The communicative logic of negotiation in B2B e-commerce

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Abstract: Negotiation is an important challenge for B2B e-commerce that is hardly supported by current systems. In this paper, we present a short overview of different perspectives on negotiation and describe the ESPRIT project MeMo (Mediating and Monitoring Electronic Commerce) which aims at supporting B2B negotiation. A prototype has been built and tested in the Dutch construction industry. Our aim in this paper is a formal logical analysis of negotiation protocols. Dynamic Deontic Logic is used as a starting point for our model, but, as we argue, some extensions of this framework are necessary. A formal analysis of so-called norm-based negotiation is presented. Some alternative negotiation protocols are discussed as well.

1. INTRODUCTION

Negotiation is a key component in e-commerce. In automated negotiation, computational agents find and prepare contracts on behalf of the real-world parties they represent. The automation saves human negotiation time and computational agents are sometimes better at finding deals in combinatorially and strategically complex settings. An example of a system supporting such agent negotiation is the eMediator system built at Washington University (Sandholm, 1999). However, it is only in relatively well-structured areas that the use of automated negotiation pays off. In most business settings, negotiation will remain to be performed by humans. In such a case, negotiation support systems can be of help. An example of a negotiation support system is the INSPIRE systems built by Gregory Kersten at Carleton University (Kersten & Noronha, 1997).

In Electronic Commerce, market transactions are supposed to consist of a couple of phases (e.g. Lindemann & Schmid, 1999). In the information phase, customer and supplier find each other. When an offer is made, the agreement phase starts. The

result of the agreement phase is a legally binding contract. In the settlement or fulfilment phase, the agreed-upon terms of the contract are fulfilled by delivery of products and payment. Sometimes, an after-sales phase is distinguished. In such a model, negotiation is located in the agreement phase.

In this paper, we first provide a brief overview of the MeMo project. In section 3, we present an overview of different perspectives on negotiation. In section 4, we introduce the Dynamic Deontic Logic that we take as starting point for our formal model, and section 5 provides a formal analysis of so-called norm-based negotiation using the Dynamic Deontic Logic. In section 6, some alternative negotiation protocols are discussed.

2. MEDIATING & MONITORING ELECTRONIC COMMERCE

Electronic Commerce is doing business via electronic networks such as for example Internet and World Wide Web (WWW). Electronic commerce can be seen as the successor of Electronic Data Interchange (EDI), but it goes far beyond EDI in that it aims at supporting the complete external business processes. Information about potential business partners can be obtained, through specialised databases, chambers of commerce, and lately also through the WWW. Also the fulfilment of the transaction is well supported.

However, there is practically no support for the connecting stage of contract negotiation. This stage has to be done manually. This is a major obstacle for the uptake of electronic commerce by Small and Medium Size Enterprises (SME's). Big companies can usually afford to undertake the time and money consuming enterprise of negotiating interchange agreements, because they can establish long-term relations with their suppliers (or customers) and they have the expertise in house. The MeMo system is one of the first solutions aimed at SME's.

2.1 Negotiation and Contracting Mechanism

The Negotiation Module of MeMo supports business-to-business negotiation and contract building. The precondition for business relations is a relation of trust between all business partners. This relation of trust depends on personal contact on the one hand and on contracts and legislation on the other. The MeMo negotiation module does not replace human informal communication, but enables human agents to structure their communication using a Formal Language for Business Communication. Since the results of the negotiation are typically laid down in a contract, it also offers a repository of standard contracts and a shared workspace in

which a standard document can be adapted by the partners to their particular need. It facilitates different scenarios and provides SMEs with safe “negotiation rooms”.

Since language is often a big barrier for international trade, especially for small companies in Europe, the Negotiation Module also contains a multilingual thesaurus in which key terms of international trade are given in multiple languages. In this way, it is possible for the human agents to personalise their MeMo interface to their particular language. By all these means, MeMo is one of the first systems that really facilitate business negotiation via the Internet.

2.2 User Evaluation

In order to involve a group of SMEs in the project, MeMo has formed a SMEs Round Table in Spain, in Germany and in the Netherlands. These user group round tables provide the ideal environment to continually discuss the incremental developments and test the EC-Brokering Service (ECBS) with SME user companies. The most extensive evaluation of the system has taken place in the Dutch constructing industry.

One of the results of this evaluation was that traditional non-automated negotiation causes the agreements to contain many errors, resulting in high failure costs in the fulfilment stage. An integrated system like MeMo can help to reduce data errors. Another result was that negotiation means quite different things for different roles in the value chain, and that a system like MeMo must be tuned to a particular role before it can be used effectively. For example, a wholesaler negotiates with manufacturers about frame-contracts on a yearly basis. He negotiates with contractors on a project-basis. During and after these negotiations, he forwards specific orders (electronically) to the manufacturers within the boundaries of the frame contract. Negotiation and fulfilment are not strictly separated, since contracts are modified and updated many times before the final delivery. Contractors negotiate with wholesalers on a project-basis, and do this typically by asking quotes from several parties and then using this information in bargaining. The bargaining is seldom about the price only, but more often about delivery schemes and extra services.

3 . PERSPECTIVES ON NEGOTIATION

A classical model of negotiation was introduced by Gulliver (1979). This process model consists of eight phases:

1. search for arena
2. agenda definition
3. exploring the field (emphasis on differences)

4. narrowing differences
5. preliminaries to final bargaining
6. final bargaining
7. post-negotiation phase
8. ritualization of outcome (signing of contract)

According to Kersten, negotiations involve two or more participants engaged in two types of complex activities: communication and decision making. The communication can be modelled using for example Speech Act Theory (e.g. Chang & Woo, 1994). The decision making occurs at two levels: individual and interindividual. The contract is typically based on an exchange of goods or services. Hence neither of the parties can decide on the contract on its own: they are interdependent. In that sense, the decision to come to an agreement is a group decision. On the other hand, each participant has his own objectives that he tries to fulfill. The decision whether a certain bid is acceptable or not, is an individual decision of one actor.

In this paper, the perspective is communicational (Habermas, 1981; Schoop & Quix, 2001). Negotiation moves are analyzed as communicative actions that have a certain effect in the social world (the world of norms and commitments), the subject world (the world of values and beliefs) and, at the end of the day, also in the object world (the world of accomplishments). We will not go into the decision problems. The social and cognitive perspectives are taken into account as far as they are relevant to the communication process.

If negotiation is about arriving at an agreement, a typology of negotiations can be based on the basis for the other party to accept the agreement. *Why does the other party agree to sign the contract?* One reason can be that he is obliged to do this. In other words, the party is supposed to be motivated by norms (at least partly). This leads to a type of negotiation that we call norm-based, and which corresponds with the classical quotation process. Another reason for signing is that he wants to do it. In other words, the party is supposed to be motivated by goals (at least partly). This leads to a type of negotiation that we call goal-based. In this type of negotiation, the parties try to fix common or mutually accepted goals. In addition to these two types, we identify what we call document-based negotiation. In this type of negotiation, the contract is built up in small steps. This type of negotiation does not look at the motivation of the parties, but tries to achieve the goal of a signed contract by getting agreement on the various parts first. In section 5, we will focus on norm-based negotiation as it turns out to be the most common in the application domain of the MeMo system. A few remarks on the other types will be made in section 6.

4. DYNAMIC DEONTIC LOGIC

In (Verharen, 1998) and in various articles (e.g. Weigand et al, 1997), a formal logic has been described for modelling communication. It is based on Dynamic Deontic Logic and extended to include speech acts. Instead of repeating all the formal definitions here, we limit ourselves to a vocabulary and some examples of its application in business process modelling.

$O(\alpha)$	action α is obliged (possibly with indices i and j to indicate the agent and principal)
$[\alpha]\phi$	(Dynamic Logic) after action α , formula ϕ holds
$Auth(\alpha)$	action α is authorized (where the action is a speech act)
DIR	directive (based on charity (c) or authorization (a) – the latter meaning that the request claims to be authorized by a previous agreement or norm)

Examples:

$[DIR_c(i,j,give-quotation(j,i,g,p))] O_{ji}(give-quotation(j,i,g,p) \text{ OR } refuse(j))$

After a request for a quotation (i.e. a directive based on charity) the company is obliged to give the quotation or send a refusal. This follows from the generic business rule that a request for a service offered is always answered.

$[give-quotation(j,i,g,p)] auth(i,DIR_a(i,j,deliver(j,i,g,p)))$

If a company gives a quotation for a certain price (p) the client is authorized to order the product (g) for that price. (i.e. a meaning definition for give-quotation).

$auth(i,DIR_a(i,j,deliver(j,i,g,p))) \Rightarrow [DIR_a(i,j,deliver(j,i,g,p))]$
 $(O_{ji}(deliver(j,i,g,p)) \text{ AND } [deliver(j,i,g,p)] auth(j,DIR_a(j,i,pay(i,j,p))))$

If a customer is authorized to order a product for a certain price (i.e. a quotation has been given for that price) then the company is obliged to deliver the product after the customer has ordered it. After delivery of the product, the company is authorized to order the customer to pay for it.

The logic can also be used to reason about violations:

$O_{ij}(i,j,ship(i,j,goods)) \Rightarrow [\sim ship(i,j,goods)] (O_{ij}(i,j,pay(100)) \text{ AND } auth(i,j,DIR_a(i,j,ship(i,j,other_goods))))$

if i is obliged to ship the goods and he does not do it, he is obliged to pay a fine and the other party j is authorized to request (other) goods

Besides **O** and **auth**, we include one more primitive operator in the deontic specification language. This is **acc**, for accomplishment. **acc**(α) means that action α has been executed. As with **O** and **auth**, it takes typically two messages, one of both parties, to establish such a fact.

The DDL model recognizes that communicative acts are joint efforts, and that requests do not automatically create an obligation. However, the fact that business negotiation is really an interaction in which two objectives have to be synchronized, is not sufficiently accounted for. (Weigand & vd Heuvel, 1998) have developed 5 levels of “meta-patterns” starting with the speech act level. Of particular importance here is what they call the level of transaction. A transaction is defined as the minimal sequence of speech acts that has a deontic effect. The typical case is a REQUEST followed by an ACCEPT. Although it can be agreed upon by the parties that a simple REQUEST already creates an obligation, we prefer to assign deontic effects to transactions only, even if in some case the transaction consists of only one speech act.

5. NORM-BASED NEGOTIATION

Let us consider an order message. As we have seen, this is analyzed logically as a request (illocution) for the delivery of a product (propositional content). A request contains an implicit validity claim: why should the other party honor the request? In (Weigand et al, 1997) three possible validity motivations have been distinguished: charity, authorization and power. Power is not applicable normally in a market environment. Charity means that the other party is not obliged in any way to honor the request, but he may decide to do so himself, and then, after his commit, an obligation is created. This is a real possibility, but there are certain disadvantages. If the buyer mentions a price, he runs the risk that the price is too high or too low. If it is too high, the seller will accept the order, but the buyer could have made a better deal. If it is too low, the seller will not accept the order and the negotiation may terminate immediately. Another disadvantage of a charity-based order from the perspective of the buyer is that he cannot compare different sellers, since the discussion is about the order, and so when the two parties arrive at an agreement, the order is placed and the buyer cannot withdraw anymore. And finally, since the order is charity-based, he does not know whether the seller will respond, or will respond timely. This uncertainty is often unacceptable in a business environment. We conclude that an authorized request is to be preferred over a charity-based one.

Figure 1. Main phases of the negotiation, with discussion layer and discourse layer below

When the order is authorized, the question is where this authorization stems from. In B2C relationships, shops are identified as such and prices are listed. These *listed prices* authorize the consumer to order (or request) a product for that price. In B2B relationships, it is less common to use listed prices. This implies that the authorization must be granted first. Of course, this is exactly what a *quotation* message does. In speech-act theory this is analyzed as an authorization message, a message that creates an authorization (namely, to order). The quotation itself is an action on behalf of the supplier that must be triggered somehow and possibly also authorized. For that reason, there is usually a message before, the *request for quotation (RFQ)*, by means of which the buyer request for a quotation message. This request is usually based on charity; the other party commits to this request voluntarily. The RFQ authorizes the seller to send a quotation.

5.1 The main phases of norm-based negotiation

This logical reconstruction of the pre-ordering communication leads to a distinction in at least two phases: the RFQ phase and the QUO phase. In the simple case, these messages (and their uptake by the other party) are sufficient. But if something is unclear or not satisfactory to one of the parties, a discussion can start (Fig. 1). In terms of the Language/Action Perspective, a *break-down* occurs. A break-down means that a discussion starts and only after having finished this discussion, the phase can be closed (Reijswoud, 1996).

In the MeMo view, the discussion in the RFQ phase centers around the identification of the goals of the transaction. This includes the identification of the participants themselves ("who are you?") as well as the precise identification of the product ("what do you want?"). In terms of Winograd (1988), the discussion is a *conversation for clarification* and the typical speech-acts in this phase are questions and answers. The discussion ends when both parties have sufficient confidence that the intended transaction is properly identified (to both) and the seller commits himself to make a quotation.

In the QUO phase, the seller fulfils his obligation to send a quotation. This quotation contains an authorization for the buyer to order the product. It may contain alternatives (different products, or different prices for different product quantities). A discussion can start on this proposal that in terms of Winograd takes the form of a *conversation for possibilities* and the typical speech acts are proposals and counter-proposals. The discussion ends when both parties accept one or more proposals and the buyer accepts the (modified) quotation.

It should be noted that often the quotation message *also* contains a (conditional) request to the buyer to pay the quoted price. Accepting a quotation implies accepting this request. Again, a discussion may arise in the case of a break-down. This discussion typically takes the form of a *bidding process* and the typical speech acts are bids and counter-bids. The discussion ends when both parties agree on a certain price. The bidding process can be structured by using a monotonic concession protocol (Zlotkin & Rosenschein, 1996) which means that a next bid is always stronger than a previous one (in plain words, the buyer only goes up with his bid and the seller only goes down). Note that this bidding process can run in parallel to the conversation for possibilities, although the parties can also decide to finish this conversation first. The advantage of doing the bidding at the end, is that price gets less attention during the exploration of the possibilities, which will probably result in more alternatives to be considered and worked out. However, if the goods or service are not very specific and easy to describe, the price may be the most important decision factor, and hence is better taken into account immediately. Our research in the Dutch construction industry showed the following picture: first, a quotation process is performed in which price is the most important attribute. Then one or two suppliers are selected and negotiations start with them in which all kinds of possibilities are explored. In terms of the formal model used here, this means that within the QUO phase, there is a bidding process first, followed by a conversation for possibilities.

After the quotation is accepted by the buyer, there is no contract yet. The buyer can negotiate several quotations from different suppliers and then choose the one that fits him best. At this point, different scenarios can be followed. One is that the buyer fills in a purchase order or some other formal contract. After having being signed by both parties, this contract is binding and contains not just authorizations, but obligations of both parties to perform their part. It is also possible that a frame

contract is set up and afterwards, a delivery order is sent in accordance with the frame contract. The most simple case is that the buyer sends an order to the seller and the seller accepts this (note that normally, the seller is obliged to accept the order since it is authorized by the quotation).

Also in the ordering phase, a discussion can arise. From the negotiation perspective, we are only interested in discussions about the contract, so we ignore discussion about a delivery order after a contract has been signed. In the MeMo system, this discussion is not done by means of speech acts, but by collaborative writing (document-based negotiation). Both parties have access to a shared workspace in which the draft contract is stored as a document. Parties can update this document into a newer version. The "discussion" ends when both parties agree on a certain version.

5.2 Logical semantics of the quotation phases

Summarizing, from a logical view on negotiation we distinguish four phases and their postconditions:

[identification] *social world:* $O(y, \text{quote}(y, x, p))$.
subject world: $\text{ident}(x, i), \text{ident}(y, j), \text{Des}(x, p)$

In words: the parties mutually know the identity of x , the identity of y , and that x desires product p . This is a change in the subject world. The change in the social world is that y has an obligation to send a quote. p is a product description.

[proposal] *social world:* $\text{auth}(x, \text{order}(x, y, p))$
object world: $\text{DONE}(y, \text{quote}(y, x, p))$

In words: x is authorized to order product p from y , and the obligation of y to send a quote has been fulfilled. Note that the price still needs to be determined.

[bidding] *social world:* $\text{auth}(y, \text{invoice}(y, x, f))$

In words, y is authorized to invoice x for the amount f - where invoice means: request to pay.

$([\text{quotation}] = [\text{proposal}] + [\text{bidding}])$

[contracting] *social world:* $O(y, \text{delivery}(y, x, p)), O(x, \text{pay}(x, y, f))$.

In words: y has an obligation to deliver and x has an obligation to pay. There may be additional clauses, for example, requiring the seller to deliver *before* sending

the invoice. In the case of a frame order, both obligations are conditional (the condition can be the delivery order message, or a stock status change).

All these phases are essential in the sense that they have a specific effect on the social world, but each phase may be passed in one step, or may contain an extensive discussion. The second and third phase (proposal/ bidding) are often done in the same message exchange. The advantage of having four phases is that the discussions in each phase can focus on one issue at the time.

5.3 Tender-based negotiation

In the above, we assumed one seller and one buyer. However, it is also possible to negotiate with several parties at the same time. Instead of a request-for-quotation, the buyer can send a tender to a set of sellers. After receiving the bids, the buyer typically selects the cheapest one (or best one, given multiple criteria), and puts his order. The phases are the same as in quotation-based negotiation; the bidders are typically *obliged* to perform the transaction when they are selected, so it also a kind of norm-based negotiation.

Roughly, two subtypes of tender-based negotiation can be distinguished. In one type, the tender procedure is pre-defined, and all parties involved are informed about the rules of the game. The buyer is usually *obliged* to select the cheapest (or best) bid. There is no room for discussion. The bids may or may not be revealed to the other bidders. In the other type, the tender-based negotiation is nothing but the performance of a number of quotation-based negotiations in parallel. The buyer can use information that he receives in one negotiation to press the party in another negotiation. There are no rules defined for all parties, and in each negotiation there is the possibility of discussion.

The advantages of a formally defined tender protocol are (a) the efficiency of the process, (b) and built-in guarantees for a fair competition. A disadvantage is that, since discussion is excluded, the subject of the tender must be clearly defined in advance. Also the evaluation criteria are determined in advance (most often, this is the price), which leaves little room for suppliers to distinguish themselves with special services.

The MeMo system does not only support quotation-based negotiation, but also tender-based ones. The shared workspace can be used to publish the details of the tender and tender procedure.

6. GOAL-BASED AND DOCUMENT-BASED NEGOTIATION

Besides norm-based negotiation we distinguish goal-based negotiation and document-based negotiation.

Goal-based negotiation does not aim at an authorization, but assumes that the parties (whether human or software agents) are motivated by goals. Hence, if a deal can be defined that meets the goal of the other party, this will motivate him to agree.

A goal-based negotiation protocol may consist of four main phases: (1) the introduction, in which the parties greet each other and introduce themselves, (2) goal identification – in which the parties express some of their goals, typically only after being asked, (3) exploration – in which the parties suggest opportunities, alternative ways of achieving the mutual goals, and (4) agreement in which one of the alternatives is agreed upon by both partners, perhaps with some small modifications. The exploration phase may be diverging first and converging in the end. The speech acts in the first introductory phase are greetings and self-introductions, the speech acts in the second goal identification phase are mainly questions and answers in the form of expressives, the speech acts in the third phase are suggestions and expressions of agreement/disagreement. Finally, the agreement phase consists mainly of proposals. Not only in the second phase, but in all phases, questions are very important, to make the parties express their goals and their proposals. This is in sharp contrast with the typical norm-based negotiation, where requests are predominant.

Negotiation styles are influenced by cultural backgrounds (Ulijn & Strother, 1995), and it may be the case that the goal-based negotiation is closer to the Oriental cyclic style. It is important to note that whereas norm-based negotiation is grounded in what Habermas calls the social world, the goal-based negotiation is grounded in what Habermas calls the subject world. It may be argued that goal-based negotiation lends itself less well to computer-mediated forms. It is not supported yet in the MeMo prototype.

Document-based negotiation is a negotiation process in which some document – typically the contract – plays a pivotal role. It can work very well if a document template is available, such as the contract templates issued by the International Chamber of Commerce. The process proceeds in steps determined by the contents of the contract. The clauses of the contract are grouped, and in each step, one set of clauses is discussed. After some agreement is reached, the next group of clauses is considered. Finally, when a preliminary agreement (soft commitment) is reached on all parts, the parties discuss the whole. A document-based negotiation is especially interesting in complicated situations, such as in international sales. In such cases, it is better to first see if an agreement is possible at all, and the legal safeguards are sufficient, before bargaining about the price, or other one-dimensional parameters such as delivery time, makes any sense. Document-based negotiation is currently

supported in the MeMo prototype in the form of a contract base with a number of template documents and a negotiation protocol around this contract.

7. CONCLUSION

In this paper, we have described the MeMo system and the negotiation support it currently offers. We have described the formal semantics of norm-based negotiation using Dynamic Deontic Logic. In addition, we have sketched two other negotiation types. The MeMo system aims at flexible negotiation support; instead of imposing one protocol on each negotiation session, the parties can choose a preferable protocol themselves. So in the case of a sales contract, the quotation-based protocol can be used, while for the negotiation about an agency contract, a document-based protocol is more appropriate. Combinations are possible as well.

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