its *filter function* and its successful *navigation aid* through the ocean of offers.

A further strategic element will be the *confidence* the customer exhibits towards the electronic mall. Confidence is a result of how much the client can rely on the information presented by the electronic mall and how it manages erroneous or overdue deliveries. Along with CompuServe and CommerceNet electronic malls are beginning to establish themselves. There are three key elements of the electronic mall:

- *Free access and competition for the suppliers.* This means, taking the example of banking services, the ability to function as a multibank system. Every supplier of goods or services should be granted access to the system and be free to offer its products and services, as long as it belongs to a specific group and observes the system guidelines.
- *Open competition market for agencies.* Every agent who observes the rules (especially as to standards and interfaces) may offer any services published in the system to its retail clients. The agent negotiates with the suppliers regarding the conditions surrounding the services and the means of transport from supplier to customer.
- *Free market for the clients software.* Every software company is free to implement services offered in the electronic mall in its software, or to develop client software. The company negotiates with one or a group of agents on market modalities and the appropriate means of transportation, or it develops the software upon the agent's request.

The openness of this system, given free competition, are to be considered in a context of a growing economy. Such a system will be very flexible and superior with regard to the creativity of the client software profile and as to the services of agencies. Therefore, a relatively fast growing transaction volume can be expected. ■

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Modelling Interorganizational Trade Procedures Using Documentary Petri Nets

Global information infrastructures are rapidly becoming a reality. Such worldwide networks help companies to operate not only on a local or regional level, but also on a global level. Especially for small and medium enterprises (SMEs) this would offer tremendous opportunities to do global business electronically. However, communication networks alone are not sufficient to enable international electronic trade.

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In the past it has been shown that the introduction of Electronic Data Interchange (EDI) can have tremendous benefits for the efficiency of trading both between and within organizations (see for instance the proceedings of the annual EDI conference in Bled, Slovene). On the other hand, it can also been shown that in many cases long and costly negotiations are necessary between the trading partners before they can exchange their first EDI message.

As a result, most successful EDI implementations have been realized in what could be called 'closed trading relationships', i.e. long-lasting trading relationships, involving a high number of transactions, between parties that have a high level of trust and possibly a close coordination of the parties' business processes (Table 1). In these kinds of relationships, parties can gain extra benefits by closely coordinating each others' actions, thus compensating for the extra start-up costs stemming from detailed trading partner negotiations. This process is an example of business process redesign or re-engineering.

However, when the partnership is established for a limited period, covering a few transactions only, and on an 'arms' length' basis, EDI linkages are seldom observed since the costs of the necessary negotiations cannot be recovered from the benefits. These shorter-term partnerships could be called 'open trading relationships' (Table 1). The main aim of our research is to contribute to the lowering of the barriers for using EDI in these open trading relationships.

The Negotiation Process

One of the main reasons for the complexity of the negotiation process is the fact that parties have to know about each others' 'way of doing business' before they can start exchanging data electronically. Extra knowledge about the preferred way of doing business of one trading partner has to be conveyed to the other; in other words, the parties have to agree upon the *trade procedure* they are going to follow.

A major reduction in these negotiation costs could be achieved through the availability of standardized (electronic) trade procedures, specified by industry groups such as EDIFICE, SWIFT or CEFIC or international trade facilitation bodies such as UNCTAD or the International Chamber of Commerce (ICC). Although international standards for the structuring of EDI *messages* exist (i.e. UN/EDIFACT or ANSI X12), such standardized *trade procedures* have not been developed yet. In order to build these procedures, two steps should be taken:

- The first step is the definition of a common language in which these procedures are described. This language should be formal, graphical and computer interpretable. We propose the Documentary Petri Net (DPN) formalism for that purpose.
- Second, groups of business experts should specify these standard trade procedures. The procedures that these groups define should be then registered in a repository, governed by an international body. Computer-aided support is desirable in this process, in order to assess several properties of these procedures, to simulate these procedures in a testing environment before implementing them and, finally, to support the reusability of certain parts of trade procedures.

An ISO/IEC sub-committee (ISO/IEC JTC1/SC30) is working on the definition of standards that should minimize the set-up costs for new EDI linkages. This initiative is called 'Open-EDI'. Open-EDI standards include both technical and business aspects of interoperability. In the business aspects work is being conducted on the specification of a standard formal description technique for trade procedures. The authors of this paper participate in these standardization efforts.

Documentary Petri Nets

We found Petri Nets as being one of the few acceptable candidates that offer

both a graphical representation and a formal basis for the verification of various properties of these nets. The main advantage of the Petri Net formalism, in addition to its capability to graphically model both concurrency and choice, is that it offers various kinds of both formal and informal analysis methods. We have extended the classical Petri Net formalism to be able to distinguish between several document types and to attribute actions to specific parties. This extension is called Documentary Petri Nets (DPN). In our modelling, a trade procedure is composed of a number of seperate DPN models representing the individual parties participating in the procedure. These DPNs can be easily combined to generate the integrated trade procedure. A more detailed description of this formalism can be found in [1, 6].

	Open	*Closed*
Level of Trust	Low	High
Number of Transactions	Low	High
Duration of Relationship	Short	Long
Level of Coordination	Low	High

Table 1: Open vs. closed trading relationships

To support the modelling of interorganizational trade procedures using DPNs the tool 'Case/Open-EDI' was developed by Lee [5]. Case/Open-EDI offers a graphical interface to specify trade procedures in the DPN formalism. The graphical specifications are compiled into executable code which is used to simulate these trade procedure specifications in a laboratory setting. Furthermore, several analyzing techniques are built in to support the validation of proposed trade procedures. Using this tool, business expert groups can specify the trade procedures proposed for standardization in both a bottom-up and a top-down fashion.

The Design of Trade Procedures

Most current interorganizational trade procedures were gradually constructed over the last decades and sometimes even over the last centuries. As technology evolves, these procedures have to be adjusted or redesigned in order to benefit from new possibilities offered. In the coming decade, user groups will be formed to define new common ways of doing business with participants from different industries, for example, banks, transportation and production companies. In these groups the participants will have to specify their preferred way of doing business. Then, these specifications have to be combined in order to define the total trade procedure for all parties involved. This process might involve multiple iterations, since all parties involved need to reach consensus on the final integrated trade procedure. This could be referred to as a bottom-up approach.

An alternative to the bottom-up approach is a top-down one where the parties first agree on a single, integrated trade procedure, and then transform that into the various role procedures. (Thus, a role procedure might be regarded as a 'view' of the integrated one). However, the issue arises as to how the parties might effectively collaborate on the design of this integrated procedure. One might imagine that standardized procedures are made available.

Case/Open-EDI supports both modelling approaches. For the bottom-up approach it offers analysis techniques to check whether the combined procedures have deadlock risks. For the top-down approach it offers a more general representation which is able to represent classes of DPNs. This formalism is called Procedure Constraint Grammar (PCG) [5].

Conclusions

Our research aims at lowering the barriers for electronic commerce. We feel that the high negotiation costs necessary before the first EDI message can be exchanged should be minimized. This requires not only standard messages, but also standard procedures which are the context in which those messages have a meaning. This need for standard procedures is illustrated by the Open-EDI initiative; an ISO/IEC subcommittee is working to minimize the set-up costs for new EDI linkages. We contribute to this work in two ways; first, we have developed a formal description technique for trade procedures, called DPNs and second, we have developed a CASE tool to support the design process of such procedures using DPNs. Current research focuses at the development of formal analysis tools for trade procedure designs. These include techniques to detect possible deadlock opportunities, but also tools to analyse a lack of control in a procedure. ■

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