the establishment of Electronic Markets and Virtual Organisations. We finish this paper by introducing the reader to some existing applications.

Electronic Commerce, Electronic Markets, Virtual Organisations, Intelligent Agents

1. Introduction

Commerce is the way customers and suppliers meet at a certain place and a certain time in order to announce buying and selling intentions that eventually match and successfully start business transactions. Due to innovations in information and communication technologies of the past years, time and space restrictions have been weakened and, therefore, those business transactions became easier.

In this paper we show how Electronic Commerce technology has changed the way traditional business has been done, and enables the arising of new economical structures.

This paper is organised as follows. Section 2 gives a brief definition of Electronic Commerce and introduces the internet as a communication technology support for this application field. Section 3 describes the artificial intelligence based methodologies, which enable and promote Electronic Commerce activity, and Section 4 presents the new economical organisation structures which are emerging from the use of the Electronic Commerce facility. In section 5 some examples of available Electronic Commerce systems are briefly described. Finally, section 6 presents some conclusions and a brief overview of future research directions.

2. Electronic Commerce

A business transaction can be defined as a set of interaction processes between participants playing different roles - customers, suppliers and eventually intermediaries. This transaction is considered as complete when a trading agreement is made between customer and supplier, and the exchange of products or services takes place.

The life cycle of business transactions can be decomposed in three fundamental stages: ***information***, ***negotiation*** and ***exchange*** [Well].

i) Information
   The market environment is described, and relevant information about participants has to be made available. This information includes available products or services, their respective specifications, suppliers and delivery terms, as well as identification of potential customers. Notice that customers can be stimulated through product information.
   This stage results in a list of potential partners in the market and their respective offers and demands.
ii) Negotiation
   It consists in a decision-making process where involved parties (customers and suppliers) jointly reach a space of possible solutions. Protocols and strategies must define such interaction. This stage results in a matching pair of supply and demand. In traditional retail markets, prices and other aspects of the transaction may be fixed. In other markets, however, price value as well as other factors involved on the deal are subject to agreement between participants.
iii) Exchange
   In this stage the transaction is done, goods or services are exchanged for (secure) payments. Optionally, this stage includes after sales service and the customer satisfaction evaluation.

Traditional commerce concerns the establishment of business transactions where participants meet personally in physical places.

Today, the convergence of new advanced computing and telecommunications technologies is radically changing the traditional commerce. Due to the rapid growth of network communications, commerce participants are now facing a new innovative and challenging way of doing business: the so-called ***Electronic***

Commerce. Electronic Commerce (EC) uses the information and communication technology enabling the electronic support and, optionally, the business transaction automation, at least up to the completion of the negotiation stage.

Facing this new situation, where economical structure is naturally changing, the Portuguese government has recently created the National Initiative for Electronic Commerce [DR98]. It consists of a specialised commission whose aim is the study of regulations to apply to Electronic Commerce transactions, namely the establishment of legal laws to apply to electronic documents and digital signatures, as well as electronic invoices and payments.

2.1. Advantages of Electronic Commerce

Due to the use of large communication networks, Electronic Commerce enables the spread of information more widely in such a way that real commerce will be closer to the idealised commerce. Efficiency will increase and goods will be provided at better prices (and other business features) due to increasing competition.

Some of the most important features that EC brings to today's business transactions can be summarised in the following items:

- Reduction of costs for both customers and suppliers. Customers lower the cost to obtain information about supplier's offerings. Suppliers lower the cost to communicate information about their products to a large number of customers.
- Permanent availability. Business transactions and information display are available 24 hours a day.
- Possibility to reach a larger number of participants. Everyone can participate in the EC, by connecting to the communication network that supports it. Generally this participation is free, but in some cases a previous registration could be imposed.
- Competition is increased and commerce activities are decentralised. Due to the existence of a large number of participants in a business transaction, the competition will be increased leading to better results. Commerce participants are not obliged to stay in a centralised place; instead, they can be located in very distant places although virtually they meet each other in the communication network infrastructure.
- Commodity is increased. Customers are able to compare an incredible amount of value added products without needing to leave their homes.

2.2. Internet as a communication technology

Internet is becoming the first global public computer network that is accessible to all, easy to use and inexpensive. Its popularity and accessibility has radically increased the number of organisations (individuals as well as large and medium enterprises) doing business electronically. The use of Internet has the following advantages:

- Accessibility from any part of the world.
- Accessibility to any individual and company (small or large).
- Easily to use, due to the inclusion of friendly utilities managing powerful communication tools: HTTP (Hyper Text Transport Protocol), HTML (Hyper Text Markup Language), WWW (World Wide Web).

There is confidentiality and security issues that must be addressed before the Internet as well as any public communication network, can be used in large-scale automated business applications. Securing the Internet has been a major challenge in the advancement of EC. Cryptography and related certification and authentication services will play vital roles in this field.

Many of the organisations use the Internet to publish and maintain electronic catalogues or even to automate their transactions. More advanced applications include the use of **software agents** designed to help the user in their business transactions. We will refer to this particular subject later on in this article.

3. Methodologies for Electronic Commerce

Search and Filtering

In Electronic Commerce, it is important to selectively search for particular products and services. The wide variety in offering and demanding will mean that making the best choice will involve balancing of multiple factors such as price, availability, quality, locality, reputation, etc. Several techniques are employed in the EC to help finding the most appropriate products or suppliers, namely: *content based filtering* (through keyword based search or extracting semantic information), *collaborative filtering* (looking up to goods based in reported preferences of others with similar profiles) and *constraint satisfaction problems* (through satisfaction of the hardest feature constraints). Softbots, software programs especially designed to look for focused information in the web, have been used to implement those principles [Doo97]. Although our research group has been involved with this subject, it falls out of the scope of this article.

Negotiation

Negotiation can be defined as a kind of decision making process where two or more parties jointly search a space of possible solutions with the goal of reaching a consensus [Gut98]. Specific protocols and strategies must support the negotiation process. A protocol comprises the rules of the negotiation process, that is, the valid actions in that context. In EC, such protocols must be designed in order to encourage customers and suppliers to negotiate fairly, and to reduce unproductive strategic counter speculation as well as fraud. A strategy is a plan of action that provides the maximisation of the participant's utility function: which is the model of its preferences, reflecting its self-interest and/or a desired social welfare.

Several protocols can be defined for negotiation, but we can consider two main mechanisms: ***take-it-or-leave-it*** mechanism, and ***auction*** mechanism [Wur98].

Take-it-or-leave-it is a simple mechanism where one participant (typically the seller) presents an offer to the other participant that can accept or reject the offer. If a rejection is got the first participant will announce another offer, if possible.

Auctions include an explicit set of rules determining resource allocation and prices on the basis of bids from the marketplace participants. Auctions are employed not only in electronic trading, but could also be considered an important co-ordination mechanism in other fields, e.g., in resource allocation. Different types of auctions are used, and we will refer only the most important ones. A first distinction must be made between ***open*** and ***sealed*** auctions.

In open auctions, bids are made public and the bidders know each other's bids. In sealed auctions, only the auctioneer knows all the bids. We will now mention the most popular auction types [Fis96], supposing that the auctioneer is the seller (if the auctioneer plays the role of the buyer the system behaviour will be symmetric):

- *English auction* (open auction)
  Several bidders submit their bids involving values that must increase over time. All bidders know all the others' bids. The auction is finished when no more bids are submitted. The highest bid wins and the winning bidder pays the bid it has announced.
- *Dutch auction* (open auction)
  The auctioneer posts the price to pay. The auction starts with this higher price which is then gradually lowered by the auctioneer. The first bidder who accepts the price wins.
- *First-price auction* (sealed auction)
  Several bidders send their bids to the auctioneer. The auctioneer awards the bidder that gives the highest bid. The winning bidder pays the price bided.
- *Second-price auction* or *Vickrey auction* (sealed auction)
  As in the first-price auction, several bidders send their bids to the auctioneer. The auctioneer awards the bidder that gives the highest bid. However, the winning bidder pays only the second highest bid price.

The concrete choice of an appropriate auction mechanism depends on the respective market situation: whether bidders are risk-neutral, whether the auctioneer publicises information about the value of the good, the number of bidders interested in the good, etc. For example, if there is a large number of bidders, the auctioneer will yield better results using an open auction mechanism because that will increase the price competition.

Communication protocols, Languages and Ontology

Electronic Commerce imposes very high demands in standardisation. It is still an open question how transactional terms should be universally defined and who should manage their evolution. Communication facilities must be defined in order to allow heterogeneous partners to successfully participate in a given dialogue. The communication must be permanent and reliable, in terms of message transportation, as well as conveying the desired meaning of the message.

It is necessary to create a mutually comprehensible information sharing language, a mean of describing and referring to the domain terms involved in the transaction process.

Communication languages and protocols including KIF [KIF] and KQML [Fin94] are being used by several companies in order to try to standardise their application systems.

A protocol specifies the role of the message interchange. Moreover, participants on the transaction must understand the meaning of the message contents. That is why they have to share common ontologies.

In the EC context, ontology is a way of categorising objects representing goods such that they are semantically meaningful to all participants.

Agents and Multi-Agent Systems

Many researchers and commercial companies have created intelligent agent-based systems that support various aspects of Electronic Commerce. Deliberative agents can be defined as problem-solving entities that exhibit the following properties [Jen96]:

- *Autonomy*: ability to make decisions based on an internal representation or perception of the world, without being controlled by a central instance. The agents control their own actions and internal states.
- *Social ability*: interact with humans or other agents in order to complete their tasks or to help others with their activities.
- *Responsiveness*: perceive their environment, and responds to changes that occur in it.
- *Proactiveness*: have goal-directed behaviour and take the initiative when appropriate.

Agent technology may be an important method for participants in the EC to be able to cope with the complexity and large volume of commerce services, particularly on open communication networks.

The biggest advantage that agents bring is their ability to automate previously manual operations, e.g., agents can visit more web sites (that a particular person never has found, or does not have the time to explore) and gather more information faster. More sophisticated agents can also exhibit more advanced capabilities when carrying out their assigned tasks: automated negotiation or even learning.

We might foresee the following uses for agent technology in the EC framework:

- Customers will employ software agents to help them to identify and locate products and services they require.
- Customers and suppliers will empower their agents to negotiate electronically with other agents in order to buy and sell products and services within this complex multimedia information trading system.

However, in order to engage humans to delegate to their agents every day commerce tasks, agents must provide security and privacy. That is the reason why generally agent-mediated commerce systems give the human the possibility to have final approval of what agents are agreeing to in his name.

Multi-Agent Systems (MAS) can be seen as a group of agents, where each one can take specific and possibly heterogeneous roles within the system. In an Electronic Commerce context, we can map the business organisation structure in a MAS where agents play the roles of the several different business participants. With the inclusion of specific rules, it is possible to guarantee that particular agents follow particular rules of behaviour, in order to defend the reputation of the all economical organisation.

In a MAS, though individual agents may be simplistic, the entire system may behave in a sophisticated and intelligent manner.

4. Electronic Commerce in use

Electronic Commerce principles are now starting to influence economics organisation of all society. New types of economical structures can now be identified, due to the proliferation of EC: *Electronic Markets* and *Virtual Organisations*.

4.1. Electronic Markets

Traditional markets are economical physical locations of exchange where demand and supply meet together. The market place provides the location and infrastructure for the interaction of the market participants. The rapid changes occurred in computer science and information technology enabled business organisations to reach new customers and open new markets in an electronic marketplace, called *Electronic Market*.

An ***Electronic Market*** is the virtual marketplace where business participants can meet each other. It has to exhibit several roles [Col97] found in physical marketplaces, namely the *advertising* facility, the *synchronisation*, the *enforcement* of market rules and the satisfaction of basic *security requirements* (confidentiality possibly by encryption; data integrity; message authentication possibly by digital signatures or certificate mechanisms).

Important elements of an Electronic Market include [Col98]:

- An *ontology* that specifies the terms of discourse within the domain of the market. It includes specification for the products or services within the domain, as well as terminology for quality, quantity, features, terms and conditions of business.
- A *protocol specification*, which formalises the types of negotiation, supported within the market.
- A *registry* of market clients who have expressed interest in doing business in the market.

Electronic Markets can be seen as electronic environments where certain kinds of goods are traded under explicit trading conventions. These conventions impose explicit objective requirements to the admission of goods and traders into the marketplace, and constrain the participant's behaviour to only those actions that are necessary and sufficient for trading under those conditions.

4.2. Virtual Organisations

One of the areas where improvements are starting to be especially visible, is the information technology for supporting business practices. Information technology can be helpful in providing infrastructures like:

- Computer and communications networks and associated intra, inter or local area networks;
- Large and distributed data bases
- Agent-based programming

We may define **Virtual Organisation** (VO) (identified as Virtual Enterprise by many authors) as a temporary network of independent companies having several different roles (suppliers, customers, sellers and buyers) connected through a communication network in order to share skills and competencies to access new markets. Due to their greater flexibility and agility, VO is capable of responding to rapidly changing requirements.

The VO life cycle can be decomposed in four phases [Fis96][Fai97]:

- *Identification of Needs*: conceptual design of the VO. The VO description is product driven.
- *Partners selection*: rational selection of the individual organisations that will compose the VO, based in its knowledge, skills, resources and availability.
- *Operation*: control and monitoring of processes between partners, including resolution of possible conflicts, and VO reconfiguration due to partial failures.
- *Dissolution*: breaking up the VO, and distribution of the obtained profits.

Virtual organisations can be characterised along several different axes:

- Scope of the activities: either single or multiple line
- Range of influences: local, national, regional, global
- Clients: organisation working for specialised clients or for the global market

If we follow M. Porter's organisation strategic analysis we may ask how is VO placed to answer the challenges of the market:

- What is the level of competition between organisations offering similar products?

A: VO introduces at this level a new paradigm: the possibility of easily creating temporary alliances with previous competitors as long as it is profitable for all of them.

- How can suppliers as well as customers influence and possibly impose a pressure on the Organisation?

A: VO gives the possibility for customers and suppliers to be on the same side and create alliances to keep useful common policies (concerning pricing, quality, etc).

- How does the organisation evaluate the risk of introducing new products in the market?

A: It is hopefully that VO can early detect threads and dangers coming from the bad market reactions to both the introducing of new or the substitution of old products.

Thompson and Strickland [Tho97] are responsible for what is called the SWOT analysis of current organisational and environment situations, regarding its Strengths, Weaknesses, Opportunities and Threats. In which the Virtual Organisations is concerned, the results of the SWOT analysis is given below:

Strengths:

- high flexibility of operation
- high speed of transaction
- reduction of transaction costs
- reduction of investments for organisation development
- minimisation of legal services
- bringing into the VO the best competencies of each partner.

Weaknesses:
- need of financial resources for the information technology
- need of trusting all the VO members
- possibility of inclusion of unreliable organisations
- difficulties in identifying and/or punishing VO members causing failures
- lack of formal supervision in transaction execution

Opportunities:
- fast reaction on environment (market) changes
- execution of the transaction despite barriers (laws, bureaucracy…)
- utilisation of up to date methods and management techniques
- possibility of co-operation between parties unknown to each other before
- reaching new groups of clients

Threats:
- inefficiency of technical equipment
- lack of laws regulating responsibility of the VO members and clients
- lack of clients' and companies' readiness to use VO services
- psychological resistance

According to this SWOT analysis, and comparing both advantages and disadvantages, we tend to conclude that the SO part is stronger than the WT one and, therefore, VO gives a chance to get more competitive advantage on the market.

5. Application examples

Several researchers and commercial companies propose architectures that support various aspects of Electronic Commerce. EC applications can be found in a variety of domains, from the simple buying and selling of goods to situations that require complex multi-participant negotiation and contracting. Below, we mention some of the best known EC systems already in practice and available through the internet.

Amazon [AMAZ] is a virtual book and music store. Due to low transaction costs, can offer a greater selection at lower prices than its physical-world competitors. It consists in a simple buying/selling process.

BargainFinder [BARG] was the first merchant brokering shopping agent. This system searches several music stores for lowest prices on CDs, and presents its results to the customer. Shopping is limited to suppliers that subscribes to the system. This system is no longer available in the world wide web.

Jango [JANG] is a system that performs queries to merchant sites for its availability, price and related information that is presented to the customer. Customers can then compare merchant offerings. This system is similar to BargainFinder, but with more product features to search.

Firefly [FIRE] is a system that suggests products to the customer based on reported preferences of others with similar tastes. The system attempts to establish the customer's preferences in music styles and artists, and offers a list of CDs that conform to these preferences. It compares customer's product ratings with those of other customers identifying the customer's "nearest neighbours", and recommends products that they have rated highly. The system works very well after a small period of training. However, it is limited to one retailer.

PersonaLogic [PERS] is a system that guides customers through a large product feature space, enabling to narrow down the products that best meet their needs. The system filters out unwanted products, and returns an ordered list of only those products that satisfy all of the hard constraints.

Tete-a-Tete [TETE] is a system that tries to efficiently match customers' needs with suppliers' offers. This matching process will encompass not only price, but also multiple terms of a transaction like warranty, shipping time and cost, quantity, payment options and credit/loan options. It is an academic research system developed by the MIT Media Laboratory.

Tap [TAP], *Onsale* [ONSA] and *Aucnet* [AUCN] are electronic auction houses developed for commercial use.

Tap uses an electronic open auction, based in the English mechanism, to sell airline tickets. *Onsale* sells refurbished computer and high-technology goods, employing also the English mechanism. *Aucnet* [AUCN] is a remote auto auction conducted via satellite, where bidders can access periodic inspectors' reports as well as photographs of the vehicles.

Kasbah [Cha96, KASB] is an agent-mediated electronic marketplace where users can create autonomous agents that buy and sell goods on their behalf. Agents are placed in a centralised marketplace, where they meet potential buyers or sellers and negotiate with them on behalf of their owners. Users give to the buyer agent a strategic direction that can be chosen from three available ones: frugal, anxious and coolheaded, corresponding to an exponential, linear and quadratic function respectively for increasing its bid over time. Each agent's goal is to make the best possible deal, subject to a set of user constraints such as desired price, reserve price and a date by which to complete the transaction. Agents use a very limited message protocol. Kasbah is an academic research system developed by the MIT Media Laboratory.

AuctionBot [AUCB] is an auction server developed at the University of Michigan, which allows people to design agents to run, or participate in, auctions over a network. A selection of auctions types and parameters are available for agents that create new auctions. The agents presented in the system collect bids, get the result of the auction and notify the users by email notification.

Fishmarket [FISH] and *Magma* [Tsv97] are others examples of agent-mediated electronic auction houses. *Fishmarket* tries to map the traditional fish market industry, and uses Dutch auction mechanism. *Magma* is a system where designed agents can trade several kinds of goods using the Vickrey auction mechanism.

Below we present a table summarising these Electronic Commerce systems, identifying the methodologies already mentioned in section 3:

	Information	*Negotiation*	*Settlement*
Bargain Finder	keyword based (merchant brokering)	—	—
Jango	keyword based (merchant & product brokering)	—	—
Firefly	collaborative filtering (product brokering)	—	—
PersonaLogic	constraint satisfaction (product brokering)	—	—
Tete-a-Tete	constraint satisfaction (merchant & product brokering)	—	—
Kasbah	keyword based (merchant brokering)	take-it-or-leave-it	—
AuctionBot Fishmarket / Magma	—	auction	—
TAP / Onsale Aucnet	—	auction	—
Amazon	keyword based (product brokering)	—	—

Note: product brokering – find what to buy
merchant brokering - find who to buy from

6. Conclusion

EC is changing the way business is being done. The rapid development of public and easily accessible network communications has enabled the proliferation of EC. However the use of these public networks pose some important problems that must be solved:

- Security of transactions, namely for electronic payments.
- Privacy in transactions information. The communication infrastructure must support standard encryption protocols that enable the privacy of the information exchanged between participants in the EC.
- Certification of participants. In order to ensure that all the information exchanged during the business transaction is coming from the true participants, digital signatures and certification protocols must be used.

Intelligent agent-based systems can be used with advantage in the automation of a variety of tasks in the EC field, namely searching of information and negotiation. The use of agents' technology introduces the problem of standardisation: agents, as software programs, must communicate and understand each other without human intervention.

The area of automatic information search has already been covered by several well known agent-based systems employing efficient artificial intelligence techniques (information filtering and constraint satisfaction) to both product and merchant brokering.

Negotiation is already an available feature in some agent-based systems. In which the negotiation process for Electronic Commerce is concerned, it should be improved by using more complex strategies including multi-attribute utility theory, distributed constraint satisfaction and also learning techniques. Some of these research issues are being addressed in our group (see [NIAD]).

Since the technical infrastructure for EC has been our main concern in this paper we could not conclude without stressing that all the efforts will be lost if the economical and business community do not face this challenge. Many enterprises have now the chance to pushforward in wider markets where they have not been present before, but they also will meet new stronger competitors.

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