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Languages for Electronic Business Communication: State of the Art

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Abstract

Electronic commerce (e-commerce) is the new buzzword for doing business on the Internet. A main problem for business-to-business e-commerce lies in the need for the information systems of the involved organizations to exchange meaningful information. For letting the information systems of business partners accomplish electronic business communication, semantic interoperability is necessary to ensure that exchange of information makes sense — that the provider and receiver of information have a common understanding of the 'meaning' of the requested services and data. Effective exchange of information between cooperative systems needs to be based on a common understanding of the transferred data. Domain-specific standards and ontologies may be used to define the semantics of common terms.

Traditional EDI is not sufficient to solve electronic business communication problems in an open and dynamic environment. This review paper summarizes the development from traditional EDI towards new advanced electronic business communication approaches offering agent-based e-commerce marketplaces in which the meaning of business messages is managed by means of shared repositories for formally specifying the semantics of business messages. Within this framework, XML is the practical foundation for structuring the information to be interchanged.

Keywords: Electronic Commerce, Electronic Data Interchange, Business Communication.

1. Introduction

E-commerce is taking off on a global scale, not only in the consumer market but particularly in business-to-business (B2B) application areas. However, there are also many barriers that still need to be taken. One barrier is the standardization of the message formats and contents for business communication. Although B2B e-commerce has a longer tradition of electronic data interchange in the form of EDIFACT, it is generally observed that traditional EDI is too costly and not flexible enough to cope with the dynamics of the new economy (Kimbrough & Lee, 1996; Kimbrough & Moore, 1997; Meltzer & Glushko, 1998). However, traditional EDI is often being re-examined to define the *meaning* of the transferred data (semantics), and XML is employed as the practical foundation in which to structure this information (syntax). XML is a markup language for creating self-descriptive data; in contrast to HTML, it separates style and content and is extensible in the sense that new tags can be used as long as they are defined in the DTD (Document Type Definition). For e-commerce, it is particularly interesting that one format can be used both for electronic messages (to be processed by computers) and for human interfaces. An XML document itself is already, to some extent, readable for humans (what an EDI document usually is not), but especially when it is accompanied by a style document (XSL), it can be presented by means of a web browser in some desired layout. This feature not only allows

to have one single interface to application systems (for humans and for systems), but also enables hybrid set-ups in which humans and systems are involved in different stages of the business processes and the same format can be used throughout.

Anyway, XML on itself will not do the job. The receiving party can recognize something as a valid XML document, and when it has the accompanying Document Type Definition (DTD), it can check whether it adheres to this DTD, but nothing is said yet about the meaning of the data elements. If every company were to develop its own DTDs, there would be no real interoperability. Although XML is technically superior to traditional EDI formatting, it does not solve the huge problem that EDI standardization has worked on for years, namely, how to define the *contents* of the messages. What elements should be there, how are they represented and what do they mean? If XML shall be used in B2B e-commerce, something equivalent to the EDIFACT standards must be in place.

For the exchange and automatic processing of messages, a standardized language is needed. This standardization can be at different levels:

- at the lexical level of character sets (data representation),
- at the syntactical level of message structures, and
- at a deeper semantic level of vocabulary and integrity constraints.

If communicating parties want true communication, they must agree not only on the form but also on the meaning of the messages. The agreement can be implicit or explicit. Implicit means that the parties rely on, for example, the 'common English meaning' of a lexical, whereas explicit means that the lexicals have a precise formal definition. If the message is to be processed automatically, the meaning must be formalized, although the formal definition may or may not be explicit — it can somehow be incorporated in the code of communication partners.

The paper is organized as follows. Section 2 starts with a look at the background of e-commerce. Sections 3 and 4 then summarize approaches to XML/EDI standardization and to global, shared repositories for business communication standards, respectively. Formal semantics for business communication languages are discussed in Section 5, and the role of agents in Section 6. Section 7 discusses some initiatives for establishing electronic marketplaces before Section 7 summarizes the paper with a look at further issues.

2. Background: E-commerce

Electronic commerce (e-commerce) is a somewhat emerging area. The literature and trade press tend not to clearly delineate among "electronic commerce", "electronic business", "electronic markets" and related terms. This is not so surprising because the field of e-commerce and inter-organizational processes is subject to fast and often dramatic technological changes. As it is often the case in emerging application areas, terminology is often used inconsistently (Hasselbring, 1999).

E-commerce is about the use of information technology for the support of business transactions. Business transactions can be, for example, pre-sales activities, sales, purchases, finance and insurance, placing an order, delivery and payment, after-sales service and maintenance, joint product-development, transactions with the government, etc. E-commerce comprehends trade in physical products as well as trade in services. Concerned are products and services that are traded electronically, but usually end in physical delivery, as well as services that are traded and delivered electronically (e.g. software or music). The applications that support these transactions can be broadly divided into two major categories:

- **Business-to-consumer** (B2C) transactions: examples are electronic retailing (shopping malls offering consumer goods) and electronic payments.
- **Business-to-business** (B2B) transactions: an example is a company that uses a network (with EDI) for ordering from its suppliers, receiving invoices and making payments.

Additional categories such as business-to-administration are sometimes introduced, but the basic distinction can be made among B2C and B2B e-commerce. Much has been written about B2C e-commerce via the Internet. One of the best-known examples is Amazon.com. B2C e-commerce is growing rapidly, but it looses some significance when compared with the expected growth of B2B e-commerce, as predicted, for instance, by IDC (IDC, 1999).

Although the term e-commerce has only recently started to receive a lot of publicity and attention, the fact is that e-commerce started more than two decades ago with the introduction of electronic data interchange (EDI) between organizations. This means that organizations exchange orders and information about deliveries as well as payments electronically. Consumer-oriented e-commerce also has some history. Automatic teller machines (ATM) that automate "money business" are in existence for many years. The systems for EDI and ATM, however, are *closed* systems. They only operate between the parties involved in the transactions and are shielded from the outside world.

E-commerce now is not longer only the electronic ordering and supply of products, but it means doing business electronically, in any possible way. E-commerce can also support negotiation about terms and contract conditions, building up electronic business relations, exchanging product information, and all the other things that also take place in traditional business.

2.1. Business-to-business E-commerce

The objective of B2B e-commerce is to eliminate manual trading processes by allowing internal information systems of different companies to directly exchange information. Hereby, inter-organizational information system integration is required (Hasselbring, 2000b). B2B e-commerce encompasses a wide range of (business) operations and transactions among the involved parties, for instance:

- The establishment of an initial contact between a potential consumer and potential supplier.
- The delivery and exchange of information.
- Pre- and post-sales support.
- Contract negotiation.
- Electronic payment.
- Distribution and distribution management of goods.

Seen from a buyer-seller perspective, and using a life cycle model, electronic commerce can be used in all the phases of business transactions.

In this paper, the focus is on B2B e-commerce, as opposed to B2C e-commerce, which only covers a small part of the global electronic market. B2B e-commerce has a few specific requirements, which should be taken into account when addressing this type of e-commerce. Factors like standardization of communication protocols between organizations, and the fast implementation of new technologies to gain competitive advantage are of critical importance in B2B e-commerce.

2.2. Traditional Electronic Data Interchange (EDI)

Traditional electronic data interchange is conducted using an automated system of business-to-business data exchange. The two most important areas of EDI are data interchange and electronic transfer of money. Data interchange is used for sending orders and invoices between companies, while electronic transfer of money is mainly used among banks (the S.W.I.F.T. organization manages this since the seventies, www.swift.com). The major goal of EDI is to replace paper documents with their electronic versions for reducing the time spent on printing, mailing and re-entering information. EDI links the computer processes, so that duplicate data entry is not necessary. EDI is an approach that can save costs and time and also can improve customer service

(shorter delivery times). Compared to the Internet, traditional EDI offers high security and safety measures because EDI runs on closed, private value added networks (VANs). This is an advantage, but also a big disadvantage, because the number of trading partners is always limited to those who are connected to these VANs.

Standards like ANSI X12 (the dominant EDI standard in the United States, www.x12.org) and UN/EDIFACT (the international standard defined by the United Nations, www.disa.org) are established. While traditional EDI is very costly and difficult to implement, the potential benefits are significant. EDI may help organizations with, for instance:

- improve efficiency by enabling companies to eliminate expensive and slow manual methods, like the processing of purchase orders and bills;
- improve intercommunication between dissimilar systems and databases;
- manage the supply chain efficiently;
- improve the inventory control.

Although many standards for EDI were developed, the majority of the business community still has not accepted EDI as a way to do business electronically. It is too expensive and even though there has been a lot of effort to standardize the transactions, the software developed to date still does not make it easy to use EDI as a trading protocol between different trading partners.

Lacking powerful computing systems, a common transport mechanism, and a file format that allows for flexibility, strict transaction data sets have been defined for traditional EDI. These transaction sets are defined by standards bodies such as the United Nations Standard Messages Directory for Electronic Data Interchange for Administration, Commerce and Transport (EDIFACT), and the American National Standards Institute's (ANSI) Accredited Standards Committee X12 sub-group. These standards specify fields for purchase orders, shipping documents, invoices, payments, etc. Transaction sets define the fields, the order of these fields, and the length of the fields. Together with these transaction sets come business rules, which are referred to as implementation guidelines. EDI standards define:

- Data elements (e.g., purchase order number and quantity on order);
- Segments, which are logical groupings of related data items (e.g., address);
- Message interchanges, which are groups of segments selected for a specific purpose;
- Functional groups, which are groups of messages of the same type;
- Syntax rules, which specify the concrete file structure for an EDI dialogue.

To actually implement EDI, trading partners (e.g., a customer and a supplier) have to follow the following steps:

1. Trading partners enter into an agreement, called a trading arrangement.
2. They select a Value Added Network (VAN).
3. The trading partners build or purchase custom software that maps between the two data set formats used by the trading partners.

Each time a new trading partner is added, new software has to be written to translate between the sender's data for the recipient. Traditional EDI suffers from many problems that have limited its growth. Some of the problems are:

- EDI is based on the transfer of *fixed transaction sets*. This rigidity makes it extremely difficult to deal with the normal evolution necessary for companies to introduce new products and services, or evolve and replace their information systems.
- *Fixed business rules* are encapsulated in the definition of the transaction sets as implementation guidelines.
- EDI is hampered with a *slow standard evolution*. The process for defining standards for transaction sets can take years. This simply will not work in today's business environment, which is characterized by accelerated change and increased competition.

- EDI has to be carried out over *protocols that use a VAN*. A situation that can be very costly, particularly for *small-to-medium enterprises.*

The low adoption of EDI and the lack of alternatives causes many organizations still to use paper intensive, manual, and thus costly ways to exchange business documents and messages with their trading partners. The big problem, however, with both "traditional" systems is inflexibility. EDI-based as well as manual paper-based processes are simply not able to change at the same speed as the business environments surrounding today's organizations do.

2.3. Open EDI

Traditional EDI is mostly used in communications between companies, which have high volumes in relatively small numbers of data items, and a long-term relationship. Also, because setting up EDI is expensive, only large organizations can afford it. As a result, the actual implementation of EDI is limited. This also has consequences for the development and use of standards for EDI, because cooperating organizations often develop their own standards forcing their business relations to use the same, proprietary standards.

To cope with these difficulties, Open EDI (ISO, 1997), a more flexible EDI, which can carry more diverse types of data and is more cost-effective for short-term operations was proposed by ISO. For Open EDI to work, new standards for communications are necessary, such that the problem of EDI only being possible between firms with long-term relationships can be solved.

2.4. EDI and Internet Technology

The widespread use of personal computers, coupled with the proliferation of telecommunication networks and the Internet, as well as their joint integration, has made paper-free trading a reality (Wigand, 1997). With the development of the Internet, new possibilities arose for e-commerce. Because the Internet is open for everybody, is accessible all over the world, and has an easy user interface in the form of the World Wide Web (WWW), many people and organizations can be reached. By using the Internet instead of a VAN some of the problems of traditional EDI are solved. The use of the Internet is much cheaper than the use of a VAN. VANs charge money for each individual message or for a collection of messages. The Internet costs almost nothing and is "free" to be used by anybody. EDI makes use of expensive software, for example, for message conversion and delivery. Internet software is usually not expensive, for instance Java parsers for XML are available for free from software vendors such as IBM and Sun Microsystems (although more software is usually needed for deploying XML/EDI, such as Enterprise Application Integration tools like Mercator from TSI Software, www.mercator.com). VANs for EDI require a prior relationship, which is not necessarily needed for the use of the Internet. Anyway, the Internet does not "replace" EDI. The Internet can be exploited as an EDI infrastructure.

Because the Internet consists of a large number of decentralized networks, security is a big issue, if the Internet is used for EDI purposes. VANs are relatively secure in comparison with the Internet because VANs are closed networks.

2.5. The eXtended Markup Language (XML)

To solve the problems mentioned with traditional EDI messaging, the business documents and messages that flow between organizations must be manageable for each involved organization, independent on which information systems are used. XML (McGrath, 1998) is a technology that may be used for structuring business documents and messages that are interoperable and comprehensible. Moreover, XML is easy to understand. Therefore, XML is one of the developments that enables the new Internet economy.

XML actually is a markup language, used for creating self-descriptive data. It is a subset of the Standard General Markup Language SGML. XML is platform and application independent,

because of its simple text-oriented structure. Both humans and computers can understand the syntax of XML documents, which makes XML a suitable tool for advancing the existing web applications for e-commerce.

The fact that XML is understandable by humans and computers is very important. A major drawback of EDI was that handling errors by humans was very difficult, because of the lack of information in the EDI messages. The only way to solve problems was with the use of thick manuals explaining all the codes in EDI messages. When using XML as a representation for the EDI messages, interactive web applications can be used with the existing EDI processes. The easy-to-use web interface makes it possible for humans to review and edit EDI documents easily, provided that appropriate XML tags are used.

3. XML/EDI Standards for Business Communication

Of course, the flexibility of XML also brings with it some risks. Each organization can develop its own dialect of XML messages, suited to its business processes. If every organization does this, organizations will be unable to communicate with each other, because information systems will not be able to understand each other. Therefore, just like EDI in the past, XML needs standards.

A problem for implementing XML in today's businesses is the vast amount of legacy EDI systems that have been implemented in the past. Companies will not just give up their old, costly infrastructure for a new, more uncertain technology; certainly not if their business partners also continue using EDI. Thus, a solution would be to create a way for organizations to gradually change their EDI infrastructure to an infrastructure supporting XML, while still being able to communicate with traditional EDI business partners as well as business partners that have already implemented XML. EDI provides the business methods of traditional e-commerce. It provides the ability to express data in a simple format and send it to someone else who can then interpret and use the received data. XML/EDI does not discard the investments made in EDI systems and knowledge, but uses it to incorporate EDI in future B2B e-commerce. The XML/EDI Group and others address this goal.

XML and EDI both are languages that consist of data and metadata, which is described in predefined formats and structures. Therefore, existing EDI mechanisms can be expressed in XML syntax, and new more flexible EDI methods can thereby be created. The vision of the XML/EDI Group is for XML/EDI to allow organizations to deploy cheaper and more flexible systems. XML/EDI is thus equally accessible to small and large organizations (Webber, 1998). XML/EDI advances EDI from the static communication between a small amount of large companies into the dynamic setting of the Internet.

Simply redefining the EDI messages into XML is not enough by itself to solve traditional EDI's problem of fixed structures and inflexibility. The XML/EDI Guidelines proposed by the XML/EDI Group add three additional key components:

- process templates,
- shared repositories, and
- software agents.

These three additional components transform traditional EDI into XML/EDI allowing dynamic B2B e-commerce among business partners. *XML* provides a foundation for transporting the other components across the network. XML tags replace or supplement existing EDI identifiers.

Templates provide the description of processes in the XML/EDI method. Process templates come in the place of traditional process control language syntax and are supplemented by XML DTDs. DTDs define the structure and content of a message and thus enable transaction interoperability. Templates enable the processing of transactions. DTDs let two organizations understand each other's data, while process templates define what happens to the data.

The shared *Repository* provides automatic lookups for the meaning and definition of EDI elements. The Repository provides the semantic foundation for global business transactions and gives the software agents the information to perform their tasks. Repositories for business communication are discussed in Section 4.

Software *Agents* take care of communication between the components of the model. They interpret the Process Templates to perform the work that is needed, but can also create new templates, using the EDI transaction data definitions and the user's business applications. Agents also can look up and attach the right templates for the jobs that have to be done. Agents for business communication are discussed in Section 6.

Electronic business eXtensible Markup Language (ebXML), for instance, is an international initiative established by the United Nations Center for the Facilitation of Procedures and Practices for Administration, Commerce and Transport (UN/CEFACT, www.unece.org/cefact) and the Organization for the Advancement of Structured Information Standards (OASIS-Open.org). As opposed to most EDI/XML approaches, ebXML is not based on traditional EDI, but intends to provide a new basis from scratch.

Of course, not every organization has to cope with an EDI legacy. The great amount of new business opportunities evolving from the Internet revolution, which will be the key factors in the future of e-commerce. They do not carry the burden of old EDI legacy systems. Also the small- and medium-sized enterprises for which EDI was too expensive in the past can start using XML for e-commerce. But also these organizations have a need for standardization of communication for business, to be able to participate in the worldwide electronic market.

Table 1 lists several initiatives that aim at defining XML messages for electronic business communication.

URL	Short Description
www.Xmledi.org	XML/EDI Group
XEDI.org	Re-defines EDIFACT and X.12 in XML
www.Commerce.net www.CommerceOne.com	Common Business Language CBL
Ontology.org	Defines standard taxonomies (ontologies)
www.cXML.org	Defines Commerce XML for B2B e-commerce
EbXML.org	Electronic Business XML defined by UN/CEFACT.
Rosettanet.org	XML Standards for supply chain automation for the PC industry
www.Openbuy.org	XML Standards for buying and selling
www.OTP.org	Open Trading Protocol: shopping and buying
IFXForum.org	Interactive Financial eXchange: banking services
www.OFX.net	Open Financial Exchange: financial services
www.fpml.org	Financial Products Markup Language for financial derivatives
FinXML.org	Communication for capital markets
IDEalliance.org	Standards for exchange of publications, Information & Content Exchange ICE
www.OpenTravel.com	Communication in the travel industry
HL7.org	Communication in healthcare
www.chemdex.com	Communication in life sciences
www.hr-xml.org	Standards for human resource descriptions
OpenApplications.org	OAGIS: XML for Enterprise Application Integration

Table 1: XML/EDI Approaches to electronic business communication.

4. Shared Repositories for Business Communication

In the absence of a complete and comprehensive set of document formats, as EDIFACT intended to provide, several attempts are made to set up repositories of components for business communication that can be inquired and used by business partners. XML.ORG, for instance, aims at being an independent industry portal for the standardization of XML applications in e-commerce, whereby it serves as a repository for XML DTDs. BizTalk.ORG is a competing industry initiative started by Microsoft. In these initiatives, the goal is to put pre-defined DTDs in shared repositories at the disposal for communication partners.

Such shared repositories are also the topic of research on electronic business communication. (Lee, 1998) suggests the use of a central repository in which formal trade procedures can be stored. Users can download these trade procedures — formally represented as Petri-Nets — adapt them if necessary, and then adopt them immediately for execution. (Gisler, 1999) proposes a central repository of standard contracts that can be used by negotiating partners in the process of contract building. (Huemer, 1998) advocates a Trading Partner Agreement in which business partners describe a new business process. The definition can be exchanged by means of EDIFACT meta-messages.

Figure 1 illustrates the role of a share repository in the context of XML/EDI business communication. In step 1, some information system of organization A queries the shared repository for the Document Type Definitions (DTDs) for the XML messages to be passed to trading partners. In step 2, the trading partners exchange references to the DTDs as part of the set-up process for the transaction. In step 3, the references are used to interpret the actual received data and map it into the organization's local information systems.

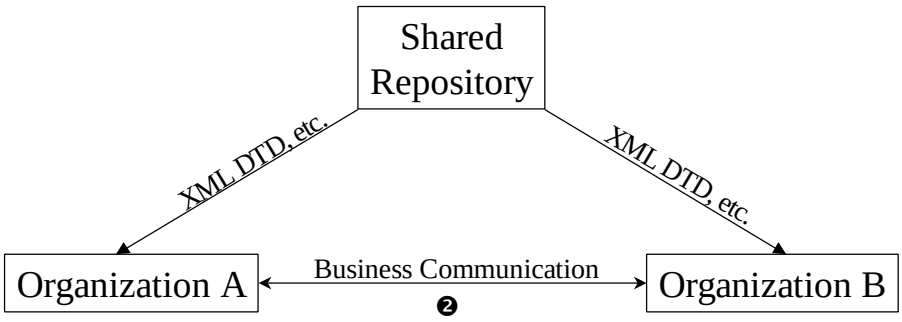

Figure 1: Repository Approach to Electronic Business Communication.

Table 2 lists some initiatives that develop shared repositories for electronic business communication.

URL	Short Description
XML.org	Independent industry XML repository
www.XMLx.com	ComerceNet's repository
MySAP.com	SAP's repository
BizTalk.org	MicroSoft's XML repository
www.EDI-TIE.nl	Repository for EDIFACT variations

Table 2: Repository Initiatives for Electronic Business Communications.

5. Formal Business Communication Languages

A number of researchers have investigated the possibility of developing general-purpose formal languages for business communication (FLBC), notably Kimbrough, Moore, Covington, and Lee. The impetus for this research has been a common assessment of the fact that existing EDI standards leave much to be desired in flexibility, in expressivity, in clarity, etc. (Kimbrough & Moore, 1997) mention two assumptions of the FLBC approach:

Public-only lexicons: Using only publicly available lexicons (with a public grammar) — that is, without recourse to direct conversation — possible business partners should be able to commence a meaningful and effective exchange of messages. These lexicons can be managed in the shared repositories (see Section 4).

FOL: First-order logic should be used insofar as possible and reasonable for expressions in any FLBC.

The first assumption states that a properly designed FLBC should permit business messaging to begin and to proceed without the business partners having to come to a separate and specific agreement concerning the content, structure, and proper interpretation of the messages to be exchanged. This assumption is very close to the approach called Open EDI (see Section 2.3). It does not require that all messages are based entirely on public lexicons. Exchange of particular vocabularies should certainly be allowed, as should 'linguistic bootstrapping' (agreement to define new expressions in terms of existing expressions). The second assumption calls for a logical-semantic foundation for the language.

FLBC is based on speech act theory that makes a distinction between the illocutionary force of a message and the propositional content (Kimbrough & Moore, 1997). By explicating the illocutionary force, FLBC makes clear that messages are not just pieces of data, but (intend to) have some social effects, such as creating an obligation. Moreover, the propositional content is represented in such a way that it contains indeed a proposition, that is, a statement that can be logically true or not (in the case of a assertive message), or an action to be taken (in the case of a directive message). This is in contrast to traditional EDIFACT messages where all the necessary data elements are present (otherwise it would not work), but not structured in the form of a proposition or action. As a result, the syntax definitions of traditional EDI are somewhat arbitrary and unpredictable. In the FLBC approach proposed by Kimbrough & Moore, the basic structure of FLBC messages is defined once for all. Of course, different message types can be defined on this basis, such as for ORDER, INVOICE, etc. These message patterns differ in the actions that they refer to and the arguments that these actions take. However, they can always be parsed, and interpreted to some extent; for the full interpretation, the receiver should know the meaning of the terms and predicates.

FLBC makes a distinction between the illocutionary or standard effects and the perlocutionary or extended effects. The illocutionary effects depend solely on the meaning of the illocution and are always the same. For example, a request always expresses a desire of the speaker that some action is performed. The illocutionary effects are fixed in the FLBC communication standard. The perlocutionary effects are defined by the user and determine how the message is processed after the first illocutionary interpretation. The extended effects depend on the meaning of the terms in the message contents.

XLBC (Weigand & Hasselbring, 2000) is a recent variant of FLBC that not only describes message types but also conversation structures. Just like XML/EDI, it makes use of XML syntax. XLBC is a business communication language, but includes also the use of a component library/thesaurus and a document language in a shared repository. The latter can be used, among other things, for representing formal contracts. Using XLBC, it is possible to specify a frame contract and subsequently exchange messages that are authorized by (and can be checked against) the contract. Particularly, the specific (semantic) representation of business message components

(in the shared repository) may incrementally evolve in this architecture. This would not be possible when relying only on prescribed XML DTDs for message exchange. An important concern is the separation of the semantics in the repository and the concrete syntax in XML. An important difference with traditional EDI, which typically also relies on (paper-based) contracts and agreements, is that the contracts are managed within the business communication system and that it is formalized. It is expected that these capabilities will make it easier to adapt standard contracts and set up new ones from pre-defined components.

FLBC and XLBC are based on the premise that by applying what we know about natural language communication, we can improve computer-based, automated business communication systems. Improvements are expected, in particular, to come with the increased variety of messages that can be handled.

6. Agents for Electronic Business Communication

Agents are software components that exhibit the well-known properties of autonomy, social ability, pro-activeness, and responsiveness. Agents are increasingly used in e-commerce, not only for searching information over the web, but also for negotiating orders in an agent marketplace (Ma, 1999). Part of the social ability of agents is the use of a common and standardized communication language. One of the oldest and best-known agent communication language is KQML. This language is based on Speech Act Theory (SAT), although the interpretation structure does not rely on SAT. ACL (Agent Communication Language) is the newest and perhaps most complete proposal based on SAT, which is prepared by the Foundation for Intelligent Physical Agents (www.fipa.org). The specification consists of a set of message types and the description of their pragmatics, that is the effects on the mental attitudes of the sender and receiver agents. Every communicative act is described with both a narrative form and a formal semantics based on BDI logic. It also has a conversation management system, although it does not offer a very extensive theory of conversation structures.

Agent communication languages are important for electronic business communication, not only as a source of inspiration, but also because agents are expected to participate more and more in business transactions. The advantage of the agent paradigm is that it not only supports a communication language, but also an agent architecture that structures the interpretation process. One example is the use of shared ontologies (managed in shared repositories). For an agent, the ontology is not fixed, the agent can access new ontologies if needed and subsequently use them in the interpretation of messages. Of course, this requires a shared language for ontologies, a topic of intensive research. An example is the Ontology Interchange Language OIL (www.ontoknowledge.org/oil). OIL combines the modeling primitives of frame-based languages with the formal semantics and reasoning capabilities of description logic and uses XML for describing the syntax.

In contrast to traditional EDI, agents are not only able to exchange messages and transform them automatically to internal formats, but they can also interpret them and react automatically based on specified strategies. This means, for example, that a lot of the business communication can be formalized. In particular, agents can be used to negotiate. Negotiation messages were not included in older EDI standards, since negotiation was not supposed to be done by machines. One of the oldest and widely used approach for automated negotiation is the Contract Net protocol (Smith, 1980).

The agent architecture offers the possibility to describe not only a language for business communication, but also the interpretation process. Although currently not fully proven in actual practice, it has the potential of becoming the paradigm for a new generation of business communication.

7. Electronic Marketplaces

In the future, e-commerce approaches that offer electronic marketplaces will dramatically change the way business partners trade with each other (Patel, 1999), and consequently pose new requirements on electronic business languages. Electronic marketplaces are specifically designed to enable multiple buyers and multiple sellers to interact and to collaborate. They provide a place where multiple buyers and sellers can come together and conduct e-commerce without compromising individual processes and relationships among the participants. Marketplaces can be created or hosted at any point along the commerce chain. The creation of new electronic marketplaces will change the way we think about B2B e-commerce and will play a very important role in the growth of the Internet economy.

The creation of electronic marketplaces enables new dynamic methods for exchange of business information and requires new business communication methods such as matching of buyer and seller information. Many first-generation e-commerce solutions were not much more than web representations of traditional business applications. They have not really changed the way in which business is done. Electronic marketplaces, however, create entirely new methods of commerce, such as online searching, auctioning and negotiating. They also facilitate the sharing of information and knowledge in trading communities.

For the *sellers* of goods, electronic marketplaces provide, for instance,

- new channels to reach their customers,
- better service possibilities,
- comprehensive product information to the buyer,
- automatic order and fulfillment processes, and
- decreased overall operational costs.

For the *buyers*, electronic marketplaces provide, for instance,

- access to large number of suppliers,
- access to auctions, and
- formation of buyer groups to get lower prices.

Electronic marketplaces support many-to-many trading relationships in ways that traditional sell-side or buy-side e-commerce cannot do. Establishing these relationships in the real world is extremely expensive. In the virtual world, it just depends on the capabilities of the electronic marketplace. If a marketplace is able to achieve enough critical mass — what depends on issues such as security, reliability, and trust — the highest chances for success exist.

Table 3 lists some initiatives that develop marketplaces for electronic business communication.

URL	Short Description
www.marketsite.net	Commerce One's marketplace
MySap.com	SAP's Internet Marketplace for Business Collaboration
web.netmarketmakers.com	Consumer-oriented marketplaces
www.ariba.com	Ariba's marketplace for various industry domains
Metalsite.com	Marketplace for metal products

Table 3: Some Electronic Marketplaces for Business Communication.

8. Summary and Further Issues

From an institutional point of view, standards are vehicles for facilitating coordination of economic activities (Helgesson, 1995). Instead of repeated coordination between actors, a standard solves a number of dilemmas for actors in a situation where communication is required. A standard therefore diminishes the need for ad-hoc coordination. On the other hand, there is an

increased need for concerted action when standards are created or changed. Normally, this concerted action is performed at the level of standardization committees. However, this often turns out to be infeasible, or only feasible to a very limited extent. For example, a standardization committee or industrial consortium can decide on the syntax of a specific XML DTD for a quotation message, but this does not say whether the quotation is binding or revocable. In today's open and dynamic business environment, the partners have to take over part of the standardization process to themselves. This can involve two or more partners who intend to set up a business relationship on the spot, or an industrial platform/market owner who does this standardization for its members. For such a setting, flexible system architectures for business communication are required.

The standardization process — defining a business communication language and its semantics — is a process that is usually done by standardization committees, but if the users need to do it by themselves, the question arises how it should be supported. We distinguish five aspects of this support:

Representation support: How to represent the syntax and semantics of messages?

Accessibility support: How to store the definitions and make them available?

Methodological support: How to arrive at a definition of redefinition?

Process support: How to manage the standardization process?

Implementation support: How to implement the language in the context of pre-existing legacy systems?

Representation support is the goal of XML/EDI approaches and of ontologies for defining common terminology. Accessibility support is provided by shared repositories, electronic marketplaces, and accomplished by software agents.

The other support aspects are beyond the scope of this paper, but we can make a few remarks. Methodological support has to do with the definition process itself. (Viskil, 1994), for instance, provides an extensive study on how dictionary definitions should be made. It is important to have a method in order to control consistency and uniformity.

Process support is needed especially in the case that there are more than two stakeholders involved, for example, a business group or virtual community. In that case, the process should start by identifying all relevant stakeholders and ensure that everyone who wants to be involved has the possibility to do so. It is important that the process is legitimate so that the results are acceptable to all stakeholders. In (de Moor, 1999), a method is described in which virtual professional communities can arrive at acceptable specifications. This method can also be used for a definition process.

Implementation support is especially important for the coupling of the standardized language with the legacy systems of the parties involved; thus integrating the involved local information systems (Hasselbring, 2000b). Typically, the communication language is not identical to the language spoken by these legacy systems. A translation or mapping is needed to transform one representation into the other. This translation software is one of the major components of current EDI systems. (Hasselbring, 2000a) discusses the role of standards in the construction and mapping of global data models for cooperative information systems with different individual data models. The traditional bottom-up approach is to start with the data models to be integrated, and then trying to define super-classes of which the original classes are specializations. The study shows that this can lead to very complex integrated models. A top-down approach starts with an available domain model, as the multilingual thesaurus may provide, and maps this to the situation at hand in the legacy systems. In the case of a message standard, a top-down approach could be followed if generic concepts, such as order, invoice but also product, buyer, seller, or transport

medium, are available. The top-down approach and the bottom-up approach can be combined in a so-called *yo-yo* approach.

References

(de Moor, 1999) A. de Moor. Empowering Communities: A Method for the Legitimate User-Driven Specification of Network Information Systems. Ph.D. thesis, Tilburg University, 1999.

(Gisler, 1999) M. Gisler et al. Requirements on secure electronic contracts. Technical Report MCM-institute-1999-01, Univ. St. Gallen, 1999.

(Hasselbring, 1999) W. Hasselbring: On Defining Computer Science Terminology, Communications of the ACM 42(2):88-91, February 1999.

(Hasselbring, 2000a) W. Hasselbring. The role of standards for interoperating information systems. In K. Jakobs, editor, Information Technology Standards and Standardization: A Global Perspective, pages 116–130. Idea Group Publishing, 2000.

(Hasselbring, 2000b) W. Hasselbring: Information System Integration, Communications of the ACM, 43(6), June 2000.

(Helgesson, 1995) C.-F. Helgesson et al. Standards as institutions. Problems with creating all-european standards for terminal equipment. In J. Groenewegen, C. Pitelis, and S.-E. Sjostrand, editors, On Economic Institutions, pages 162–184. Edward Edgar Publ., 1995.

(Huemer, 1998) C. Huemer. The growing need for meta messages in electronic data interchange. In Proc. 6th ECIS, Aix-en-Provence, France, 1998.

(IDC, 1999) International Data Corporation (IDC). The Global Market Forecast for Internet Usage and Commerce (order information at www.idc.com), 1999.

(ISO, 1997) ISO/IEC JTC1/SC30. Information Technologies - Open-EDI reference model. Paper, ISO/IEC, 1997. URL: http://www.x12.org/international/sc30tag.htm.

(Kimbrough & Lee, 1996) S. O. Kimbrough and R. M. Lee. On formal aspects of e-commerce: examples of research issues and challenges. In Proceedings HICSS'96. IEEE Computer Society Press, 1996.

(Kimbrough & Moore, 1997) S. O. Kimbrough and S. A. Moore. On automated message processing in e-commerce and work support systems: speech act theory and expressive felicity. ACM Transactions on Information Systems, 15(4):321–367, 1997.

(Lee, 1998) R. Lee. Towards open electronic contracting. Electronic Markets, 8(3), 1998.

(Ma, 1999) M. Ma. Agents in E-commerce (introduction to special section), Communications of the ACM, 42(3):79-80, 1999.

(McGrath, 1998) S. McGrath: XML by example: building e-commerce applications, Prentice Hall, (1998).

(Meltzer & Glushko, 1998) B. Meltzer and R. Glushko. XML and e-commerce enabling the network economy. SIGMOD Record, 27(4): 21-24, 1998.

(Patel, 1999) J. Patel. IT Impact: Where Buyers, Sellers Meet. Information Week Online, June, 1999. URL: http://www.informationweek.com/741/41uwjp.htm.

(Smith, 1980) R. G. Smith. The contract net protocol: high level communication and control in a distributed problem solver. IEEE Transactions on Computing, 29(12): 1104-1113, 1980.

(Viskil, 1994) E. Viskil. Definieren: een bijdrage tot de theorievorming over het opstellen van definities. Ph.D. thesis, Univ. of Amsterdam, 1994. (in Dutch).

(Webber, 1998) David RR Webber. Introducing XML/EDI Frameworks. Electronic Markets, 8(1), 1998. URL: http://www.electronicmarkets.org/netacademy/publications.nsf/all-pk/804.

(Weigand & Hasselbring, 2000) H. Weigand and W. Hasselbring: An Extensible Business Communication Language, submitted for publication, 2000.

(Wigand, 1997) R.T. Wigand. Electronic Commerce: Definition, Theory, and Context, in The Information Society, 13:1-16, (1997).

Biographies

Wilhelm Hasselbring received his Diploma in Computer Science from the Technical University of Braunschweig; Ph.D. in Computer Science from the University of Dortmund. He was researcher in Software Engineering at the Universities of Essen and Dortmund. In 1998 he moved to Tilburg University. In between, he visited Trinity College, Dublin, the University of Edinburgh, Department of Artificial Intelligence and Edinburgh Parallel Computing Centre (EPCC). Currently, he is Assistant Professor at the Dept of Economics and teaches courses in the area of Software Engineering and Electronic Business. His main research interests include software engineering for parallel and distributed systems, in particular software architectures for heterogeneous information systems in the application domains of Electronic Business and Healthcare.

Dr. Wilhelm Hasselbring is a fellow of the Research School CentER (for economic research). Recently, he received an individual Marie Curie Fellowship Award from the European Commission. He has published more than 40 refereed papers in international journals and conference proceedings.

Hans Weigand studied Computer Science at the Vrije Universiteit in Amsterdam. His Ph.D. thesis, written at the Vrije Universiteit, applied linguistics to the field of knowledge representation. In 1989, he moved to Tilburg University and worked on an ESPRIT project in document databases for two years. Currently, he is Associate Professor at the Dept of Economics and teaches courses in the area of Computer Infrastructure, Electronic Commerce, and Group Support Systems. His research is focused on the use of linguistic instruments in knowledge engineering and communication. As part on the ESPRIT project TREVI, a multilingual lexicon is being developed that supports news filtering. As part of the ESPRIT project MEMO, work is done on Electronic Commerce; in particular the development of a Formal Language for Business Communication based on speech act theory and logic.

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