DOC.COM: COMBINING DOCUMENT AND COMMUNICATION MANAGEMENT FOR NEGOTIATION SUPPORT IN BUSINESS-TO-BUSINESS ELECTRONIC COMMERCE

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Abstract - Negotiation in traditional commerce is a complex commu-nication process. Research in negotiation support for elec-tronic commerce has focused on new negotiation protocols such as auctions. However, for peer-to-peer negotiations in business-to-business electronic commerce such protocols are inappropriate. In this paper we present a novel ap-proach to the effective support of electronic negotiations. Existing negotiation processes in traditional commerce are analysed to find out about negotiation patterns and to an-ticipate potential problems. Our aim is to exploit the poten-tial of information technology to overcome (most of) these problems for electronic negotiations. Electronic negotia-tions between business partners involve the exchanges of documents and messages. Documents are contracts which evolve during the negotiations. The evolution is coordinated through the exchange of structured messages such as of-fers, requests, quotations, counteroffers, and acceptances. In contrast to the current practice of separate management of messages and documents, we propose a powerful frame-work for effective negotiation support in electronic com-merce by combining communication and document man-agement.

I. INTRODUCTION

Electronic commerce (EC) is turning from a vision into reality. One of the challenging tasks in the area of EC is sup-porting electronic negotiations. Negotiation in traditional commerce is a complex communication process. Research in negotiation support for EC has focused on new negotia-tion protocols such as auctions [11, 10]. However, for peer-to-peer negotiations among human negotiators in business-to-business electronic commerce (BtB EC), such protocols are inappropriate. The current status of electronic negotia-tions is that usually electronic forms of catalogues are pre-sented to a customer which means that the customer can either decide to order for the price mentioned or to leave it altogether. No explicit support of interactions dealing with negotiation steps is offered. We argue that such sup-port is required and, consequently, we will present a novel approach to the effective support of electronic negotiations involving human actors in this paper. The approach is based on an analysis of negotiations in traditional commerce to find out about negotiation pat- terns and structures and to anticipate potential problems. Since electronic negotiations involve written communica-tion, existing communication problems need to be consid-ered because they pose a serious threat to smooth interor-ganisational communication and business processes in gen-eral [19]. Our aim is to exploit the potential of information technology to overcome (most of) these problems. Negotiations involve the exchange of documents which are the basis of the discussion process. In addition, elec-tronic negotiations involve the exchange of structured elec-tronic messages which form the medium of communication among the business partners. We will present a novel frame-work for structured message exchange for communication management based on theories of communication and for-mal logics. Systems based on the framework will ensure efficient unambiguous interactions in which the obligations are clear for all business partners involved.

Documents that are exchanged are versions of the con-tract between the parties involved. During the negotiation process, information in the contract is changed which leads to a new version of the contract. Similar to the novel forms of communication support, a framework for document man-agement is presented that fits the requirements of electronic negotiations in BtB EC. For example, semi-structured con-tent is necessary as the contents of documents exchanged during negotiations is not a fixed set of features. Further-more, it must be possible to discard a current version of the contract and reuse an old version. Thus, backtracking is an important requirement.

Traditional document management systems support the evolution of documents by keeping track of different ver-sions. However, such systems do not provide facilities to track the messages which are exchanged during the evo-lution of a document. On the other hand, communication management systems manage the structure of messages that are exchanged but do not consider the documents that might be initiated by the messages. We argue that there can be no separate document and communication management for ef-fectively supporting electronic negotiations. Therefore, we propose to link the messages to the documents. A powerful framework for effective negotiation support in EC will be

presented that combines communication support and docu-ment management.
The structure of the paper is as follows. In section 2, we will briefly present the general approach we have taken.
The finding that the main problems concerning negotiations centre around communication led to the idea to look at es-tablished theories of communication for help with analysing and classifying the problems observed. Before presenting the novel approach to communication management for elec-tronic negotiations, the relevant elements of two communi-cation theories will be introduced in section 3. The discus-sion of requirements for effective document management in that context follows in section 4. The main contribution of the present paper is the combination of document man-agement and communication support. Section 5 starts with the presentation of a conceptual model for electronic ne-gotiations. We then argue for a representation of message and contract contents as extensible semi-structured docu-ments. A formalisation of the framework DOC.COM will be introduced to enable reasoning about obligations and du-ties. The contents of obligations is linked to the contract and messages exchanged during the negotiation which al-lows queries about documens and messages. Thus, contract versions and messages can be accessed in many different ways, e.g. through the message type, different features of the contents (such as price, goods), sender, open obligations etc. Finally, a discussion of the merits of our approach will conclude the paper (section 6).

II. APPROACH

In this section, we present the general approach to nego-tiation support in BtB EC. We started by looking at tradi-tional negotiation processes. The idea was to find out about negotiation patterns, communication and cooperation prob-lems, and areas where negotiation in a conventional form works well. Some of the problems observed will occur in electronic negotiations as well. For example, ambiguous statements can become a serious obstacle for smooth in-teractions, especially in written forms of negotiation where no communication partner can directly be asked for clar-ification. We observed that the main problems in negoti-ation processes centre around communication. Therefore, the idea was to look at established theories of communica-tion for help with analysing and classifying the problems observed.

The theories that were found to be most relevant were Searle's Theory of Speech Acts [23] and Habermas' The-ory of Communicative Action [9]. A framework combining relevant elements from both theories for analysing multi-disciplinary written communication has been developed in [18, 21]. Based on that framework we have established the potential causes for communication breakdowns, e.g. in-comprehensible utterances, problems with trusting the other party, disagreements about the normative context of busi-ness exchanges etc.
After establishing common problems, we moved on to describe features of “ideal” systems supporting electronic negotiations. This will be the focus for the remainder of this paper. We will elaborate on the following scenario:
Company A wants to buy shoes with certain characteristics (leather sole, black colour) from company B.

III. COMMUNICATION MANAGEMENT

In this section, our vision of communication manage-ment for EC will be presented. Firstly, we will briefly in-troduce two theories of communication as the theoretical foundations. Using elements of these two theories, we then describe the structured message exchange as a means of ef-fective negotiation support.

3.1 Theoretical Foundations

It has been reported that the main obstacle to smooth and effective cooperative interactions are fundamental commu-nication problems and that communication is used for co-ordinating multidisciplinary activities [18, 19, 22]. Buyers and sellers engaging in EC often come from different areas so in this sense the communication is “multidisciplinary”. Therefore, the idea was to look at communication theories as the theoretical foundations.
The obvious candidates of communication theories were Searle's Theory of Speech Acts [23, 24] and Habermas' Theory of Communicative Action [9] since both have been influential in the field of information systems.

3.1.1The Theory of Speech Acts

The Theory of Speech Acts was published by John Searle in 1969 [23, 24]. Searle argues that the minimal unit of an utterance is not a word or a sentence but a speech act. Each speech act (such as “I promise to deliver the goods before 4/8/2000”) consists of two elements: the proposi-tional content describes what the utterance is about (deliver the goods before 4/8/2000) whereas the illocutionary force describes the way it was uttered (in this case as a promise).
Each speech act has got a “point” which characterises that particular type of speech act. For example, an asser-tion is about informing other people, a request is about get-ting the recipient to perform an action etc. This purpose of the act is called the illocutionary point. Searle clas-sifies utterances according to the

illocutionary point into five classes: assertives represent facts of the real world, e.g. reports; commissives represent the speaker's intention to perform an action, e.g. promises; directives represent the speaker's attempt to get the hearer to perform the action in-dicated in the propositional content, e.g. requests; expres-sives describe the speaker's feelings or psychological at-titudes, e.g. apologies; declaratives change the world by their utterance, e.g. sentencing a prisoner. Each speech act implies a commitment for speaker or hearer. The most important forms of commitment occur in commissive and directive speech acts as they deal directly with the coordination of actions. A commissive speech act commits the speaker to perform the action (s)he indicated in the propositional content of the utterance. A directive speech act issues a commitment for the hearer to perform the action. Uttering the example speech act above would thus mean committing oneself to deliver the goods before 4/8/2000.

3.1.2 The Theory of Communicative Action

Jurgen¨ Habermas published the Theory of Communica-tive Action in 1981 [9]. He argues that a speaker making an utterance makes four implicit validity claims:

- the utterance is comprehensible so that the hearer can understand the speaker;
- the utterance is true, i.e. it represents a fact or a common experience, so that the hearer can share the speaker's knowledge;
- the utterance is truthful, i.e. the speaker is sincere in expressing his or her intentions, so that the hearer can trust the speaker;
- the utterance is appropriate in relation to a given nor-mative context, values, or standards, so that the hearer can agree with the speaker in these values.

These four validity claims can be seen as four potential causes for communication breakdowns: If the utterance is incomprehensible then the speaker must rephrase or trans-late it. If the hearer challenges the truth of the speaker's utterance, then the speaker must be able to justify the ut-terance, e.g. by providing reasons, explaining it, supply-ing more information. If the truthfulness of an utterance is problematic then the speaker's intentions are questioned. Communication can only continue if the speaker succeeds in restoring the trust, e.g. through acting consistently, assur-ing the hearer of the speaker's sincerity etc. If the appropri-ateness of an utterance is challenged then the hearer ques-tions the speaker's right to perform the speech act, e.g. if a speaker's role does not entitle him or her to do so, if a speaker violates recognised values or acts contradictory to norms. These problems are usually solved by pointing to other (unproblematic) standards and norms, referring to common experiences, citing relevant literature or authori-ties.

3.1.3 The Language-Action Perspective

The broader context of the present work lies in the so-called Language-Action Perspective (LAP). LAP is based on Searle's and Habermas' theories and focuses on commu-nication aspects in information systems which is also im-portant for the present work. This section introduces the Language-Action paradigm.

The Language-Action Perspective was first introduced in the field of information systems (IS) in 1980 [7]. It was stated that human beings are fundamentally linguistic be-ings and act through language. It was argued that language is not only used for exchanging information as in reports, statements etc. but also to perform actions, e.g. promises, orders etc.

The conventional perspective on information systems stresses the contents of messages rather than the way they are exchanged [13]. For example, data flow diagrams are used as primary design tools. Thus, the focus is on the form and structure of messages. In contrast, the Language-Action Perspective emphasises what people do while com-municating, how language is used to create a common real-ity for all communication partners, and how their activities are coordinated through language. Here, the focus is on the pragmatic aspect of language, i.e. how language is used in particular contexts to achieve practical goals such as agree-ments or mutual understandings. This new approach argues that as social action is mediated through communication, the main role of an information system should be to support organisational communication. LAP has since developed into a new paradigm for the design of computer systems. There are a number of basic assumptions underlying LAP [12, 27], e.g.:

The basic unit of communication is a speech act.

Natural language sentences correspond to the perfor-mance of speech acts.

The meaning of sentences can be revealed by specify-ing the speech acts that have been performed.

Speech acts obey socially determined rules.

Cooperative work is coordinated by the performance of language actions which are speech acts.

The early work on LAP is based on Searle's Theory of Speech Acts. As a result of criticism of the shortcomings of Searle's theory (e.g. [4, 25]), Habermas' Theory of Com-municative Action is nowadays combined with Searle's the-ory as the philosophical foundation of LAP. Although both Searle and Habermas talk about “speaker” and “hearer”, their theories can be applied to written communication as well [22].

3.2 Structured Message Exchange

We argue that communication management plays an im-portant role for an effective support of electronic negotia-tions. During negotiations, the partners communicate with each other. In traditional forms of negotiations, the commu-nication can take place directly (i.e. face-to-face), via tele-phone, using

letters or faxes, sending emails etc. If nego-tiation is to take place electronically, the forms of business exchange will be primarily email messages. On the one hand, this enables distributed work as the negotiation partners do not need to communicate with each other at the same time (as, for example, in telephone or face-to-face conversations). It is possible to reach new business partners all over the world . Furthermore, other people that are not the main negotiators but that are involved in some way (such as lawyers or financial advisors) can be kept in-formed easily (e.g. by using cc. in emails). Finally, email exchanges can be logged so that there is the possibility to trace back business processes. On the other hand, there are a number of potentially se-vere problems concerning email messages. Email is one form of written communication. It has been reported that communication problems which can easily be solved in face-to-face interactions, can become serious in the case of written communication [17]. If such problems are not solved, then communication can break down completely which in turn can lead to a breakdown in cooperation [20, 22]. Therefore, it is of prime importance to anticipate potential communication problems to ensure unambiguous, structured, and efficient message exchange as the basis for the support of electronic negotiations. Next we will present our notion of which features an ideal communication management system for electronic ne-gotiations would contain. Elements from the two theories of communication introduced in section 3.1 will be used and extended.

3.2.1 Message Type

To ensure unambiguity, the message type needs to be specified. A negotiation process starts either with a request or an offer made by the customer and supplier respectively. A supplier needs to know whether the message concerning certain goods (s)he receives is meant as an order of these goods or as a mere inquiry without obligations. Further-more, reading only the content of a message might leave it unclear whether it is meant as a request to buy something or as an offer by a certain supplier wanting to sell the goods. Referring to the scenario, a statement such as “100 shoes for 25 USD” could be interpreted as a request for quotation or as an offer. Therefore, the illocutionary force of each mes-sage (which indicates the message type) needs to be made explicit. This will also make the state of the negotiation process clear for the communication partners, i.e. whether they are in the inquiry phase or in the commitment phase. It has been shown that Searle's classification into five types of illocutionary force is useful for specifying the types of messages in the present context [19].

3.2.2 Message Content

Speech act theory and its formalisation, i.e. illocutionary logic [24], treat the propositional content as primitive. We argue that a formalisation of the message content needs to take place to ensure unambiguity of the message contents. In the example, the content of the message might be mis-understood. The exact specification of the product or the quantity (100 shoes or 100 pairs of shoes?) might be prob-lematic. On the one hand, the content of messages needs to be specified to enable queries such as “Which goods do we need to deliver to company A?” or “What did company B offer?” that concern the propositional content. On the other hand, systems that only offer predefined message contents appear too rigid and inflexible. Therefore, semi-structured message contents should be aimed for.

3.2.3 Validity Claims

Validity claims as introduced by Habermas play an im-portant role in negotiations. Validity claims are critical to the success of speech acts. Only if the recipient of a speech act says implicitly “yes” to all the claims raised, can the speech act be successful. The consideration of validity claims allows fruitful discursive communication.

Table 1. Relations between validity claims and speech act components

Validity Claim	Speech Act Component	
	Illocutionary Force	Propositional Content
Comprehensibility	+	++
Truth		+
Truthfulness	+	
Appropriateness	++	+

We argue that the recipient of a message needs to have the opportunity to challenge the claims made by the sender. To allow only sensible challenges, a system for negotia-tion support should present the recipient with the relevant claims for the particular type of speech act. We will briefly summarise the relations between the validity claims and the components of the speech act (i.e. propositional content and illocutionary force) for all types of act, see table 1. The in-terested reader is referred to [18, 20] where an extensive discussion is presented.

An utterance can be incomprehensible because the propositional content is not understood by the recipient. This is a common communication problem. However, it is also possible to challenge the comprehensibility of the il-locutionary force used in a speech act. Illocutionary forces are not always specified in an utterance which can lead to misunderstandings about which force the sender meant to use when uttering a sentence, e.g. what was meant as a re-quest is understood as a mere statement. Questioning the truth of a statement means questioning whether the statement really represents a fact, a common experience etc. Thus, the validity claim of “truth” is related to the propositional content only. The challenge of truthfulness is only related to

the illocu-tionary force since the recipient doubts whether the sender is really committed to the illocutionary force used. Here, the ostensible nature of the speech act is questioned, e.g. what seems to be an assertive act is really an attempt to deceive.

Both the illocutionary force and the propositional con-tent can be inappropriate. However, a challenge of appro-priateness concerns more often the illocutionary force than the propositional content. The recipient challenges the ap-propriateness of the force used by the sender by questioning whether the sender is entitled to use the force in the partic-ular context. The sender could have violated existing power relations, recognised norms, or professional standards. A propositional content can also be inappropriate. Here, the recipient questions whether the sentence fits a given norma-tive context, i.e. whether it is legitimate to say so.

The relations between validity claims and the five types of speech act have also been analysed, see [18, 20]. To sum-marise, comprehensibility problems can occur in all utter-ances, the claim of truth is only related to assertive speech acts, truthfulness can be challenged for all types of utter-ance, and appropriateness is related to assertive, directive, expressive, and declarative speech acts.

3.2.4 Order of Messages

The order of a negotiation process should be specified to guide the actual business interactions. For example, a ne-gotiation can start with a request by the buyer or an offer made by the seller. In the first case, the seller can accept the request, can reject it, or can reply with a counteroffer. In general, negotiation steps cannot be done in a random or-der. For example, a counteroffer of company A cannot be followed by another counteroffer or a request of company A, because only company B is allowed to respond with a counteroffer or to accept the offer. Because of this, in con-ventional negotiations it is sometimes unclear which com-pany has to react. Therefore, the possible answers to certain message types need to be specified.

3.2.5 Obligations

As mentioned in section 3.1.1, directive and commis-sive speech acts issue commitments for the recipient and the sender respectively. For example, an inquiry (which is a directive speech act) commits the recipient to answer.

A request made by a buyer and accepted by a seller implies that the seller is obliged to perform the action indicated in the message. Once a speech act is accepted (cf. 3.2.3), an obligation arises. It needs to be specified what kind of obligations the companies have already accepted during a negotiation. To ensure that all business partners know their duties, the obligations resulting from the exchanges need to be made explicit.

3.2.6 Traces

An important requirement of electronic negotiations is that the exchanges should be logged to allow backtracking and traceability. In a message-oriented view, the different messages that were exchanged are linked. Any message (apart from the one starting the negotiation) is a reply to one message; any message (apart from the one terminat-ing the negotiation) can have many answers. The temporal sequence of messages can be displayed in a tree-like struc-ture. Being able to trace messages of a particular negotia-tion process provides many advantages, e.g. enabling the evaluation of different negotiation strategies, providing a reminder of what has already taken place in a negotiation process, telling other parties involved about important in-formation, providing the basis for monitoring mechanisms in case of later conflicts.

3.3 Example

Using our scenario, let us imagine that a buyer of com-pany A contacts a sales person of company B by electronic means. They will start a negotiation about the contract de-tails and exchange messages with the following contents:

1. Company A sends a request for quotation concerning 100 pairs of shoes (code MM-48-1112) for 20 USD each to Company B and asks for a possible delivery date and the terms of business of company B.
2. Company B replies with a counteroffer: the shoes can be delivered until 03/01/2001, but only for a price of 25 USD. It also sends a document which specifies its terms of business.
3. Company A does not accept this offer and makes itself a counteroffer by proposing a price of 21 USD for each pair of shoes.
4. Company B responds now, that it can deliver the shoes until 10/01/2001, but the price is 23 USD.
5. Company A accepts this offer and thereby ends the message exchange.

IV. DOCUMENT MANAGEMENT FOR ELECTRONIC COMMERCE

The negotiation process between business partners does not only involve the exchange of messages. Documents such as contracts and general business conditions are also important. Thus, the management of documents during a negotiation is also necessary. In this section, we will present our vision of effective document management for EC by specifying features of ideal systems.

4.1 Contract Management

By defining a contract, the business partners work co-operatively on a document. The contract evolves over time until a final agreement has been reached or the negotiation is terminated. Therefore, documents are both the medium and the outcome of negotiations.

During the negotiation process, a new version of the con-tract may be a dead end. In this case, the partners will go back to an earlier version of the document. Thus, the system must be able to manage different versions of a document and reuse of an old version must be possible. The version management can also be used to trace the evolution of the document. For example, the versions of a document can be displayed in a tree-like structure with the initial version as the root and the revised documents as successors.

Business documents, especially contracts, do not have a fixed structure. The structure evolves during the negotia-tions, e.g. items are added and removed. Because of this, the management in a traditional relational database system would be very inefficient. The first possibility would be to store the document as a binary object without knowing the details about the contents. In this case, one can only search for keywords in these documents. The second possibility would be to store each item of the document as an attribute of a relation. However, as the structure of the document evolves, the database schema needs to be changed as well. Thus, the database schema might be changed very often so that it becomes difficult to have an efficient database design.

4.2 Semi-structured Data and XML

A more efficient way to handle documents is to view them as semi-structured documents. A document-oriented database system such as Lotus Notes [15] manages semi-structured documents: some parts of the document can be identified as fields (similar to attributes of a table in a re-lational database), but the document may also contain un-structured elements such as text and images. The structure of documents is not described in a schema. Therefore, each document can have a different structure and may adjust its structure as needed.

This has also been pointed out by [1]. It is not sufficient to store a document in a binary field within a database. One also needs to take care of the internal structure and se-mantics of a document to enable more efficient document retrieval and processing techniques. Recently, XML (eXtensible Markup Language) has be-come a popular standard for representing (semi-)structured data [26, 3]. Basically, XML is a syntax specification for in-formation exchange between different tools. The advantage of XML is its flexibility and extensibility, while at the same time being simple and easy to understand. Therefore, XML has been used by a huge number of commercial products in the area of EC.

XML documents have a tree-like structure. A document has one root element which can have multiple elements as successors. These elements can again have multiple ele-ments as successors and so on. Each element is marked by a tag. For example, “ <productcode>MM-48-1112</productcode>” is the tag for a product code with the contents “MM-48-1112”. The structure of an XML document can be described in a Document Type Definition (DTD). A DTD specifies the tags which may appear in the document (e.g. <product> and <productcode>). Fur-thermore, it describes the order (or structure) in which the elements of an XML document may appear. The set of tags is not restricted in contrast to HTML. New tags can be de-fined as they are needed.

A DTD is not necessary for an XML document. How-ever, for data exchange between different application pro-grams, the applications must agree on the same DTD. There is some standardisation effort in different industry sectors going on to define DTDs for their application domain.

4.3 Document Management Systems

Some of the functionality discussed before is offered by document management systems [8]. Document manage-ment systems are used to support the workflow management within an organisation. In this environment, documents are containers of information which can be read or filled in by a group of people in a coordinated way. Such a function-ality is especially support by systems such as Lotus Notes or BSCW (Basic Support for Cooperative Work, [2]) which combine the features of a document management system and E-Mail systems.

However, the focus of such systems is obviously on doc-ument management and their support for communication management is rudimentary and not well integrated with the document management system. As we have discussed in section 3, the communication process also needs support in a more structured way than is offered today by most mes-saging systems.

Therefore, our approach is based on a combination of document and communication management. The contents of messages and documents is represented in XML which allows a more structured representation of the contents.

V. DOC.COM: COMBINING DOCUMENT AND COMMUNICATION MANAGEMENT

Although some of the functionality required for manag-ing messages and documents in BtB negotiations is avail-able in individual systems, the combination of messages and documents is essential. Traditional document manage-ment systems support the evolution of documents by keep-ing track of different versions [8]. However, such systems do not provide facilities to track the messages which are exchanged during the evolution of a document. On the other hand, communication management systems are not concerned with documents that might result from message exchanges.

We argue that there can be no separate communciation management and document management if the goal is effec-tive support of electronic negotiations. Both messages and

documents are an essential part of the negotiation process and both are interlinked. An electronic negotiation starts with a message sent from one company to the other. The type is either a request or an offer. In either case, a new document is derived from the message. The document is the first version of a contract between the business part-ners. In the course of the negotiation, new documents (i.e. new contract versions) are created through the message ex-change between the negotiators. We propose to link the messages to the documents, thereby combining document management and communication management. We do not consider a message as a subtype of a document because the relationship among messages is of a different type than the relationship among documents (replies vs. versions). Fur-thermore, the content of messages should be related to the content of documents to indicate why a certain information is included in a contract version. The combination of docu-ment and communication management (DOC.COM) is the main contribution of this paper and will be presented in this section.

To prepare for this work, a conceptual model to capture the relationship between documents and messages will first be introduced. Then it will be shown how the content of messages and documents can be represented in a more for-mal way to enable reasoning about the consequences of the negotiation process. Finally, we will present applications of DOC.COM, thereby showing its merits for negotiation support in BtB EC.

5.1 A Conceptual Model for Electronic Negotiations

Our conceptual model of document management in elec-tronic negotiations is shown in figure 1 in entity-relationship notation. The context of business interactions is a negotia-tion which involves two or more parties and has a certain subject. Negotiations can be active or terminated which is represented by the attribute " status". A negotiation contains documents as well as messages.

A message is sent by one of the business partners to the other partner. It is sent at a certain time and has a semi-structured content which represents the propositional con-tent as described before. We will elaborate in more de-tail on the representation of the content in the next section. Furthermore, the message type needs to be specified (e.g. whether it is a request, a counteroffer, an assertion etc.) which represents the illocutionary force. As messages are sent among the business partners involved in the negotia-tion, they are linked in a content-based sequence: When sending a message, the business partner answers a message sent by the other partner (cf. order of messages, section 3.2.4). One message can of course have many answer mes-sages. Imagine the situation where a request for products with a certain price and a due date is sent. The seller might send a message agreeing on the price whilst having to talk to the production manager about the due date. Later on, a new message is sent answering part of the original request which in this case would constitute a reply to the proposed due date.

A document has a status which specifies whether it is the final contract or an evolving version of the contract. The content of the document is the subject of the negotiation steps. As we will discuss in the next section, the content of a document is also represented in a semi-structured form. Documents can be ordered in a tree-like structure. Thus, there is a many-to-many relationship called " is successor of" between documents. It is possible to turn back to a cer-tain earlier document (say document version 5) during the negotiation process and to create a new version of the con-tract (i.e. a new successor of the document version 5, say document version 12) from there. Thus, it is necessary to keep track of the time of the relationship. Document version 5 had only document version 6 as a successor before, but at a later point in time, document version 12 also became the successor. Thereby it is possible to keep the documents in a temporal sequence (cf. the discussion of version control in section 4.1).

Messages and documents are linked because messages initiate new documents, i.e. new versions of the contract. For example, a request made by company A to company B of 100 pairs of shoes of code MM-48-1112 for 20 USD each is a message that creates a document (i.e. a contract version) with the content of "B sends 100 pairs of shoes of code MM-48-1112 for 20 USD each to company A". This docu-ment then leads to further discussions through the medium of structured message exchange.

5.2 Representing the Contents of Messages and Documents

The conceptual model provides a relationship between messages and documents. However, the model does not go into detail about the contents of messages and documents. Relationships between specific items of a message or doc-ument cannot be captured by this model. A more struc-tured representation of the contents is necessary, because the model alone does not provide information about why a data item in a contract has been inserted. Furthermore, the obligations which are derived from the contract and negoti-ation can be represented in a more formal way.

The idea of DOC.COM is to represent the contents of messages and documents as extensible semi-structured doc-uments. The idea is based on the observation that a contract or a message consists of several items which are important to identify. For example, a statement such as "B sends 100 pairs of shoes of code MM-48-1112 for 20 USD each to company A" contains information about the selling

and buy-ing companies, the quantity, the product, the product price, and the product code.

These information items should be marked in a message or document as items with a special meaning. This can be done by using XML. Each element of interest can be tagged with a special tag as XML is extensible. Continuing the example, a contract between company A and company B can be drawn up in the following way:

<contract>
<delivery>

<supplier> B </supplier> delivers to <recipient> A </recipient> <quantity> 100 </quantity> <unit> pairs </unit> of

<product> shoes </product> of code <productcode> MM-48-1112 </productcode> until <date>10/01/2001</date>
</delivery>
<payment>
<payer> A </payer> has to pay to
<recipient> B </recipient>
<amount> 2300 </amount>
<currency> USD </currency> within a
<term> month </term> after delivery
</payment>
</contract>

The example specifies a contract between companies A and B. The first part describes the obligation that company B has to deliver shoes within a certain time to company B. If B has delivered the goods, A has to pay 2300 USD to B within a month.

The individual obligations of a company can now be identified as a part of the contract. For exam-ple, the obligation of company B to deliver shoes to company A can be represented as the path ex-pression contract.delivery. Individual items of the document can also be identified by path ex-pressions, e.g. the delivery date is identified by

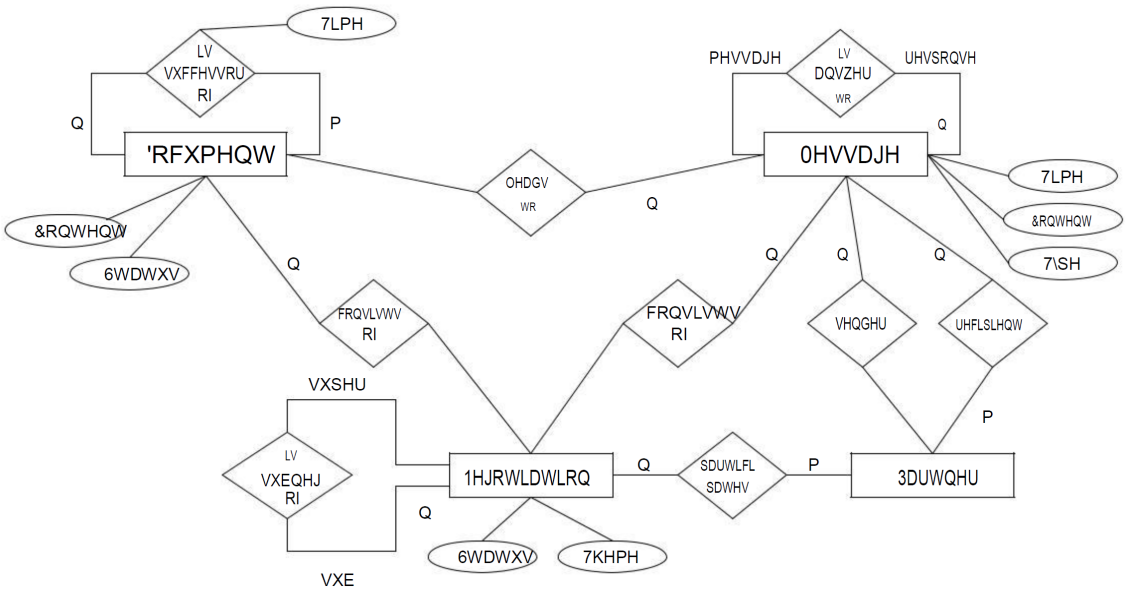


Figure 1. The conceptual model of electronic negotiations

contract.delivery.date. Items can now also be linked to the messages in which they were proposed, thus giving information about who proposed this item in which context.

5.3 Formalisation of the Framework

So far, the framework of combined document and com-munication management has been introduced on a concep-tual level. Here, we will briefly present a formalisation which provides the basis for reasoning mechanisms, e.g. about arising obligations. A language cooL (standing for cooperative language) has been developed and is presented in [18]. It is based on a combination of dynamic deontic logic [14] and illocutionary logic [24], originally developed in [5, 6, 27] but considerably extended and enhanced for the present purposes, namely communicaton partners coor-dinating their work by exchanging speech acts about certain actions or propositions in a particular temporal order. The language enables statements about speech acts concerning actions or propositions to be made by a author to a recipient; it enables the resulting effects such as beliefs or obligations to be specified; and it allows deadlines for certain types of speech act to be made explicit. A classification of utterances is provided based on the illocutionary force. Each class of utterances is related to certain obligations. However, only if the recipient explicitly accepts the author's utterance in the particular context can the obligation arise (cf. section 3.2.3).

Since obligations only hold for a certain time (i.e. until they have been fulfilled or violated in case of missed deadlines), temporal operators are included into cooL. If an obligation exists, it is possible to specify deadlines. For example, an action might have to be carried out before a certain date or before a certain proposition becomes true. It is also possible to specify that the action needs to be done immediately or between two dates. The language cooL allows the obligations to be checked at any point in time. It is possible to query the existing obligations, the ones that have already been fulfilled, and the unfulfilled obligations. If an obligation has not been fulfilled and the deadline is past, then the obligation no longer exists because it could never be fulfilled anymore. However, it is clear that there exists an unfulfilled obligation. This could, for example, lead to penalties, reminders, automated actions etc. cooLmakes it possible to reason about ideal and actual behaviour and to initiate actions or procedures if violations occur, i.e. if the actual behaviour is not the desired one.

Rather than specifying the semantics of the language we will now give some examples to illustrate it. Bs( ) stands for: s believes in proposition ; Ors( ) stands for: r is obliged to s to bring about ; Ors( ) stands for: r is obliged to s to perform action ; [ ] stands for: holds after the performance of ; (1; 2) stands for: sequential performance of 1 and 2.

Coming back to our scenario, imagine the following interaction. Mr X of company B and Ms Y of company A start a negotiation about shoes. Mr X states that B has reduced the prices within the last month (represented by 1). If Ms Y accepts this assertion (i.e. accepts the validity claims associated with it) she now believes in the statement.

[stateXY (1); acceptASS$_{Y\,X}$ (1)]BY (1)

Ms Y makes a request to buy 100 pairs of shoes for 20 USD each (represented by 1). Mr X refuses. Therefore, no obligation arises.

[request$_{Y\,X}$ (1); refuseXY (1)]:OXY (1)

Mr X now makes a counteroffer: Company B could offer a price of 23 USD each but could deliver the shoes (represented by 2) before 10/01/2001 (represented by 2). Ms Y accepts this offer and thus the obligation to deliver the shoes for the price specified before the deadline (represented by OXY (2 < 2)) arises for Mr X.

[offerXY (2); acceptCOM$_{Y\,X}$ (2)]OXY (2 <2)

If the obligation is violated (i.e. the shoes have not been delivered in time) certain actions can be initiated. For example, a fine could have to be paid. This can also be expressed in cooL.

Instead of representing the actions and propositons (i and i) as natural language expressions, we can use the semi-structured representation introduced in section 5.2 and refer to the contracts and messages. Going on with the example, the obligation to perform 2, i.e. company B has to deliver shoes to company A, can be represented by the path expression contract. delivery. The proposition 2 is expressed as contract. delivery. date.

In addition to the information about the negotiation phase, the traces of the fulfilment phase may also be recorded. All this information about messages, contracts and their execution can be used for evidence in legal conflicts. This is probably the most important use of such information. Companies will only make business with other companies if all obligations of each partner are written down in a contract and signed by each partner. Our model provides also the basis for a monitoring system which can be used by a trusted third party to monitor the negotiation and execution of a contract.

5.4 Application of the Model

In traditional commerce, most of the documents and messages exchanged during a transaction are kept for evidence in case of conflicts. Furthermore, offers and invoices from previous transactions contain valuable information, e.g. they might be useful for pre-calculations and cost estimations for new projects.

Our approach provides a framework for a document and communication system for negotiation processes in BtB EC. The conceptual model presented in section 5.1 provides the basis for this work. The history of documents represents information about offers, requests and contracts. The final document of a negotiation, i.e. the contract, formalises the obligations of each partner. The history of messages can be used to find out which partner included a certain item in the contract. In addition, the messages might give more information about the reason for a specific contract clause and clarify ambiguous statements. Thus, the history behind an agreement can be seen by the business partners involved. Furthermore, the trace of the negotiation can be represented in a document-oriented view (i.e. a graph-like structure that shows the evolution of a document) or in a message-oriented view (i.e. a tree-like structure of message threads).

Using the formal representation of documents, messages and the obligations and the link to the classification of business terms, we are able to provide access to documents and messages by a variety of different means such as:

content, e.g. Show all messages concerning bricks; Show all documents dealing with shoes.

type, e.g. Show all offers of company B; What are the requests I sent to Ms Y?

people involved, e.g. Show all messages sent by Mr X; What are the documents changed by Dr Z? duties, e.g. What are the open obligations of our company?

Which obligations did my business partners not fulfil?
time, e.g. Show all request sent to a company be-fore 1/1/2001; Which documents did I receive between 4/8/2000 and 11/12/2000?

CONCLUSION

Negotiation is an essential component of EC processes. Traditional forms of negotiation have long been the subject of research concerning different strategies, policies, com-munication patterns etc. Electronic negotiations provide a challenging research topic as, on the one hand, they offer many new possibilities for the negotiators (cf. section 3) but, on the other hand, they remove the direct interpersonal rela-tions that seem to be inherent in many negotiaton processes.

In general, negotiation is a complex communication pro-cess and involves the exchange of documents. In electronic negotiations, communication takes place in a written form through message exchange and the documents involved are versions of the final contract. Both documents and mes-sages are, therefore, essential elements of such interactions. We have presented an approach to support negotiations in BtB EC more efficiently by combining communication and document management. The approach is based on commu-nication theories which provide the framework for a struc-tured message exchange. We have identified several fea-tures for an ideal communication system. The medium and outcome of a negotiation is a contract.

We pointed out that a version control and a semi-structured representation for contracts is necessary. The main contribution of this paper is the framework DOC.COM in which all aspects of communication and doc-ument management are integrated. Messages can be ex-changed in a structured way. The document management is enhanced by the combination with the communication about the documents. By combining messages and docu-ments we can provide effective support for all aspects of negotiation. It is important to point out that we do not ex-pect users to learn Searle's and Habermas' theories before being able to use systems based on the framework.
Rather, such systems would need a sophisticated user-centred de-sign to aquire the necessary data without causing more time and effort for the users. In this paper, we focused on one phase of a BtB elec-tronic commerce process, i.e. electronic negotiations. Our work is embedded in a holistic approach to supporting BtB interactions in the context of EC [16]. Our future work will focus on more empirical studies to aquire more knowledge about negotiation by electronic and traditional media as a basis for further evaluation. Further-more, a prototype implementation of a system that covers all of these aspects is planned.

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