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Promises and Pitfalls of SME Integration

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Abstract

The advent of Web technology and standards as XML had many hope for seamless business integration. Especially small and medium sized enterprises (SMEs) were considered to finally participate in existing EDI networks. But there are drawbacks to SME integration. In this paper we show that there are principle obstacles to integrating SMEs that are often neglected. If SMEs do not employ automated material management systems, there is obviously most likely no possible benefit from processes automation. Also, the SMEs' relative position within a value chain can pose typical problems. Addressing some of the identified problems, a solution called ASP-EDI is proposed, the concept of which has recently been proven when it was implemented as part of the new Internet strategy within the German office supply industry (95% SMEs). The co-developed WebEDI converter described in section 5.1 (ASP-EDI) has won the third prize of the German "IT inside SME 2010" award.

1. SME Integration: The Problem Has Been Here Before

1.1 Introduction

The advent of Web technology and standards as the Extensible Markup Language (XML) had many hope for seamless business integration throughout entire value chains. Especially small and mid-sized enterprises (SMEs) were considered to finally participate in existing EDI (Electronic Data Interchange) networks. But the story is – as many interesting stories are – somewhat different. In this paper, based on an analysis of technological and organizational requirements we show that there might be principle obstacles to integrating SMEs requiring technology and coordination designs substantially different from those often used. Thus, the question is discussed whether (and how) SMEs can and should participate in seamlessly integrated networks and (global) supply chains. We propose an ASP-EDI solution as a first step towards future Webservice-based scenarios.

1.2 Research Framework and Related Literature

Traditional cooperation designs increasingly fail when confronted with globalized networks of partners and customers since they cannot incorporate the fundamental implications associated with network effects (Weitzel et al., 2000). The theoretical challenge is to extend the economic theory in order to capture these effects. The practical challenge is to come up with designs to reap some of the benefits associated with networks. Decisions on ICT infrastructures and especially EDI networks are a perfect instance of that problem. To address these questions, the research project *IT Standards and Network Effects* funded by the German National Science foundation that emerged from the interdisciplinary research program *Networks as a Competitive Advantage* analyzes comprises these goals (<http://www.vernetzung.de/eng>):

- develop and evaluate coordination designs for agents deciding on ICT infrastructures
- explain innovation diffusion patterns of technologies and standards
- analyze cooperation strategies and technological approaches of standards consortia and e-business players in the IT sector
- congregate existing approaches, among others, from network effect theory, game theory, managerial accounting and controlling, and institution theory as a contribution to a general theory of networks.

Theoretical results are implemented and evaluated with industry partners, using prototypes and simulation models. Among others, the result of this work was used

to support the Internet strategy of an industry in Germany dominated by SMEs (see section 5).

Application domains include electronic market places, supply chains or corporate Intra- and Extranets. For empirical results from our project concerning large enterprises see (Westarp 2001), for a standardization framework see (Weitzel et al., 2002), for the theoretical framework and deficiencies of the traditional theory see (Weitzel et al., 2000).

As part of the research framework described, an issue of particular interest is the integration of SMEs into existing value chains which has so far stayed far behind initial expectations. Empirical research to explain this observation is introduced in (Beck et al., 2002). In this paper, we focus on technical issues associated with SME integration into EDI networks that, despite their significance, have hardly found consideration in the literature and that has made it quite difficult to understand the true nature of SME integration problems.

As a result, it is demonstrated that due to the fact that many SMEs do not employ automated material management systems (MMS), there are not too many unexploited network gains to be internalized. That is the reason why many cost reduction designs (like rebates on electronic orders) are an insufficient incentive for SMEs to standardize. This emphasizes the general finding that integration requires more than just technical interoperability. The willingness to cooperate - or in terms of game theory the willingness to eat from a bigger cake - requires new forms of coordination.

For earlier (mostly empirical) contributions to the literature on EDI see (Emmelhainz 1993) (Deutsch 1994) (Kilian et al., 1994) (Niggel 1994) (Picot et al., 1993), for WebEDI see (Curtis 1996) (Densmore 1998) (Waltner 1997).

Besides the practical economic significance of German SMEs (with currently about 3.3 million firms and responsible for 57 % of economic growth net output) and their integration into supply chains, within the research project IT-standards and network effects we seek to study prerequisites for the diffusion of innovations in the context of trying to better understand the role of SMEs in national innovation systems (Rogers 1995). The term diffusion is generally defined as “the process by which an innovation is communicated through certain channels over time among the members of a social system” (Rogers 1983). The traditional economic analysis of diffusion focuses on describing and forecasting the adoption of products in markets. In particular, the question of which factors influence the speed and specific course of diffusion processes arises (Weiber 1993). Our goal is to substantiate if new emerging IT standards are enablers for SMEs and - if this hypothesis holds - if electronic business and XML is something like a base innovation to increase economic revenue and the pace of adoption of new IT standards or more generally network effect goods. For electronic business as great invention see (Gordon 2000), for innovation and growth in general (Cantwell 2000) and for the methodological problems of measuring innovation effects see (Hargittai 1999).

1.3 Structure of the Paper

In section 2, a brief overview of the evolution from EDI to WebEDI lays the foundation for taking a deeper look at the technological requirements for electronic system-to-system communication as shown in section 3. It becomes evident that B2B communication is not as “easy” as many presume and that a substantial knowledge of application prerequisites is a key to evaluating the potential benefits and costs associated with different forms of EDI or integration depths. Our main hypothesis becomes evident: Many SMEs simply do not have “processes” to be automated when using EDI and therefore no potential benefits from automation. That is why often large enterprises focus on the benefits of EDI (Westarp et al., 1999a), (Westarp et al., 2000), and SMEs on the costs.

Afterwards, in section 4, we discuss the implications of market structure and the relative position of SMEs within a value chain. Finally, we propose some areas to improve upon.

The results presented in this article were awarded with the third price at the “IT inside SME 2010” competition of the federal state of Rhineland-Palatinate and have recently helped the German office supply industry to adapt their Internet strategy and to make a significant progress towards reaping network benefits, especially as compared to similar industries.

2. From EDI to WebEDI

2.1 Traditional EDI

EDI has been used for over 30 years for the exchange of business data (e.g. delivery notes, invoices) between two application systems in a standardized, automated form (Emmelhainz 1993). EDI solutions are used by companies to achieve a more efficient data and information management by reducing processing time and avoiding redundant data entry.

For the benefits associated with traditional EDI (e.g. cost reductions induced by rationalization and automation, shorter order processing time, improving the value-added chain (just-in-time management, etc.)) see (Emmelhainz 1993) (Niggel 1997), for the distinction between EDI over the Internet and WebEDI see section 2.2, for WebEDI benefits see (Westarp et al., 1999a) (Westarp et al., 1999b). An important finding of the literature focusing on SME integration that is also supported by our findings is that a necessary prerequisite for gaining direct and indirect benefits of EDI is the existence of a MMS (Swatman et al., 1997).

Besides all the alleged benefits, EDI is not as widespread as many had expected. Presumably, nowadays only 5% of all companies who could benefit from EDI

actually use it (Segev et al., 1997). From the perspective of an SME, among the reasons are asymmetries concerning the distribution of costs and benefits and the associated disadvantageous relative position of most small enterprises in supply chains (Maurici et al., 2002). Further important reasons are considerably high costs for implementing EDI systems. Furthermore, there are many different and mostly incompatible EDI standards. Thus, there is uncertainty about which EDI standard to use since companies are afraid to be locked-in into a standard that is expensive to change (Westarp et al., 1999a).

2.2 WebEDI to the Rescue?

The use of Internet-based EDI solutions or WebEDI has increasingly been discussed especially as solution to the problem of high EDI implementation and operating costs. First, of course, there is the ubiquitous Internet that lets enterprises replace expensive Value Added Networks (VANs) with a communication medium that is almost free ("EDI over the Internet"). Then, using Web forms allows small enterprises to communicate with their large partners over the Internet while in the background - on the server - all entries are converted to some EDI format required by the large partner ("WebEDI") (Weitzel et al., 2001). Thus, the promise of WebEDI is the low cost and small effort integration of even smallest partners of a value chain basically as long as they have a modem. In fact, WebEDI-applications are regarded as a solution to the so-called EDI-dilemma by some authors.

But it is important to note that most WebEDI approaches are mostly no more than an HTML-front-end to a shopping system. A user manually enters data into a form using a web browser as communication interface. Thus, there is no machine-to-machine connection and no way for the client, i.e. the small partner, to import the EDI data into his in-house systems or vice versa.

Another problem rarely discussed in the EDI literature is that many SMEs simply do not want to use WebEDI plainly because it simply does not pay. We discuss this and further technological prerequisites in the following sections.

3. SMEs and EDI

Regardless of size, there are necessary prerequisites for an automated exchange of data. All traditional EDI systems require material management systems that are important to understand when discussing different forms of EDI or B2B communication, to use a recently more renowned term (Swatman et al., 1997). When starting a new EDI relation, some problems become obvious especially in the context of how SMEs conduct their business. The different and originally independently designed, operated and optimized systems support different business

process designs, data formats etc. Thus, EDI is more than connecting systems in the same value chain. Very often, process redesign to fully benefit from the integration potential induces the largest part of the costs of implementing EDI systems.

A primary focus of all EDI standards (see (Westarp et al., 1999a) for empirical data about the diffusion of various EDI standards) is semantics. Tasks as automatically identifying partners and products require a set of definite primary keys. These are provided e.g. via the international article number system EAN. In the context of WebServices as described in section 5.2 registries like UDDI can be used (also within ebXML) to describe services and processes in order to facilitate automatic communication and to "enable buyers and sellers and marketplaces around the world to share information (and) to connect Web services at low cost" (www.uddi.org).

But a global registry for semantics is not sufficient for creating a savings potential; of course, it rather enables its realization. Locally, it is the key to also maintain a consistent database within the ERP or material management system. Here the difference between what - even process-based - frameworks like ebXML (see section 5.2) can offer and what remains within the scope of the individual firm becomes clear: technologies and initiatives like UDDI, ebXML or WSDL can facilitate certain aspects of business communication. But as long as there is no underlying process that is advantageous to automate, those scenarios only incur costs. And accordingly very small firms frequently do not employ processes orchestrated by ERP systems and the like. Besides a lack of automation potential, this implies media discontinuities. Thus, ERP systems or at least software-based material management systems are a prerequisite often ignored in the mainstream literature but among the main reasons for significant errors in EDI practice.

Besides the famous EDI converters, prerequisites even for the most basic EDI processes include:

- a **material management system** to generate and send an EDI messages such as purchase order or invoice,
- an **inventory administration system** for an automatic delivery schedule,
- a **dispatch handling system** to produce a dispatch notification,
- **scanning systems** for physical access and exit control to handle the selling data and
- an **accounting and billing application** to send the invoice to the EDI partner.

Professional large scale EDI applications ("real EDI") for seamlessly integrated cross-enterprise electronic business processes come with further technical requirements. The most important are:

- **data select programs** to extract the relevant data,
- **converters** to convert the data format used in-house into a common EDI standard,

- **interfaces** like communication software
- **net providers** (VAN or Internet).

The EDI converter is the heart of an EDI system. It basically includes the implementation rules and partner profiles, the data allocation directory and the norm database.

The partner profile includes a set of rules and guidelines about the EDI standard in use and its version, valid message types, data transfer details and the time of data transmission. Furthermore, the partner profile contains rules and methods for transmission error handling. A possible contract between EDI partners could be the validation of data at send-time, though rarely found in practical use. Send time and receive time validation are among the features most efficiently supported by recent XML/EDI approaches.

The data allocation directory of the converter is responsible for mapping data elements from the in-house format to the EDI standard et vice versa. The main conversion is done by the norm database, e.g. according to the UN/EDIFACT framework provided by UN/ECE. The use of the norm database also allows automatically finding and partly recovering incorrect or implausible data. Furthermore, it guarantees the proper shipping of the EDI message in a correct version.

The norm database is nothing more but the place within the converter at which a collection of agreed upon message types is deposited. The use of a norm database is not undisputed due to its non dynamic structure and its difficulties to implement new partners. A modification of the norm database requires skilled EDI engineers. For this reason, more recent converters support DIRDEF messages which permit dynamic adjustments. Depending upon configuration and depth of integration of the converter, the converter application supplies the data in accordance with the data allocation directory directly to the appropriate real time system at the recipient (application to application) or to a buffer in the form of catalogs (door to door). The EDI recipient must then “manually” decide whether he wants to accept the data or not as well as select the final destination of the data.

The function of the converter is essentially determined by the organization of the norm database, the data allocation directory and the partner profiles. Message dispatching is an example. The material management software generates the order for electronic dispatching. It supplies the message to the converter system which fills out the relevant data fields or adds them (for instance ILN) by using the data allocation directory.

The selected data are transferred together with the data description of the norm database into the appropriate EDIFACT message format. Together with the data from the partner profile the application can automatically address and dispatch the message. This can be a Point-to-Point or X.400 connection, depending upon agreement.

Secure data communication and reliable data quality are tantamount to EDI users. These are services offered by VAN (Value Added Network) providers.

Successful EDI systems have needed many integrated partners and high transaction volumes to accommodate for the high setup costs and the complex requirements. The Internet seems to be an economical alternative to expensive VANs or X.400 since communication costs are the major part of the variable transaction-induced EDI costs.

Though often surprising to those not too familiar with traditional EDI, in many (if not most) cases, SMEs EDI data used to be exchanged via mailing (without “e”) disks. Only recently, the Internet and associated lower communication costs and basically no technological barriers to entry have changed this situation somewhat.

There is a prevailing opinion that the running costs of EDI – which are of substantial importance when deciding on using EDI applications or not for SMEs - can be lowered significantly using WebEDI or Internet-EDI. There are two different possibilities of using the Internet as communication infrastructure: EDI-over-the-Internet and WebEDI, using different applications and services like e-mail (smtp), file transfer (ftp) or hypertext (HTTP) (Kalakotta 1996). The described procedures differ essentially in whether they use only the TCP/IP based Internet and its protocols (Internet-EDI) or applications such as browsers or mail systems (Web-EDI) beyond that.

As a result, many hybrid forms of EDI have emerged responding to the bilateral availability of some of the stated requirements between particular partners. In consequence, a combination of EDI and already available technologies such as fax or e-mail were used. Examples are EDI hybrids like EDI-to-fax which after all turned out to be of quite little success (Schmied 1998).

4. The Importance of an SME's Relative Position within a Value Chain

So far the adoption of classical EDI applications has failed with SMEs due to the high costs of setup and the too small number of electronic vouchers and documents. See (Beck et al., 2002) for empirical evidence in the German office supply industry. As a consequence, no advantage from an automated batch processing can be realized. Small- or medium-sized enterprises are normally not in the position of a 1st tier supplier within a value chain. Mainly they are suppliers for MRO goods.

According to unanimous opinion, WebEDI is no substitute for classical EDI connections, however, but it will be used by enterprises that have no economic alternatives to their avail. The unspoken idea is: let the small partners suffer as little as possible as long as the larger partners get their requested data format. As our empirical investigations in the consumer goods industry have shown, the utility

from using a WebEDI solution for SMEs can be small or even negative (Beck et al., 2002).

Depending on the specification of the WebEDI application the utility is divided asymmetrically between the involved business partners. This depends closely on the particular interests of the operators or initiators of the WebEDI application. In principle two forms can be differentiated: procurement (MM) and sales and distribution (SD) networks.

4.1 Optimizing e-Procurement with WebEDI (Demand-Side WebEDI)

Markets with monopolistic or oligopolistic structures often focus on buy-side benefits. Accordingly, in these markets demand-side driven WebEDI applications without electronic catalogue systems can be found frequently. The process is as follows:

1. The ERP system of the demander (big enterprise, also called “hub”) generates an order (e.g. an UN/EDIFACT ORDERS) and transmits it to a Web server. The order can already be personalized and addressed to the appropriate suppliers, or it can be uploaded to an electronic market place e.g. for reverse auctions.
2. The supplier (SME, also called “spoke”) gets an E-mail with the order information and has to log on to the WebEDI system via Internet to fetch the order.
3. The supplier can now indicate - either online using a Web form or offline in so-called turnaround documents - what he can supply at what price. This information will be sent to the demander.
4. After acknowledgement of the order the supplier receives a delivery note, invoice and dispatch labels with dispatch numbers, and EAN. Now the supplier can commission the ordered commodity and provide the customer with readable labels. An own supplier side entry of the order data is not applicable. The invoicing takes place the conventional paper-based way.

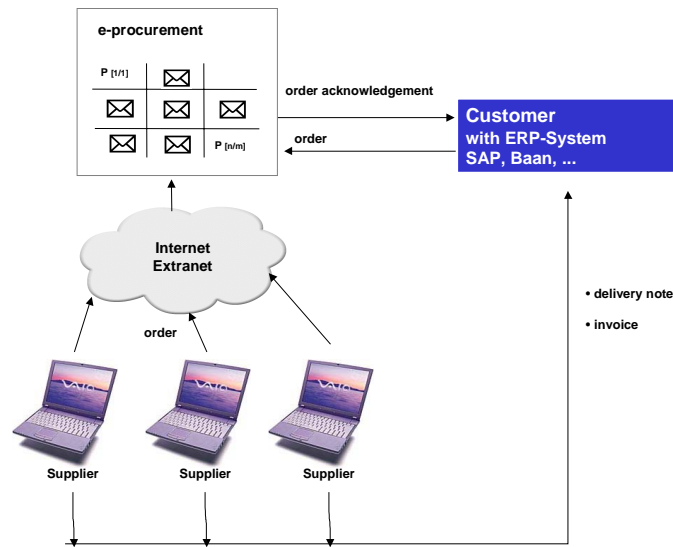


Figure 1: Demand-Side WebEDI Application (e-Procurement Initiated by "Hub")

In these models, the SMEs not EDI capable have to fetch their orders over the Internet, but they get all necessary documents for delivery so that the additional work with WebEDI is opposed by the discharge concerning delivery, package and account creation. Thus, the application represents an improvement to the existing process for both, the EDI capable demander and the WebEDI user.

4.2 Optimizing Sales and Distribution with WebEDI

Another form of WebEDI applications is supply-side driven and centers around an electronic catalogue. In these markets, there is not necessarily monopolistic market dominance (on the supplier side). In such a symmetrical polypoly case none of the business partners can be forced to use the WebEDI application (though it might be sensible in many cases). The design of the existing WebEDI application as, for example, executed in the German consumer or office supplies industry (Beck et al., 2002) is shown in the following scenario:

1. The supplier places his whole orderable article stock for potential customers on the Internet, including individually customized and edited price and catalogue data for the customers.
2. After the electronic catalogue and the individual conditions for the users are deposited, the SME in the role of the spoke enters his order in the Internet form comparable to shop solutions in B2C scenarios.

- After sending the order the EDI capable supplier gets an EDI ORDER which can be processed in his ERP system.

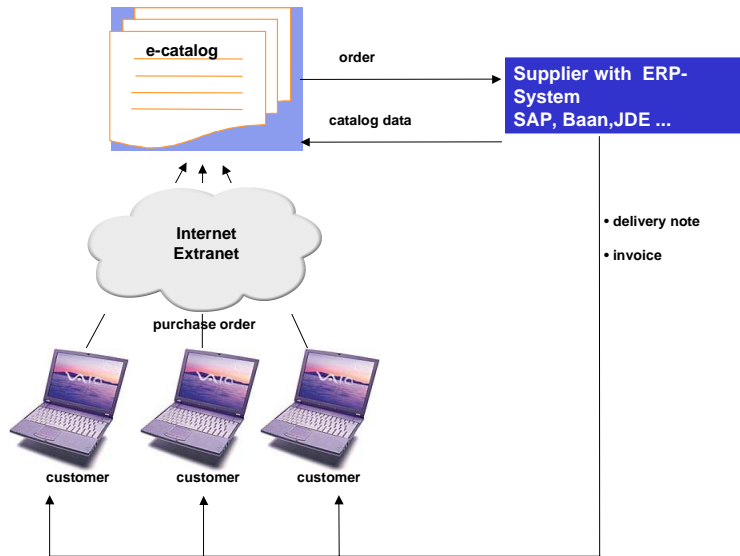


Figure 2: Supply Side Initiated WebEDI Application (e-Catalogue)

In contrast to the conventional order process the burden of a correct, electronically captured and dispatched order is exclusively on the side of the SME (as WebEDI user). The expensive and error-prone input of telephone order or orders which are received by fax are not an issue for the EDI capable hub. However, there is no additional utility from using WebEDI for the spoke except for the supply of current price and catalogue data. Without an ERP system an SME cannot improve its situation compared to conventional order processes. Additionally, the costs for personnel and communication increase.

Contrary to the demand-side WebEDI application there is no balanced symmetrical distribution of utility between hub and spoke. In order to solve this problem and to remedy the EDI dilemma on supply-side driven markets, an application (as described below) was developed in the German office-supply industry which solves the problem with WebEDI on an organizational level.

5. New Forms of EDI for SME

5.1 ASP-EDI: A New Form of WebEDI Solution

As a result of our investigation in the German office supply industry we have co-developed and accompanied a simple redesign of the WebEDI concept in that industry called ASP-EDI. The designed solution, based on the application service provider concept, helps to minimize the investment for a real bi-directional EDI connection between SMEs that employ software-supported material management (or sales processes) and the industrial business partners without organizational overhead and intricate side payments. The result is published as *Web converter* and used in the office supply industry in Germany (Beck et al., 2002). The Web converter convalesces the weaknesses of the WebEDI solution through connecting the existing ERP system employed at SMEs without requiring an own expensive EDI converter. In the context of the findings of the previous section this means that employing MMS is still compulsory but that the necessity of operating an individual converter is omitted.

The function of ASP-EDI is very simple and requires no additional software. For an order, every material management system generates a simple printer spool in ASCII format (CSV). This file will normally be printed out or sent to a fax. The small enterprise transmits the order created by the MMS in ASCII code as CSV file by electronic mail to a server on the Internet which then transfers the order in accordance with a mapping (defined beforehand) into the appropriate EDI order format the recipient can handle. Analogously, the SME can receive and use incoming EDIFACT PRICAT data as ASCII strings. The material management system of the SME has to provide three ASCII interfaces: one for the outgoing orders and two for the incoming article and individual prize data. This is significantly easier for the SME than to handle an own EDI converter.

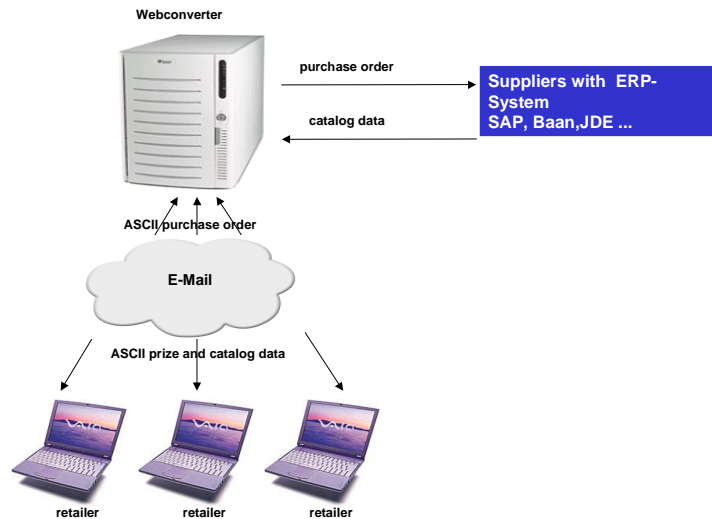


Figure 3: Web-Converter Solution for SME with MMS

The use of the Internet as communication platform for a Web based converter reduces the entrance barrier for SME, while at the same time servicing and maintenance of expensive and complicated EDI converters are omitted. First pilot users already use this solution in the office supply industry. Through supplying the mapping information by the ERP or MMS software house the transfer between spoke (SME) and hubs will come to an automated process. For a transaction cost based comparison of WebEDI, traditional EDI and ASP-EDI, further research must be conducted. Until now only qualitative utility analysis is possible. In the future the application of XML/EDI is conceivable in order to map the data at the SME immediately to reduce the costs. This service, too, could be provided by external entities. A generalization of this concept is known as WebService.

5.2 WebServices

Web Services have been defined as "encapsulated, loosely coupled contracted functions offered via standard protocols" (www.webservices.org). On an abstract layer, these can be interpreted as autonomous services accessible via the Web that can serve as components of a dynamic value chain.

Services as described above - including converting the EDI print-spool data to standard XML/EDI formats like xCBL - can be another step towards the integration of the most heterogeneous partners in that they increasingly allow the outsourcing of compatibility problems. Already, XML-based languages for calling, describing,

and registering WebServices like XML-Protocol, UDDI and WSDL are available. The Electronic Business XML initiative (ebXML) (<http://www.ebXML.org>) provides a very promising framework for future SME integration in WebService scenarios. It originated from a working group established by UN/ECE/WP.4 (predecessor of UN/CEFACT) in 1995 to elaborate recommendations "for creating the next generation" of web-based electronic business communication especially focusing on the needs of SMEs; it is now hosted by OASIS, the worlds biggest industry consortium for XML-based business applications. Accordingly, among the primary requirements were easy access and low implementation costs. A major advantage of the framework is that the infrastructural requirements are easily met. Almost every web browser is a suitable XML client, a chance EDIFACT has never had. Problems of defining semantics for business documents and describing processes as well for finding partners and their services are still virulent, though. Promising work has been proposed as early as 1998 (eCo framework by CommerceNet (Weitzel et al., 2001, 94-103), other initiatives include the integration specifications of OAG, cXML (Ariba), RosettaNet or UDDI (Weitzel et al., 2001, 104-156) and especially ebXML. XML-based initiatives as especially ebXML, their role for SMEs and future trends are extensively described in (Weitzel et al., 2001).

6. Conclusion

In our view, for a successful supply chain it is key to thoroughly consider integrating SMEs. Inside an interlaced economy automatic electronic data interchange is important not only for the hubs or the industry partners respectively. WebEDI is no automatic solution and it is based on a human to machine interface. Due to this weakness, WebEDI can only be an interim solution. A necessary condition for SMEs to participate in reaping network benefits is to use material management systems. Thus, a goal has to be to design and develop related software easy to use and to adopt. As our Web converter solution has shown, using existing standards like ASCII code as common denominator, in combination with ASP concepts it is possible to connect even SMEs. In the future, we believe ASP in combination with new technologies like XML and lean material management systems will contribute to solving the so called EDI-dilemma.

What does the future hold? Apart from the more individual issues described above, advances in the area of WebServices and especially the ebXML framework might prove to be very valuable. Learning from decades of EDI experiences, OASIS has set up an *ebXML Implementation, Interoperability, Conformance* technical committee focusing on implementation issues surrounding ebXML and providing guidelines to industry groups, vendors and users seeking to adopt the specifications in order to support easy adoption and sharing of experiences.

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