Agent-Oriented Concepts to Foster the Automation of E-Business

Andreas Bartelt, Winfried Lamersdorf
Universität Hamburg, Fachbereich Informatik, Verteilte Systeme (VSYS),
Vogt-Kölln-Strasse 30, D-22527 Hamburg, Germany,
[bartelt|lamersd]@informatik.uni-hamburg.de

Abstract

Improving the efficiency of e-Business usage requires the further development of automation techniques for interorganizational business processes as a major driver. Automation can be employed at various stages and application areas of e-Business. The innovative concepts and enabling technologies we argue for in this context are automated negotiation, dynamic interoperability between standards, completeness, trust between business partners and graded anonymity. These agent-oriented areas strongly contribute to automated systems in e-Business and their acceptance by users. We conclude with the presentation of the relationship between current agent technology and the suggested basic concepts for the automation of e-Business.

Keywords. *Electronic Business, Electronic Commerce, Agent Technology, Automation, Completeness*

1. Motivation

The area of e-Business, which can be divided into subdomains like Electronic Information, Electronic Commerce and Electronic Cooperation, spans a wide range of applications useful to enhance the traditional business world. e-Business supports business processes by using web technologies. Enhanced with agent-oriented techniques it will allow a higher level of automation of the processes performed (see figure 1).

Major advantages of e-Business include cost reduction, an enormous speed up of interorganizational business processes and more convenient services to the customer. These advantages are primarily driven by the automation of processes. But the e-Business systems in use today still lack real automation in many cases. The required automation capabilities can be provided with the aid of agent technologies. This was shown with the first approaches to Shopping Agents [6]. Various stages of the consumer buying behaviour, like automatic merchant brokering, have been supported and steps towards a higher integration of systems are anticipated. These ideas should be enhanced and deployed at the broad base of Electronic Business.

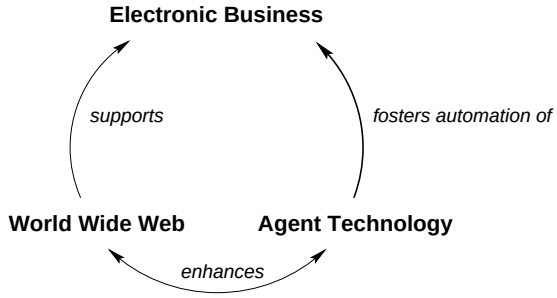

Figure 1. World Wide Web - Electronic Business - Agent Technology

1.1. Automation Demand in e-Business

To provide a basic example for the lack of automation today, just consider a company in a business-to-business scenario. Traditionally, the company received orders face-to-face. Then, telephones were invented and finally the fax machine made ordering easier and faster. By now, the medium of the Internet and Online Shops make the ordering even more efficient and reliable [1]. But most systems are not integrated. Wether not at enterprise application level (EAI is only performed for the major systems in the market [3]) nor even at the interorganizational level. Electronic Data Interchange (EDI) and Supply Chain Management (SCM) were important approaches to this area [11], but were focused and only feasible in specialised application areas. System like these allow a *static* automation of the execution of business processes in specific scenarios. But they need to be set-up

beforehand, requiring costly manual procedures.

Set-up here is meant twofold. The initial set-up is an issue but also the modification and maintenance of existing relationships matters. New versions of processes or data emerge at one side of the relationship and should still interact with the other system. Table 1 shows an evolution of the handling of business processes.

For automated systems there should be explanation and report components as well as manual interference features to get better acceptance from users.

Type	*Examples*
Manual	Face-to-Face
Supported	
→ Technical	Phone, Fax
→ Computer, Internet	E-Mail, Online Shops
Automated	
→ Execution Automated	
→ static	EDI, SCM
→ dynamic	?
→ Set-Up Automated	?

Table 1. Evolution of business process handling

2. Scope for Automation in e-Business

Automation can be employed at various stages and application areas of e-Business. The possible application areas are identified in the next but one section. First, the automatic set-up of automated business processes in addition to today's automated execution is discussed.

2.1. Automatic Set-Up of Automated Business Processes

Automation should allow the flexible automatic interaction between systems of competitive organizations.

This imposes various difficulties due to any differences between the systems. Figure 2 shows a possible structure of the differences to be managed before a business process may be executed. Usually this set-up is done manually, but there should be ways to automate this procedure to a greater extent.

(1) Interfaces: The first step is to establish interoperability between the interfaces of the systems. This already includes the management of system and information heterogeneity. Currently this will only be possible under predefined circumstances. This step can especially be supported

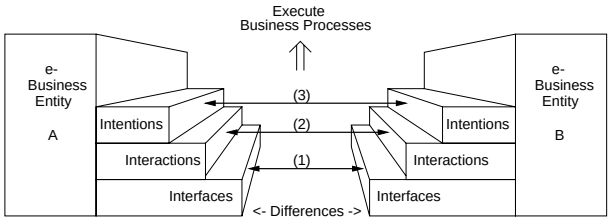

Figure 2. Model for Dynamic Setup

with dynamic interoperability of standards (see section 3.2), and negotiation on the details of the interoperable interfaces (see section 3.1).

(2) Interactions: To guarantee a smooth execution of business processes, it has to be agreed upon a set of possible interactions, protocols, rules and environments for communication. Also the content and objects of the interactions should be clarified. This step can be supported with negotiation on an interaction set (see section 3.1).

(3) Intentions: On the basis of the jointly set of interactions it should be negotiated between the different intentions of the entities to mutually agree upon the execution of a business process. Negotiation (see section 3.1) and Completeness (see sections 3.3, 3.4 and 3.5) support this step.

Execute Business Processes Finally the business processes, which may vary from simple queries of product catalogs to complex financial transactions, may be executed, even if they were not manually configured beforehand in detail. At this point Automated Negotiation may be the base for *dynamic* execution of business processes.

2.2. Automation Application Areas

The application areas where automation techniques are most useful to be deployed need to be identified. A potential classification framework is shown in figure 3.

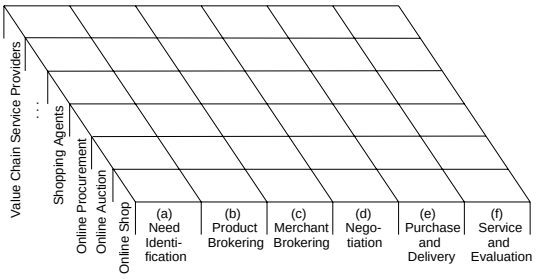

Figure 3. Automation Application Areas

The potentials for the automation of e-Business pro-

cesses may be analyzed 'horizontal' along each business model [19], from Online Shops and Online Auctions to Value Chain Service Providers. They may be 'vertically' analyzed using the phases in the Consumer Buying Behaviour (CBB) model as described by Guttman et al. [6]. The CBB model covers the phases of (a) Need Identification, (b) Product Brokering, (c) Merchant Brokering, (d) Negotiation, (e) Purchase and Delivery and finally (f) Product Service and Evaluation.

This analysis will result in detailed fields where automation may be applied. So common needs for automation concepts will become obvious.

3. Concepts and Technologies for the Automation of e-Business

The following building blocks provide functional capabilities to support the discussed dynamic cooperations between e-Business entities with different interfaces, interaction sets and diverse intentions — leading to a higher quality and new level of automation in e-Business.

The subsequently discussed concepts and technologies are: *automated negotiation*, *dynamic interoperability between standards*, *completeness*, *trust between business partners* and *graded anonymity*. These agent-oriented technologies help to implement automated e-Business systems.

3.1. Automated Negotiation

A negotiation can be described as "a discussion in which interested parties exchange information and come to an agreement" [5]. There is a two-way exchange of information where each party evaluates the information from its own perspective. The final agreement is reached by a mutual selection. Negotiations are common practice in the traditional business world. For the automation of relationships in e-Business there have to be Automated Negotiation capabilities, which are adapted to the special needs of e-Business.

The techniques of Automated Negotiation can be structured into protocols and strategies. For each possible situation of a negotiation participant the protocols define which (communication) actions are valid. Besides auction protocols [16, 17] there are several other protocols for Automated Negotiation [17, 13, 7]. The most important ways to model negotiation protocols. are dialogs, finite state machines [8] and petri nets [20]. Strategies of a negotiation participant select one action from the set of possible negotiation actions in each situation. The selected action should lead to the preferred outcome for the participant. Strategies are orientated at the utility of the outcome of a negotiation for the participant. The currently used strategies are mostly adapted to one special application problem. There are mathematical/analytical, heuristic/evolutionary, local and distributed strategies [20].

Automated Negotiation may be used in the set-up stage of automated business processes as well as in many situations in e-Business where negotiation is needed between different intentions and goals of the partners.

3.2. Dynamic Interoperability between Standards

A pre-condition for the automatic interaction of e-Business applications, by means of communication, coordination and cooperation, is the interoperability between the interorganizational systems. But today there is only inadequate support for the interoperability of systems, especially in the case of dynamically changing environments and interaction partners like in the e-Business domain [18]. Even the heterogenity of systems is fostered by producers to enhance their unique sales propositions[1].

Common standards are often claimed (e.g. [15]), but heterogenous norms and environments are the fact [18]. Even if there are standards, they may change over time in a mostly unpredictable manner. Accepted standards may have an inadequate dissemination. The specific needs in a situation may not be fully covered or the standard is too broad which both leads to a higher effort for the solutions. So it should be the overall goal to have systems with the ability to establish interoperability in an autonomous and dynamic way. Thereby different kinds of heterogeneity have to be handled (cf. [14]).

To get practical results in the e-Business area the problem may be restricted to the dynamic interoperability between relevant standards by means of information heterogeneity. This is still demanding, but there is a smaller scope and better basis due to the specifications of the standards. Important overlapping standards are the different versions of EDI, new XML based developments like CBL and cXML, various proprietary specifications for describing and referencing products, ECML supporting automatic interaction with e-wallets, potential upcoming protocols like 'Open Buying on the Internet' (OBI), 'Open Trading Protocol' (OTP) and 'Open Financial Exchange' (OFX).

3.3. Completeness

Besides the rare *really* new possibilities of e-Business, the most important element is the transition of conventional business transactions to the new electronic medium. Looking at the basic transition it is obvious that many reasonable parameters of the conventional business transactions

[1] Evident examples are the incompatibilities in Netscape's and Microsoft's web browsers and the different XML business initiatives CBL [10] and cXML [4].

are not used today in the new e-Business systems. In a usual electronic ordering system it is not possible to arrange the delivery conditions in an individual and flexible manner. Even the payment modalities can't be negotiated between the business partners. Shopping agents[2] often only take the prices of products into account and work on a very incomplete set of parameters for business transactions. Also the modelling and realistic interaction options with the business partners have been left out. But comprehensive and systematic handlings of these issues are needed to allow the development and acceptance of automatic e-Business systems. The missing parameters and interaction options must be identified, structured and weighed in accordance of their relevance to e-Business situations. Domain specific and domain independent areas should be included.

The aspect of *Automated Negotiation* as presented in section 3.1 may be seen as common interaction option for e-Business systems, leading to higher Completeness. Further common areas like *Trust between Business Partners* and *Identity and Graded Anonymity* will be described in subsequent sections.

3.4. Trust between Business Partners

The aspect of trust has a relevant role in the business world. Contracts used to be completed by handshake. Contracts could provide a framework for the relations and help when vaguenesses are coming up [9], but they could not be the exclusive basis of a business relationship. All phases of a contractual agreement depend on more or less mutual trust, because full certainty can't be or would be too costly to achieve. In the context of *Completeness* it seems useful to map the aspect of trust between business partners to the e-Business area. Systems enhanced with trust models and trust handling should be able to perform a broader range of tasks in an autonomous manner and with higher quality.

An example would be the automated merchant brokeraging. The impartial decision for a concrete merchant isn't easy, since there are many competing suppliers. Besides price and other decision factors there would be the aspect of trust. If someone already ordered from an specific online merchant and was content with the procedure, it would add to the rating to choose this merchant again. Another example are the reputation mechanisms already built into real applications. EBay[3], primary an auction site for private sellers and buyers, motivates their users to give ratings on the business behaviour of the other users.

Obvious ways to aggregate trust values are own experiences or adapted experiences from others. Trust values may rise with undergone reliablity of the business partner. Besides the business partners themselves, the objects for the trust values could also be the quality of the products and services, the delivery time, liquidity or the confidential handling of information. The technical and organizational environment of a transaction may also be rated and adds to trust values for a special situation.

There is a relation of trust between business partners to the modelling of trust in multi-agent systems[12]. Business partners may be represented by agents. But there are no relevant results in this area until now. Further stimulation and insights to the theme may come from the disciplines of psychology and sociology.

3.5. Identity and Graded Anonymity

In traditional business there are steps from an anonymity level to an identity level for buyers and suppliers as a business transaction is performed. Identity and Human Identification is a complex issue [2]. Anonymity is often seen as complete anonymity and in the context of privacy issues. Graded anonymity may contribute to usable, well controlled and better accepted processes in eBusiness. For example a wholesaler may inform another company of his range of products if he knows about the branch of the company. But the wholesaler will only answer to an inquiry about prices and availability to promise when he has the full identity of the other company. It seems to be very useful to have the possibility of several grades of anonymity and identity. This may vary in the context of the different interactions along the consumer buying behaviour model [6]. Also Graded Anonymity is a two-way street between the business partners and must be seen from the supplier's as well as the customer's perspective.

4. Using Agent Technology to Support Automation

Agent-oriented concepts are useful to implement the systems described above, because they provide the necessary technologies for autonomous and flexible systems, like automated systems in e-Business. Automated Negotiation is a basic technology for autonomous systems. No automation will be possible without dynamic interoperability. A *complete* agent like modelling in e-Business supports the acceptance from users and optimizes the utility of the applications.

The presented concepts and techniques for e-Business automation contribute to the agent properties *Autonomy*, *Social Ability*, *Reactivity* and *Pro-Activeness*[4]. The number of queries sent back to the user are reduced. A new type of communication evoles as a social ability with more expressiveness and a better technological basis. A mental model

[2] See Guttman et al. [6] for an overview of shopping agents

[3] http://www.ebay.com

[4] These combinations of agent properties were presented by Wooldridge and Jennings in 1995 and are widely used today [22, 21].

of the business partner and a memory of past activities contributes to autonomous and proactive decisions.

These relations also indicate that the evolving agent technology seems to be well suited for usage in e-Business applications. Autonomy of the e-Business systems helps the user to be more efficient. Social ability and communication is a basis for the interaction of the systems. Reactivity and Pro-Activeness add to Autonomy and encourage the delegation of tasks to the agent-oriented e-Business systems.

Continuously recurring processes may be automated by coding them statically into the application systems at design time — but the abilities provided by agent systems help to automate dynamically generated processes.

5. Conclusion and Outlook

In this paper we have presented agent technology and related concepts as a major driver for the automation of e-Business. The need for *automation* in today's mostly technically *supported* business world was discussed and the possible automation areas were analyzed. The stage of the automated set-up of business processes is an important issue in this context. Automated Negotiation as a basic ability for autonomous agents and automated e-Business systems was discussed. Dynamic Interoperability is a requirement for agents as well as e-Business entities. The Completeness of attributes taken into consideration in automated systems is an issue for the utility and acceptance of e-Business systems and agent systems alike. We are currently working on a system platform which supports these concepts in an integrated way on top of a Voyager/CORBA based agent system.

As e-Business research should focus on the application of technologies it should be a task of the agent technology research to provide the required techniques for automation. We will focus on the further analysis and development of the fundamental concepts for the automation of e-Business and the implementation of concrete scenarios for efficient e-Business automation.

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