The Role of Business Objects on the Path from UN/EDIFACT to ebXML

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***Abstract*--B2B commerce was dominated for a long time by traditional electronic data interchange (EDI) standards, like UN/EDIFACT, and has been recently influenced by XML. Nevertheless, most of the B2B problems today are independent of syntax. The problems in traditional EDI are mainly based on overloaded message types resulting from reverse engineering data base structures of legacy systems. Alternative EDI approaches have been business process-centric and are based on transfer syntax neutral business objects. Both XML and business process-orientation have been the basic concepts for the ebXML initiative. This paper presents a survey on different B2B approaches that have led to the start of the ebXML initiative. Furthermore, we show how the concept of syntax-neutral business process modeling and business objects is basically reflected in ebXML without going into the details of the technical realization.**

***Index Terms*—B2B e-business, EDI, XML**

I. Introduction

In e-commerce we usually distinguish between business-to-consumer (B2C), in which people purchase products or services over the Internet, and business-to-business (B2B), which supports the efficient communication between organizations along the supply chain. B2B transactions are characterized by high business value, long-term relationships, complex business processes, inter-computer communications, security, and a multitude of transaction models [5]. We feel that inter-computer communication is the most significant property of B2B e-commerce. Organizations commonly run applications to support their business, whereas consumers do not. Therefore, organizations have a great interest in integrating their applications into the e-commerce transactions. Therefore, a B2B system must guarantee that involved organizations can perform enterprise application integration (EAI) [14]. If all involved organizations perform EAI, this leads to application-to-application systems.

However, the idea of exchanging business data between applications is nothing new and is implemented since the 1960ies. The underlying concept became known as Electronic Data Interchange (EDI) [1]. Today some people are claiming that EDI is old technology. But even if we use more hype terms like 'silent commerce' or 'collaborative systems' the problem of application integration will remain, and nothing else is defined by EDI. However, it is true that EDI—despite of its long history—has not been accepted throughout the user base: 90% of the Fortune 1000 enterprises have invested in EDI, but less than 1% of the small and medium enterprises (SMEs) are involved in EDI. So, there are millions of companies who do not profit from communicating electronically. Accordingly, future solutions must ensure that SMEs will participate in B2B e-commerce.

The area of EDI has been dominated over the last decades by standards like X12 and UN/EDIFACT. These standards specify how business data has to be structured to ensure the identification of data values. Since all these traditional standards use an implicit data identification mechanism, data is not self-describing and is thus hard to understand by humans and seems to be complex. The appearance of XML gave hopes to the B2B community. XML seems to overcome the limitations of traditional EDI standards, since it uses an explicit data identification mechanism by tagging the information. The first hype of XML led to a proliferation of XML business vocabularies [11]. However, the number of XML-based B2B implementations did fall short of the original expectations [19]. It becomes clear that a human readable syntax is not by itself a solution to the B2B problem. Although we strongly believe in the importance of XML in the future of e-commerce, we see XML only as a basic technology around which a broader e-commerce framework has to be built.

The most significant problem to solve in B2B e-commerce is to bridge heterogeneous applications. From an IT perspective message oriented middleware (MOM) might help to overcome the problem of different hardware, software, data structures, and so on. However, existing MOM approaches do not address the problem of different business requirements leading to different business semantics handled by the applications. The business semantics are independent of the messaging approach and the transfer syntax. When talking with business people about business transactions the least important thing they can think of is the transfer syntax. They understand the choreography of their business processes and know the type of data they send in (electronic) business documents or the type of data they expect from their partners to perform a business activity. Therefore, a methodology for an unambiguous definition of the business processes and the business objects supporting these processes is crucial for successful B2B e-commerce.

The separation of business semantics and the IT infrastructure to support e-commerce has been envisioned by the United Nation's Center for Trade Facilitation and Electronic Business (UN/CEFACT) over the last years. OASIS, the Organization for the Advancement of Structured Information Standards, concentrates on creating interoperable

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industry specifications based on XML and SGML. Both organizations joined together in the ebXML initiative to create a single global market on the basis of XML and business process modeling. This paper concentrates on the ebXML initiative. Section 2 gives an short overview of the failures of traditional EDI standards, which must not be repeated within ebXML. In Section 3 we give an historical overview of B2B developments leading to the ebXML initiative. The basic concepts of ebXML are introduced in Section 4. We show how the idea of syntax-neutral business process models based on common business objects is realized in ebXML. Due to space limitations we will not go into the technical details of these concepts. Section 5 concludes the paper with a short summary and outlook to the future of ebXML.

II. The Problem: Overloaded Message Types

At first sight one might believe that the syntax of traditional EDI standards prevents SMEs from participating in EDI. Admittedly, the delimiter-based syntax of X12 or UN/EDIFACT results in file structures that seem to be more complicated than well-formed XML documents. However, both UN/EDIFACT and XML files are not meant to be read by an end user. Besides the easy to learn and understand syntax XML can serve for both application-to-application as well as human-to-application interfaces in Browser-based e-commerce. Further advantages of XML include flexibility instead of a long standardization process, distribution of DTDs and schemas over the Web, usage of the Unicode standard, tremendous tool support, and a growing base of experienced programmers [8]. For all these reasons an organization might prefer XML to traditional EDI standards. Nevertheless, the main reason why SMEs were not able to participate in EDI were the high costs of setting up and maintaining an EDI relationship. Therefore, we have to investigate why the costs are that high and whether XML can cut down costs or not.

Traditional EDI is difficult and costly to implement, because it requires a unique solution for each pair of trading partners [7], i.e. that business partners must agree on a subset of a standard message and implement an interface for the agreed subset before they can start exchanging business data. Accordingly, organizations have to spend a lot of efforts in analyzing their data requirements, define a subset of an EDI message being able to capture the requirements and to harmonize their own view with the preferred solutions of their business partners. All these steps are necessary in order to map in-house data from and to EDI messages. As an example, consider a UN/EDIFACT purchase order message type, which contains more than 1000 data element types that could be instantiated. An instance of a purchase order will on the average make use of 40 different data element types.

The above mentioned problem of integrating EDI into business is a result of the generic structure approach used in UN/EDIFACT. The message types are created and maintained by IT-experts who volunteered to work in the standardization bodies. The volunteers' business know-how is usually driven by the structure of their own information systems. Consequently, their goal was to create an equivalent UN/EDIFACT component for each data field of their in-house applications. The more companies and industries were using UN/EDIFACT, both data requirements and data element types got more and more. As a result a UN/EDIFACT message type ended up as a data model that is able to capture all data requirements of the corresponding business databases (or at least of the databases of the involved volunteers). This is the main reason why the purchase order and other message types are overloaded. There was never an analysis verifying whether the corresponding business process actually requires all the data element types of the message type or not.

The fact that the business requirements of UN/EDIFACT message types were never documented resulted in vague interpretations of the message types. The same business data could be expressed in different UN/EDIFACT components in absence of clearly defined business rules. The problem of overloaded message structures and missing business rules is handled by EDI branch organizations. They trim down the EDI standard messages to suite the requirements of business partners in a particular sector, in a particular part of the world. For the resulting subsets of EDI messages they specify the semantics in so-called implementation guidelines (MIGs) which govern the implementation of EDI in the specific sector of the specific local area [17]. Since MIGs are commonly made in isolation of each other, different MIGs stay in conflict with each other.

In general, a MIG uses about 20 % of the data element types of the standard message type and eliminates about 80%. This means that a MIG for a purchase order would still include more than 200 data element types. Thus, individual organizations have to reduce the MIG by another 80% to finally get to the data element types actually used in a message exchange. Even if business partners start from the same MIG it is very likely that they come up with different subset structures. Therefore, a cumbersome, costly and hard to implement harmonization process is necessary. If companies start from different MIGs the situation will be even worse. This costly effort is only manageable by large enterprises. This is why only the Fortune 1000 organizations are participating in EDI. Furthermore, they are often in the lucky situation to dictate their preferred structures to their small business partners, which have to struggle with formats incompatible to their own data requirements.

Nevertheless, the generalization & specialization dilemma—specifying a general structure in order to reflect the requirements of a large user base and to specialize this structure for the requirements of certain business relationships—is independent of the syntax. Therefore, following a similar approach in an XML environment in which database structures of individual organizations are harmonized would lead to the same problems. To agree on a certain set of business rules that are applicable to all organizations in the world might only work in theory. This would mean to

standardize the business requirements of all organizations in the world—this is neither desired nor possible.

The alternative approach to the scenario described above is to document the business processes and their information requirements for certain business goals. The resulting business process definitions using business objects have to be expressed in an unambiguous and machine-readable way to be processed by a computer program. This should allow software vendors to build off-the-shelf software solutions that follow identified business processes.

III. Survey on Developments in B2B

Before going into details of the idea of using business objects in inter-organizational business process models to support B2B solutions, it is worthwhile to look at the history of B2B initiatives. This helps to categorize the different initiatives and shows how the influenced each other.

The concept of a paper-less exchange of business documents was already created during the Berlin Airlift in 1948 [18]. However, it took some time until the first proprietary solutions of large corporations were developed. Recognizing the disadvantages of a closed user group led to the development of vertical standards, e.g. in the US Transport Data Coordinating Committee (TDCC) in 1968. Since business relationships commonly span over multiple sectors, the branch-independent standards ANSI X12 were developed in the US in 1983 and GTDI in Europe at around the same time. Owing to the globalization of trade, the UN/ECE/WP.4 (a predecessor of UN/CEFACT) started in the mid-1980ies an initiative leading to the UN/EDIFACT standards. The UN/EDIFACT syntax became an ISO standard in 1987 (IS 9735), whereas the first message type directory was published by the UN in 1990.

The literature in the 1990ies mostly reported success stories about EDI. Starting with the appearance of XML this rapidly changed and traditional EDI became one of the most criticized techniques. One might think that the EDI community was not conscious of the limitations of their approach before. However, the EDI community was aware of the drawback of bilateral agreements on subsets of 'standard' messages. In the late 1980ies ISO created a working group with the goal to specify a framework that allows business partners to exchange data without any prior communication agreements. This work resulted in the Open-edi reference model, which became an ISO standard in 1997 (IS 14662). Although the Open-edi reference model is on a rather high level of abstraction and does not go into any implementation details, its major contribution is the distinction between an Business Operational View (BOV) and a Functional Service View (FSV), which is depicted in Fig. 1. The BOV is a perspective of business transactions limited to those aspects regarding the making of business decisions and commitments among organizations. The FSV is a perspective of business transactions limited to those information technology interoperability aspects of IT systems that are needed to support the execution of Open-edi

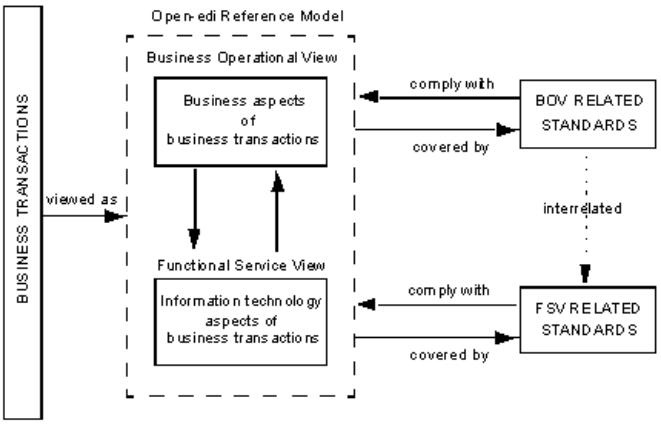

Fig. 1 Open-edi Reference Model

transactions. The BOV related standards are employed by business users understanding the operating aspects of a business domain. The FSV related standards are used by the IT-experts [10].

UN/ECE/WP.4 itself was involved in the development of the Open-edi reference model and created in 1995 an ad-hoc committee AC.1 to research on technologies to support the Open-edi reference model. These technologies should lead to the next generation of edi standards. Note, that "edi" is intentionally written in lower case signifying alternative approaches to traditional EDI. AC.1 reported that business process modeling and object-oriented technology should help to describe the real world of inter-organizational e-business. AC.1 proposed that next generation edi standards should be business process models for a particular business goal, including multiple possible scenarios. Trading partners will support one, more or all scenarios. In order for two trading partners to do business with each other they have to share at least one common scenario. It is envisioned that software providers will create applications that implement the most popular scenarios of business process models.

When UN/ECE/WP.4 reorganized itself to UN/CEFACT, the Techniques and Methodologies Working Group (TMWG) became the successor of AC.1. In 1998 TMWG recommended to use the Unified Modeling Language (UML) for modeling inter-organizational e-business scenarios to create BOV standards. At this time TMWG started to develop a methodology for inter-organizational business process modeling in order to ensure unambiguous definitions of business process models or BOV standards, respectively. The work resulted in UN/CEFACT's Modeling Methodology (UMM) [9], which is a customization of the Rational Unified Process (RUP) [12]. The definition of BOV standards by applying UMM became known as object-oriented edi (OO-edi).

Aside from the work in the EDI standardization bodies, the development of XML started in 1996 and resulted in a W3C standard in 1998. XML provided a fast and non-bureaucratic way of defining electronic document types to be exchanged

between business partners [20]. Within a short period of time a lot of XML-based business vocabularies were developed (cf. [11]). First success stories, like that of RosettaNet, underpin the strengths of XML in EDI. Similarly to the EDI history the proliferation of proprietary vocabularies was soon detected, and organizations started to develop solutions for certain verticals or user groups. Popular examples of such solutions include RosettaNet (http://www.rosettanet.org), Open Applications Group (OAG - http://www.openapplications.org), Open Financial Exchange (OFX – http://www.ofx.net), Open Travel Alliance (OTA – http://www.opentravel.com) and the Internet Open Trading Protocol (IOTP - http://www.ietf.org/html.charters/trade-charter.html). XML vocabularies shared by a large user group are certainly a step into the right direction. However, they ignore each other and have therefore incompatible implementations for the same semantic concepts, e.g. date (from a data-oriented point of view) or invoicing (from a process-oriented point of view). A comparison of several XML-based vocabularies and their basic concepts is contributed by Li [13].

The above mentioned comparison includes also cXML (http://www.cxml.org) and xCBL (http://www.xcbl.org) the languages of the e-marketplaces of Ariba and Commerce One, respectively. Especially xCBL, which was influenced by the work of the eCo-Framework project [6], has a larger scope than today's e-marketplaces. The eCo workgroup on semantic recommendations initially wanted to create a full set of semantics for business documents expressed in an XML schema language. They recognized that the vast majority of interoperable e-commerce semantics has been defined in the area of EDI. Furthermore, they also concluded that the most significant problem in EDI is that of overloaded message types as described in Section 2. Given the short period of time the workgroup was only able to highlight critical design approaches and to produce a set of recommendations. These recommendations were illustrated by some samples of business semantics using xCBL 2.0. xCBL was considered to be moving in the right direction in the use of SIMPL-edi a simplified subset of the UN/EDIFACT message standard. SIMPL-edi provides more focused EDI messages based on simple, standard international data elements and well structured master files using only about 20% of comparable UN/EDIFACT messages. However, SIMPL-edi was developed under the umbrella of UN/CEFACT in its ad-hoc group on SIMPLE-edi and forms & web based EDI (SIMAC). Accordingly, xCBL has started more or less as a reverse engineered subset of UN/EDIFACT message types expressed in an XML schema language. (Note, that reverse engineered does not mean automatic transformation by an algorithm). xCBL can be regarded as the first "joint effort" between the EDI and the XML community, although no co-operation did happen and no official link was created.

Owing to the growing popularity of XML and above mentioned vocabularies as 'UN/EDIFACT replacements', many UN/EDIFACT users asked in 1998 UN/CEFACT to look for an XML solution which should be compatible with existing UN/EDIFACT to protect their investments. TMWG was responsible for doing a feasibility study on using XML for B2B information transfer. The TMWG report on this subject rejected the idea of creating 'Yet Another XML Solution' by converting UN/EDIFACT to XML [15]. This decision was mainly based on the fact that a syntactical transformation would hardly save any EDI problem, but would just add another e-business vocabulary to the XML world. Instead the recommendation was to built up on the Open-edi reference model by using business process modeling to create BOV standards and by using XML as key concept in the FSV layer.

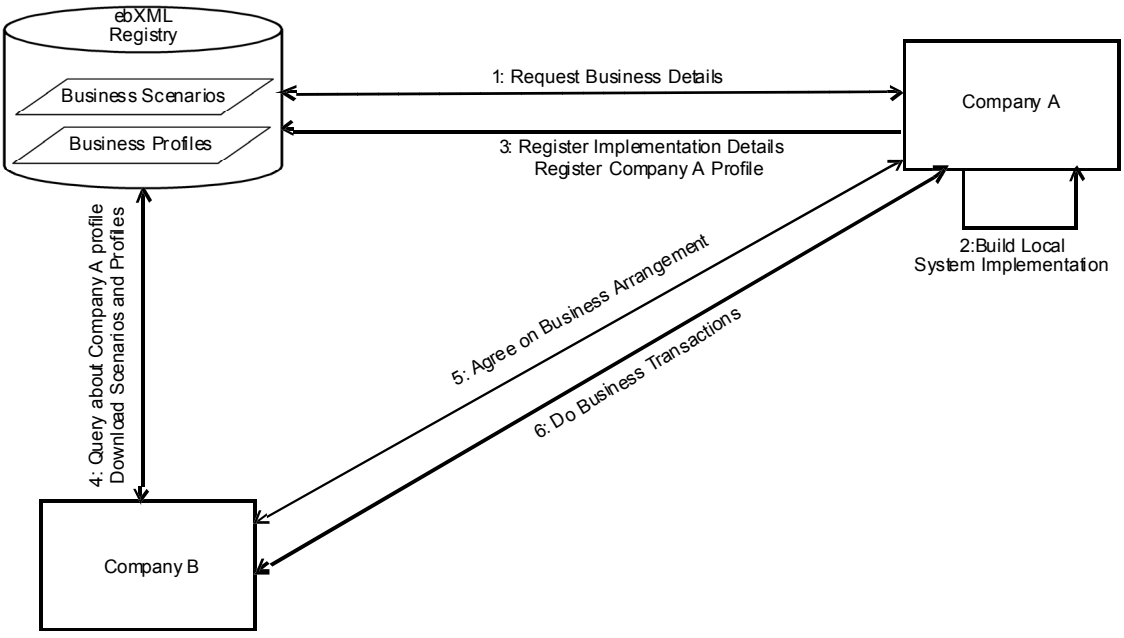

Fig. 2 ebXML Scenario

Additionally, TMWG suggested to cooperated in the development of the solution with the IT-industry to combine UN/CEFACT's business know-how with the experience of leading XML experts. The steering committee of UN/CEFACT accepted the TMWG recommendation and found an IT-Partner in the Organization for the Advancement of Structured Information Standards (OASIS) that shares the goal of open and inter-operable standards. This was the starting point for the ebXML (http://www.ebxml.org) initiative, which started in November 1999.

IV. Syntax-neutral Business Objects in ebXML

The vision of ebXML is to create a single global electronic marketplace where businesses can find each other, agree to become trading partners and conduct business. All these operations will be performed automatically by exchanging XML documents. In order to support the needs of SMEs ebXML envisions that software industries will deliver commercial off-the-shelf software (COTS) for B2B scenarios to the SMEs. This goal is expressed in a typical ebXML scenario (see Fig. 2) between a large corporation (Company A) and a SME (Company B). This scenario is described in the ebXML technical architecture specification [3]: Company A requests business details from the ebXML registry (step 1) and decides to build its own ebXML compliant application. The Company A submits its own business profile information to the ebXML registry. The business profile submitted to the ebXML registry describes the company's ebXML capabilities and constraints, as well as its supported business scenarios. Company B, which uses an ebXML compliant shrink-wrapped application, discovers the business scenarios supported by Company A in the registry (step 4). Company B sends a request to Company A stating that they would like to engage in an business scenario (step 5). Before engaging in the scenario company B submits a proposed business arrangement directly to Company A's ebXML compliant software interface. The proposed business arrangement outlines the mutually agreed upon business scenarios and specific agreements. Company A then accepts the business agreement. Company A and B are now ready to engage in e-business using ebXML (step 6).

To support the ebXML scenario described above the ebXML specifications describe a way to define business processes and business documents that are exchanged to support these processes. Accordingly defined business processes and documents must be made public in a registry. ebXML specifies a mechanism to register and discover processes and documents. The total set of registered business processes in a registry define the possibilities in an e-business world. Each organization participating in the e-business world, has to define its capabilities (IT capabilities, communication protocols, security requirements, supported business processes) as a subset of what is possible. These company profiles called collaboration protocol profiles are stored in a registry as well. This allows companies to query possible business partners and the way to conduct business with them. Before business partners can actually do business with each other they have to build a trading partner agreement. This so-called collaboration protocol agreement corresponds to an intersection of their profiles and includes additional results of negotiating variable parameters. In addition, ebXML defines a transport and routing layer to move the actual XML business documents between trading partners.

The heart of ebXML is a powerful system of registries. This registry has to contain meta information and pointers to various items: business processes, business documents, components of these documents, DTDs and trading partner profiles. It is important that the items in the registries can reference each other from the BOV level of the business processes down to the most atomic level at the FSV layer describing an element in an interchanged file [16]. This should allow for UN/CEFACT's vision to take a business process model, define a supporting information model and to derive a document structure in a certain e-business vocabulary (used as transfer syntax) by applying mapping rules.

In the following we show how the different artifacts produced by UMM will all fit together. Although business process modeling is not mandatory in ebXML, the definition of new business processes shall use UMM in order to deliver consistent results. A high level overview of steps to be taken in UMM and involved roles is depicted in the use case diagram of Fig. 3. It is important to note that UMM captures the business knowledge of real-world business processes and business knowledge is not created by reverse engineering of legacy database systems. Applying UMM creates a choreography of inter-organizational activities of an investigated business process among multiple parties. This choreography defines also the services (and their order) to be supported by an business service interface implementing a role in a business process. The information about the choreography and the services must be registered in a machine-readable

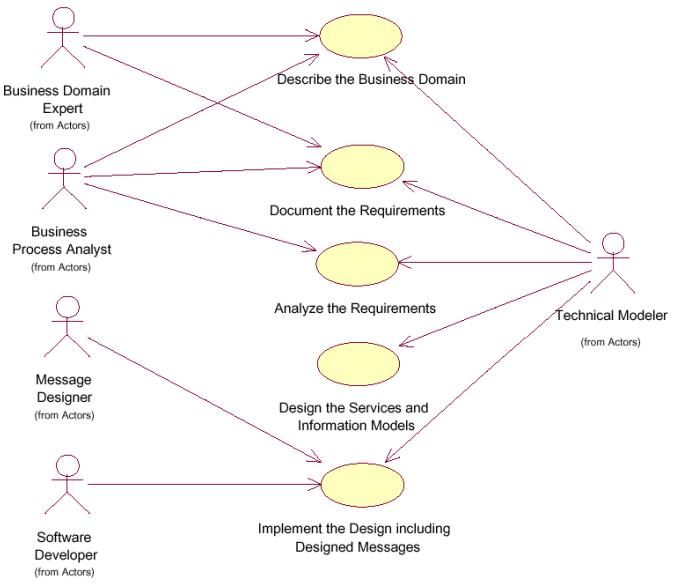

Fig. 3 Steps (Use Cases) and Roles in UN/CEFACT's Modeling Methodology (UMM)

format. Therefore, the ebXML Business Process Specification Schema defines an XML-based format for presenting the relevant UML artifacts

Business documents will be sent from one business partner to the other during the execution of inter-organizational activities. In UMM information models are used to describe the business documents' structure. Since UMM follows an object-oriented approach the information model is based on reusable object classes. Following the BOV characteristics these object classes describe neither application-dependent objects nor technology-dependent objects. Instead they describe business objects that are defined by the OMG as "representation of a thing active in the business domain, including at least its business name and definition, attributes, behavior, relationships, rules policies and constraints. A business object may represent, for example, a person, place, event, business process or concept. Typical examples of business objects are employee, product, invoice and payment" [2]. If business objects are categorized into entity, process and event objects, the information models will concentrate on the business entity objects.

Information models will follow the analyzed requirements of a business process and make use of reusable common business objects defined in a library of common business objects. This library defines the business objects that are common to most verticals in the world. These common business objects can be extended according to needs of certain verticals following their context-specific parameters, like geographical region or industry. No matter whether business objects are common or vertical-specific, they are used to describe certain business concepts. The definition of a business concept in business terms is given in a core component. Core components can be either atomic parts or aggregations of parts evidently coming together. It follows that business objects are the object-oriented presentation of core components used for the definition of the information models. The ebXML initiative has already defined how to discover and analyze components. Furthermore, the ebXML initiative has defined an initial catalog of core components, which will be extended in the near future by a joint project of ANSI X12 and UN/CEFACT.

Again the registry has to capture the business documents and their components. This includes the library of core components (or business objects which are semantically equivalent) and business documents as assembly of referenced core components. Since business documents are not defined in isolation, but rather support business processes, each inter-organizational business activity has to reference a supporting business document within the registry. These definitions are stored in the registry by the means of XML. Nevertheless, this does not mean that the XML-language used for internal presentation in the registry is equivalent to the XML business vocabulary to be used in the FSV layer. In contrary, design rules for mapping information models into a certain business vocabulary must be specified. Each business vocabulary of the FSV layer will follow its own mapping rules. Although the usage of an XML-based vocabulary is encouraged, it is not even necessary to use an XML-based vocabulary – it would

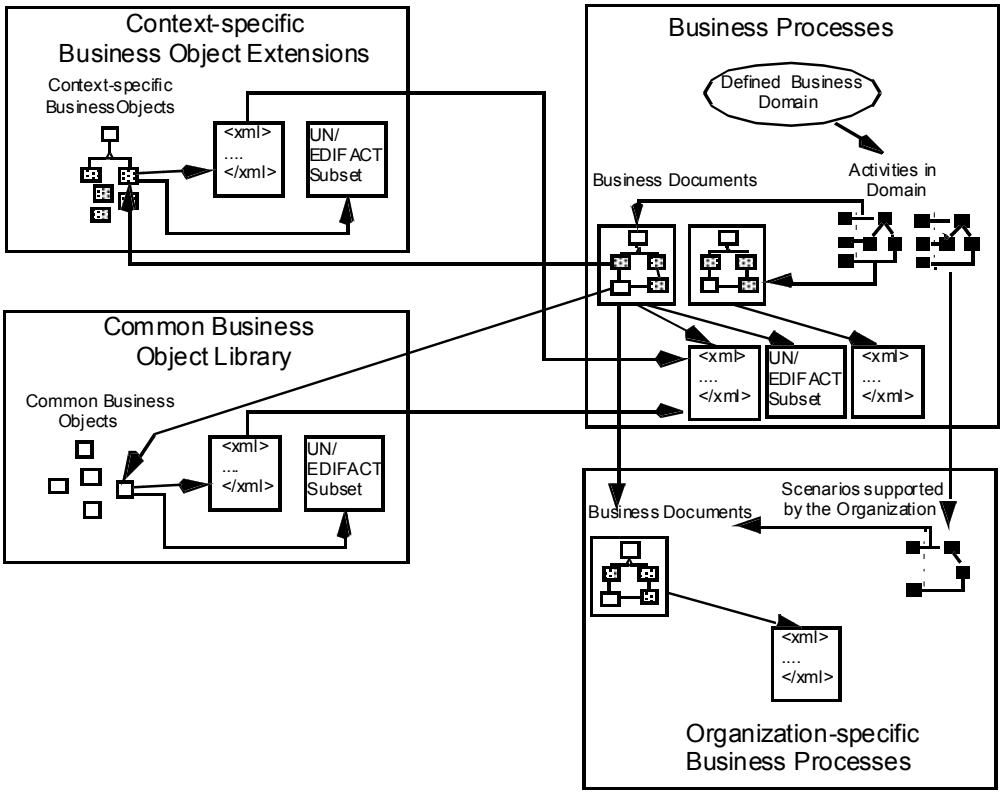

Fig. 4 Business Processes, Business Documents and Business Objects in a Registry

even be possible to use UN/EDIFACT for the transfer of business documents.

Each organization willing to participate in ebXML can register its profile in the registry. This profile references supported business processes and documents. The organization identifies the roles and the scenarios it is able to perform. In addition to that the profile will declare supported communication protocols and security requirements. These profiles can be queried by other companies and serve as the basis for following agreements between the trading partners.

Fig. 4 presents an overview of business processes, business documents and business objects within a registry. The left side of Fig. 4 depicts the common business object library and a library with context-specific extensions applying only to a certain vertical. As noted before, each common business object represents the object-oriented representation of a core component. Vertical specific extensions can comprise new independently defined business objects as well as business objects that inherit from common ones. A business object might have an equivalent presentation in a business vocabulary (XML-based or UN/EDIFACT). This presentation is not stored in the registry, but could be derived from the business objects by applying the message design rules for the vocabulary.

The right side of Fig. 4 presents the analysis of business processes that leads to the definition of inter-organizational business activities. Each of these activities is supported by—and consequently references—a business document. Business documents are an assembly of common and context-specific business objects. Applying message design rules to business documents will lead to the presentation structure in a particular e-business vocabulary. The resulting structure would be equivalent to virtually assembling the vocabulary-specific presentations of the business objects.

Furthermore, Fig. 4 depicts the fact that an organization identifies the scenarios it is willing to participate. It identifies a subset of the overall set of activities according to the roles the organization can take on. The organization has to support the business documents being exchanged within these activities. Nevertheless, the organization will not have to support all different e-business vocabularies, but only the ones as identified in its company profile.

V. SUMMARY

Traditional EDI approaches like UN/EDIFACT offer a document structure that covers a whole lot more than is actually needed for an interchange between organizations. Trimming down the document structure to the actual user needs is out of scope in traditional approaches. A lot of effort - multiple times more than that of standardization - is spent on this activity. An alternative approach is centered around business processes and data required by each activity within the processes. UN/CEFACT followed this approach on their way to next generation EDI standards. Concurrently, the Internet made its commercial success and XML became the first choice for defining data interchange formats in Internet applications. Despite a lot of XML-based business vocabularies defined, the expected explosion of XML-based B2B exchanges did not happen so far. Nevertheless, XML is still considered as one of the most promising technologies for future B2B implementations. In this paper we gave a survey of developments in the EDI community (including traditional EDI and business process orientation) as well as in the XML community.

The merge of both paths resulted in the ebXML initiative that was initiated by UN/CEFACT and OASIS. ebXML aims at providing low cost off-the-shelf software for SMEs. In order to reach this goal ebXML provides the means to define business process models and supporting information models that can be stored in a global, distributed registry. A business process model will be some kind of super-model for a given business process. Each company defines in its company profile. The profile includes the scenarios a company is capable to perform. Doing business electronically requires two trading partners to share at least one common scenario. To support the SMEs it is expected that software vendors will create applications that implement business process models with their most common scenarios.

ebXML, which began as an 18-month project, delivered its first set of specifications on time in May 2001. During the 18 months it was always the goal to prove the feasibility of the ongoing work by demonstration sessions. About 30 different software companies participated in the proof-of-concept session demonstrating interoperability by uses cases starting at the business process definitions and finally resulting in business data exchanges. Accordingly, leading software providers are already developing ebXML-compliant software. It is expected that the first commercial products will appear by end of this year. However, ebXML is not over by now. UN/CEFACT and OASIS will conduct the adoption, implementation and maintenance of the ebXML specifications. There is still a lot of work to do, especially on defining core components as the semantic foundation of ebXML. Furthermore, standard organizations, business integrators and marketplace providers are expected to populate the business processes in a to-build repository.

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