Business-to-Business E-Commerce Frameworks

Business-to-business transactions are a growing segment of the e-commerce market. This article analyzes and compares popular B2B frameworks that attempt to address such issues as interoperability and security between enterprises transacting business over the Internet.

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Electronic commerce lets people purchase goods and exchange information on business transactions online. The most popular e-commerce channel is the Internet. Although the Internet's role as a business channel is a fairly recent phenomenon, its impact, financial and otherwise, has been substantially greater than that of other business channels in existence for several decades.

E-commerce gives companies improved efficiency and reliability of business processes through transaction automation. There are two major types of e-commerce: business to consumer (B2C), in which consumers purchase products and services from businesses, and business to business (B2B), in which businesses buy and sell among themselves.

A typical business depends on other businesses for several of the direct and indirect inputs to its end products. For example, Dell Computer depends on one company for microprocessor chips and another for hard drives. B2B e-commerce automates and streamlines the process of buying and selling these intermediate products. It provides more reliable updating of business data. For procurement transactions, buyers and sellers can meet in an electronic marketplace and exchange information. In addition, B2B makes product information available globally and updates it in real time. Hence, procuring organizations can take advantage of vast amounts of product information.

B2C e-commerce is now sufficiently stable. Judging from its success, we can expect B2B to similarly improve business processes for a better return on investment. Market researchers predict that B2B transactions will amount to a few trillion dollars in the next few years, as compared to about 100 billion dollars' worth of B2C transactions. B2C was easier to achieve, given the relative simplicity of reaching its target: the individual consumer. That's not the case with B2B, which involves engineering the interactions of diverse, complex enterprises. Interoperability is therefore a key issue in B2B.

To achieve interoperability, many companies have formed consortia to develop B2B frameworks—generic templates that provide functions enabling businesses to communicate efficiently over the Internet. The consortia aim to provide an industrywide standard that companies can easily adopt. Their work has resulted in several technical standards. Among the most popular are Open Buying on the Internet (OBI), eCo, RosettaNet, commerce XML (cXML), and BizTalk. The problem with these standards, and many others, is that they are incompatible. Businesses trying to implement a B2B framework are bewildered by a variety of standards that point in different directions. Each standard has its merits and demerits. To aid decision-makers in choosing a framework, we compare these standards and examine the factors influencing B2B frameworks.

ENGINEERING BUSINESS PROCESSES

A business can be viewed as a set of processes. A process can be anything from work order generation to human resources development. Process engineering streamlines and automates processes to improve business efficiency. As part of engineering the business, company planners capture business processes in models and implement them as enterprise applications. These applications include packaged software for enterprise resource planning (ERP), sales force automa-

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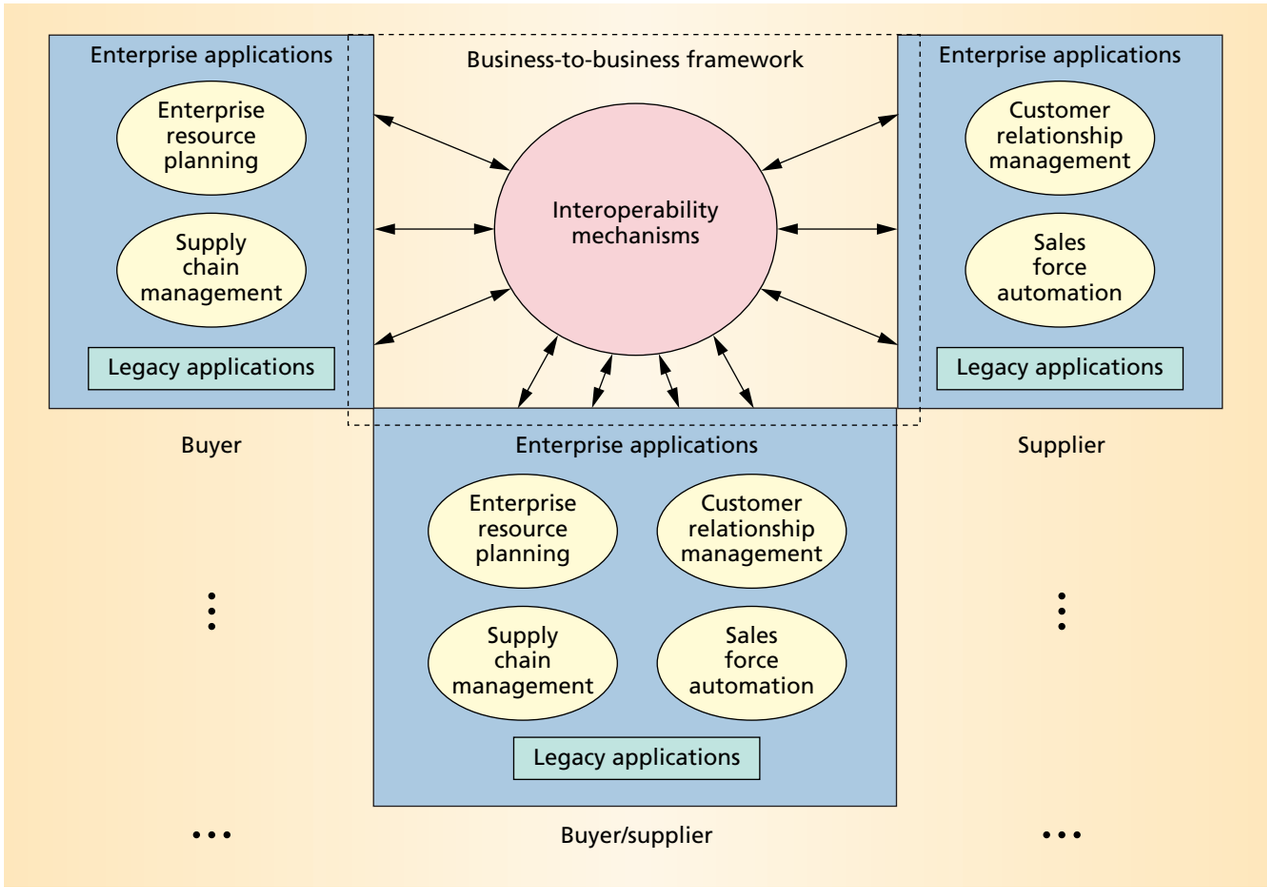

Figure 1. The role of frameworks in B2B transactions.

tion (SFA), customer relationship management (CRM), and supply chain management (SCM). The trend has been to include more and more outside entities such as customers and suppliers in process engineering. This means that evolving B2B frameworks must easily integrate with existing enterprise applications.

B2B frameworks bridge the gaps between transactions, as shown in Figure 1, which diagrams the roles of all participants in a B2B transaction. The business entities interact through interoperability mechanisms provided by the B2B framework. In addition, the framework integrates with enterprise applications operating within the business entities, such as ERP, SFA, CRM, and SCM. Any number of business entities can get involved in B2B transactions using the framework mechanisms.

EDI AND XML

Businesses conduct e-commerce transactions through standards such as electronic data interchange (EDI) and the Extensible Markup Language (XML),[1-3] which define data formats in e-commerce frameworks. EDI is the electronic exchange of structured documents between trading partners. Its primary goal is to minimize the cost, effort, and time incurred by paper-based business transactions. EDI streamlines transactions and increases overall system efficiency by improving data flow, minimizing errors caused by manual data processing, and reducing labor costs.

An EDI transaction between two systems involves three steps:

- converting the actual data document into a standard message format,
- transmitting the formatted data over the network, and
- translating the formatted data back into actual data.

EDI benefits large companies by greatly reducing the time and cost of manual data processing. However, EDI is complex and difficult to implement. For small and medium businesses, the network infrastructure and software required to implement EDI are prohibitively expensive. Also, EDI standards in different countries vary, making international transactions complex, and different industries—even if they are using the same standard—have their own implementations.

With a common framework in place, one protocol can handle all transactions.

Now, with the explosive growth of the Internet, emerging standards such as XML make transmitting data over the Web inexpensive and efficient. Although XML looks more promising as the industry standard, we don't expect XML to replace EDI but rather to complement it.

Since business models and processes may change over time, data elements must be defined in a flexible language such as XML, which has become the leading data format definition language in e-commerce. XML lets applications communicate regardless of the programming model, and many software vendors support it as a universal Internet format.[4]

Officially recommended by the World Wide Web Consortium (W3C) in early 1998, XML addresses the issues many earlier proprietary solutions tried to resolve to enhance the Hypertext Markup Language. Web developers use HTML to define a document's presentation format with a predefined set of tags. HTML is not conducive to human reading. In contrast, designers use XML, a subset of the Standard Generalized Markup Language (SGML), to create customized tags by describing the document's structure.

Since a document in XML format contains a structure, it is easy to transform structured business data into XML and vice versa. Users can search XML data for an item by looking for specific tags in a structured document. Thus, XML can enhance the functionality of today's search engines.

XML documents contain logical units called elements. With an XML parser, users can read XML documents and access their contents and structures. Three companion entities complement XML: Document Type Definition (DTD), Extensible Stylesheet Language (XSL), and Extensible Link Language (XLL), which specify the document's layout, style sheet, and dynamic links, respectively. An XML DTD defines a document's logical structure.

FRAMEWORKS

To operate across business boundaries, business process applications must follow a standard transaction exchange protocol. The protocol must be flexible, reliable, and scalable to provide efficient transactions globally. Previously, a B2B relationship involving n enterprises would involve $n(n-1)$ specific protocols. With a common framework in place, one protocol can handle all transactions.

A framework is a generic template that provides a desired functionality. To achieve interoperability and streamline business transactions, a B2B framework must provide basic features such as a standard data format, security, ontology, and content management. The frameworks we describe here take different approaches and offer various benefits.

Open Buying on the Internet

Promoted by several Fortune 500 companies and their suppliers, the OBI standard[5] addresses high-volume, low-value B2B transactions. OBI end users are ordinary employees of participating buying organizations, who may not be trained in purchase management. The standard stresses infrastructure robustness to support many users reliably and securely. Companies use digital certificates and optional digital signatures to authenticate and customize product catalogs.

The OBI standard envisions a dynamic, interoperable trading web—a network of enterprises participating in B2B transactions—which new enterprises can join easily. The web would form through a chain reaction in which buyers would influence *their* suppliers, who would in turn influence their suppliers, to join the web. The motivations for joining would be interoperability and cost reduction. Unlike architectures whereby sellers store information about millions of buyers, the OBI framework divides responsibilities: Buying organizations maintain requisitioner profiles, account codes, tax status, and approvals; selling organizations maintain customized catalogs and internal workflow mechanisms.

OBI aims to complement, not replace, existing EDI standards. It leverages existing standards to define a suitable B2B architecture. It overcomes some of EDI's drawbacks and ensures interoperability, vendor neutrality, and the flexibility to cater to participants' evolving needs. Because it is meant for simple transactions, OBI integrates easily with a company's procurement application and incurs low maintenance costs. Version 2.0 is based on the Common Gateway Interface (CGI) and the hypertext transfer protocol (HTTP); future versions may adopt XML. OBI's main benefits are

- simplicity;
- security, reliability, and robustness; and
- customizable catalogs based on the information in digital certificates.

eCo framework

The eCo framework[6,7] is the initiative of CommerceNet, a consortium of representatives from more than 35 companies, primarily sponsored by Commerce One. Viewing interoperability as a set of levels, eCo uses XML documents to describe application interfaces. Businesses can define, publish, and exchange metadata descriptions using the eCo architecture. The framework requires the identification of a "market maker," who defines "community standards" for business documents. It provides only a common basis for negotiations, leaving internal details to the concerned parties. An eCo system has six layers, each relating to the next in a defined way, to facilitate communication, querying, and information

retrieval. The eCo system achieves interoperability by exposing metadata in the six layers, which describe the system in detail.

The topmost layer, the Network, usually contains an index of markets, to serve as a search engine database. Each market in the network has its own rules, procedures, and protocols, described by the Businesses layer, which also identifies the type of business, its location, and its URL. The Services layer specifies interfaces and services that a business offers, such as catalog browsing and order-status checking. The Interactions layer captures the relationships among services and subservices and the message types exchanged in interactions. The Documents layer describes document types exchanged in each interaction. The Information Items layer specifies the type of information in each document.

The metadata in each layer is stored in type registries, which store document and element types and provide information about relationships among them. Document and element types are structured hierarchically, supporting inheritance and simple trees. Each registry publishes an interface that users can query for type information. Registry schemas are built on XML-based data elements. OEM and supplier agreements are implemented as a set of eCo services. The eCo framework offers

- extensibility to accommodate unforeseen requirements;
- a gateway Web page, eco.xml, to meet search engine needs;
- a simple set of compliance rules; and
- the ability to discover e-commerce systems, their services, underlying interactions, and modifications needed to ensure interoperability.

RosettaNet

The RosettaNet[8] consortium develops XML-based business standards for supply chain management in the information technology and electronic component industries. The consortium develops interoperable e-commerce standards for high-technology companies such as computer hardware and software manufacturers. It defines the business processes and provides the technical specifications for data interchange.

RosettaNet streamlines business transactions by providing guidelines for trading partners in the supply chain. These guidelines, called Partner Interface Processes (PIPs), specify business processes by which companies can interface with their partners. To develop PIPs, the consortium defines two other components: a master dictionary and an implementation framework.

The master dictionary, which includes a technical and a business dictionary, defines a message's vocabulary. The technical dictionary ensures that companies use the same language and understand the same characteristics when communicating about products such as computer parts and peripherals. The business dictionary defines the language of catalogs, business transactions, and business properties (payments, orders, shipping, and so on) for partner companies.

Two different organizations in the supply chain can standardize their interfaces and extend them over an existing framework.

The implementation framework defines the protocol for exchanging messages securely. It specifies message format, message content, network architecture, and security mechanisms.

In addition to the dictionary and the framework, RosettaNet defines a generic, organization-independent business process model. The model defines partners' roles in a business transaction—for example, order manager and catalog publisher.

The business process model, the dictionary, and the implementation framework are inputs to PIPs. RosettaNet distributes PIPs to the trading partners, who use these guidelines as a road map to develop their software applications. By following the PIP, two different organizations in the supply chain can standardize their interfaces and extend them over an existing framework such as OBI. RosettaNet developed its framework by adopting existing standards wherever possible. The framework

- provides in-depth support for business processes associated with a purchase order or inventory request and is not limited to technical specifications,
- addresses security issues well, and
- supports agent protocols.

Commerce XML

A joint effort of more than 40 companies spearheaded by Ariba Inc., cXML[9,10] is an open, Internet-based standard designed to facilitate easy exchange of catalog content and transaction information between trading partners. It consists of a set of lightweight XML DTDs.

The cXML specification defines two message-protocol models: a request/response model and an asynchronous one-way model. The request/response model is fairly simple and uses an HTTP connection. In the one-way model, the client transports the request using an encoding mechanism that the server understands. The transport mechanism can be either HTTP (in which case it resembles the request/response model) or URL form encoding. URL form encoding embeds the cXML message in an HTML form and displays it on a Web page. When the user submits the form, the message goes to the address specified in the HTML form. With this method, there is no direct contact between the processing server and the remote Web site. The Web browser acts as the intermediary.

Table 1. Comparison of B2B frameworks (MSMQ: Microsoft Message Queue; SSL: secure socket layer).

Feature	eCo	BizTalk	OBI	cXML	RosettaNet
Industry target	Unspecified	Unspecified	MRO materials, nonproduction supplies	MRO, office supplies, books, and so on	IT and electronic components
Security	Optional	Leverages existing standards	SSL with HTTP; digital certificates and signatures	Authentication in message header	SSL with HTTP; digital certificates and signatures
Communication protocol	HTTP	Wide variety: HTTP/MSMQ	HTTP	HTTP, URL form encoding	HTTP/CGI
Service discovery	Extensive support	Supported	Not addressed	Not addressed	Not addressed
Repositories	Locally maintained	Centralized repository	Owner's responsibility	Not addressed	Not defined within scope of standard
Message format	XML documents	BizTalk documents based on Biztags	Encapsulated EDI documents	XML documents	Valid XML documents
Query mechanism	URL-based	Not addressed	Not applicable	Not addressed	Not addressed
Scalability	Sufficient	Centralized repositories and processing may limit	One-to-one framework does not impact scalability	Scalable, based on XML DTDs	Allows extension of implementation guidelines
Ontology	Common Business Library	Collection of Biztags	EDI X12 data dictionary	Collection of XML tags	Technical and business dictionaries

The message formats for the two protocols are similar; an envelope element contains the header and the data sections. A cXML framework provides security by including the authentication information in the message header. The cXML specification focuses on maintenance, repair, and operating (MRO) services. It defines business processes such as shipping notification, status updates, acknowledgments, and payment procedures. It gives concrete examples of DTDs for business documents such as purchase orders and catalogs. An important advantage is that cXML is simple to use and easy to implement.

BizTalk

BizTalk[11] leverages existing standards to provide a framework for application integration to facilitate efficient e-commerce. It serves as a platform for rapid migration to XML to overcome the weaknesses of current systems. Businesses can use a standard set of XML tags, elements, and attributes to develop message-exchanging systems. The businesses' XML schemas are validated, versioned, registered, and stored in a repository at the portal Web site. The repository facilitates dynamic detection of all connections associated with a schema.

The BizTalk framework contains a technical specification, a set of XML elements, and the biztalk.org Web portal. Until the transition to XML-based systems is complete, legacy systems must talk to other systems in the BizTalk framework through layers of software that convert application-specific data formats to XML. BizTalk encompasses non-XML data as well, converting binary data such as images to a base-64 notation. BizTalk's key advantages include

- schema versioning, which gives businesses better schema control;
- XML, with support for non-XML data; and
- a transition plan for legacy systems based on EDI.

COMPARING THE FRAMEWORKS

The five frameworks differ significantly in approach and applicability. Overall, eCo and RosettaNet (which is partly based on eCo) appear to be more pragmatic and mature approaches than the others. RosettaNet openly acknowledges its heavy dependence on the OBI framework. Whereas OBI, RosettaNet, and cXML target particular industry segments, eCo and BizTalk are more generic. Almost all the frameworks, however, provide specifications for important features such as message formats, exchange protocols, security, and common exchange vocabularies. Table 1 compares the frameworks in terms of these features, and Figure 2 summarizes their functions.

Industry target

Ideally, all the sponsoring consortia should aim at a universally applicable, all-encompassing framework to support all B2B transactions in all industries. But while Microsoft explicitly states that it intends not to include any industry-specific details in its BizTalk framework, RosettaNet proclaims itself the "lingua franca for e-business." As Table 1 shows, the present version of RosettaNet aims at the vertical integration of the information-technology and electronic-component (EC) industries. In contrast, the eCo and BizTalk consortia are silent about their targeted industries, probably hoping, like RosettaNet, to offer universally acceptable frameworks. The simple OBI

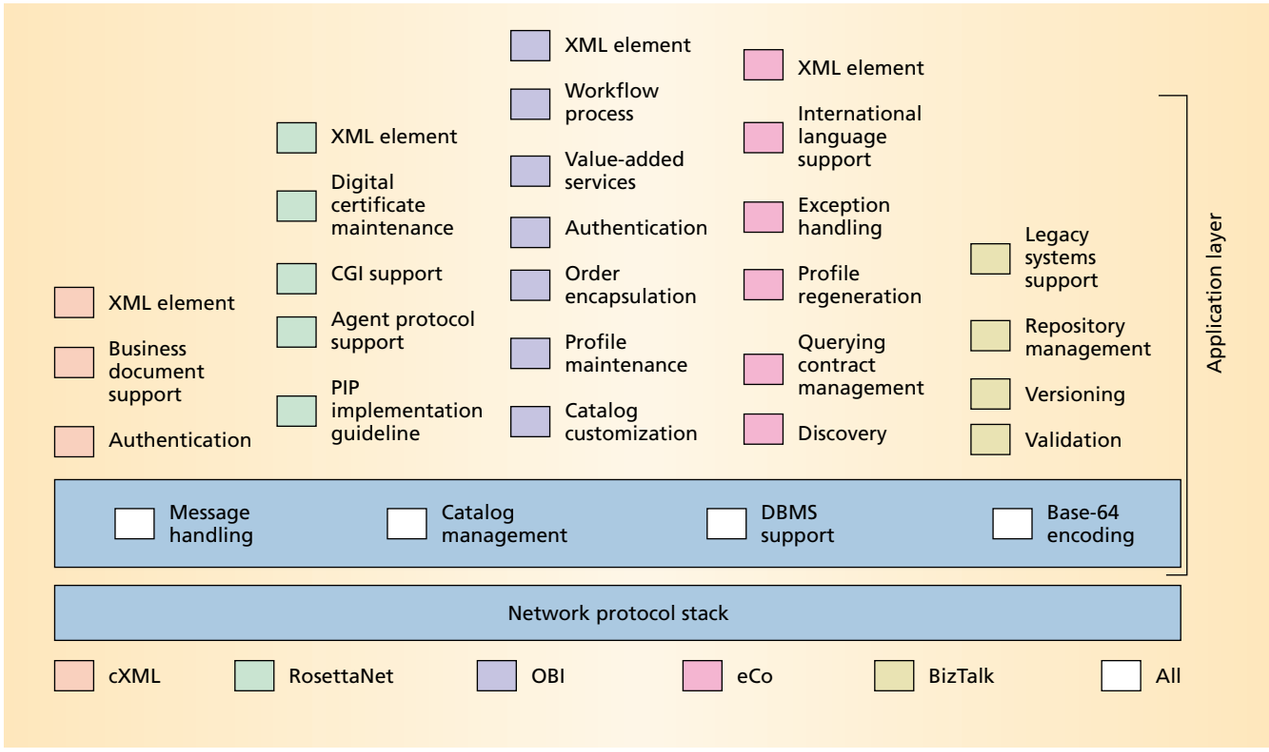

Figure 2. Functions of B2B frameworks.

framework targets only transactions involving nonstrategic materials.

Architecture

As Figure 3 shows, the frameworks achieve interoperability in different ways. Usually, they leverage existing standards. The OBI architecture, for example, has an EDI bias but gains a few advantages over EDI. The eCo framework is a pathbreaking effort, owing to its innovative layered approach and its application of XML interfaces. RosettaNet leverages both OBI and eCo, combining advantages of both successful frameworks. Both eCo and RosettaNet use layered architectures. The eCo framework defines six layers to facilitate communication, querying, and information retrieval. The RosettaNet layers provide the vocabulary, rules, and dialogs required to communicate in a B2B transaction.

The BizTalk framework is unique in defining a centralized architecture, which provides diverse functions from schema validation and versioning to repository management through a centralized Web portal. The framework consists of a centralized repository and Biztags, which are XML elements enclosing messages. On the other hand, cXML does not define a clear-cut architecture. The specifications merely provide guidelines for the messaging protocols and data formats.

Security

Because security is very important on the Internet, it is a prime target for the W3C and several other organizations. All the frameworks we discuss here leverage existing security mechanisms and add nothing new in this respect. The eCo specification makes the use of existing security mechanisms optional. OBI and RosettaNet address security issues at length. Since RosettaNet derives primarily from OBI, the security models for both these frameworks are similar. They use a secure socket layer (SSL) over HTTP for the security layer and provide additional security through digital signatures and digital certificates. The cXML framework provides message-level security by including authentication information in the message header itself.

Communication protocol

All the frameworks' underlying communications protocols are based on HTTP. RosettaNet uses the Common Gateway Interface (CGI) when the agent protocol is involved. In eCo, the mechanism for communicating between layers is quite different. The eCo layers store information in type registries, and the framework provides an interface for querying these registries. A URL-based protocol supports user queries.

Message format

The RosettaNet and cXML message formats are based on XML. A RosettaNet message contains a header and a body, both encoded in a multipart, related MIME (multipurpose Internet mail extension) message with a message preamble. A cXML message also has a header with a request/response section for data. Both elements are nested in a cXML envelope element. An OBI message has an EDI format wrapped with other information about the message. BizTalk uses Biztags. Of all the frameworks surveyed, only OBI does not use XML for messaging. OBI encapsulates EDI documents as OBI objects. As we explained

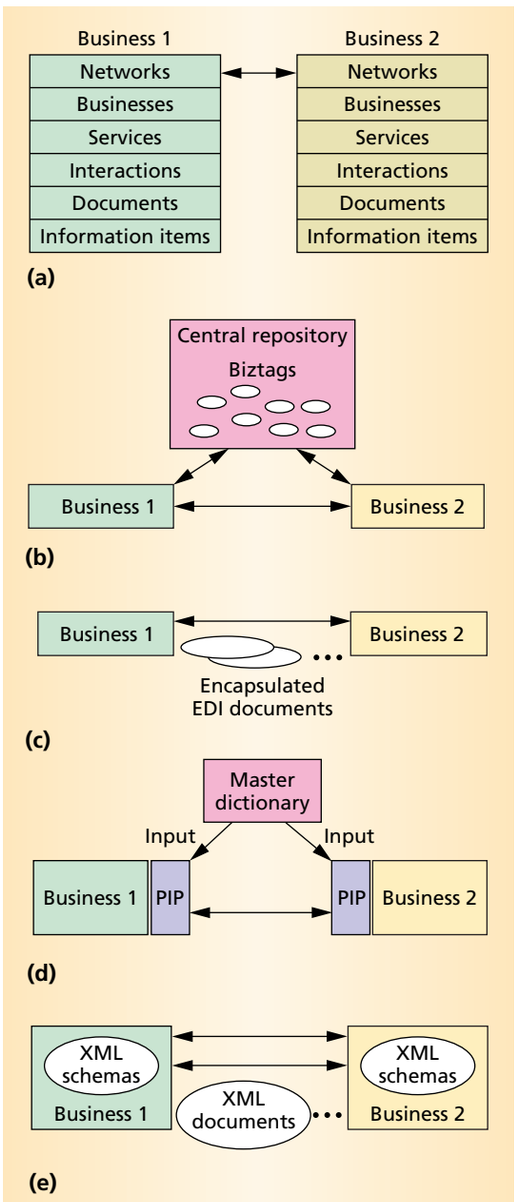

Figure 3. Interoperability mechanisms: (a) eCo, (b) BizTalk, (c) OBI, (d) RosettaNet, and (e) cXML.

earlier, eCo allows querying interfaces at different layers. Each query returns an XML document with an eCo document wrapper that includes a name space and schema information.

Ontology

In the context of frameworks, *ontology* means communication through common tags that users interpret in the same way. Ontology is the means of exchanging structured information. For example, RosettaNet defines the technical and business dictionaries. The cXML ontology is an XML schema that defines business documents. OBI's data formats rely on EDI standards, which use the ANSI X12 EDI data dictionary. BizTalk uses Biztags for document exchange and refers to W3C for the contents of document schemas.

The eCo framework uses the Common Business Library (CBL) to define a set of building blocks for developing B2B applications. The library contains several business interface definitions and process document templates. These include definitions of terms such as *company*, *service*, and *product*; business forms such as catalogs, purchase orders, and invoices; and standard measurements such as date, time, and classification codes. CBL represents these entities as a public set of XML components, which companies can customize and integrate. CBL is extensible and is intended for use by other frameworks such as OBI and RosettaNet.

Catalog

The catalog is an important component of a business process. The cXML specification addresses this issue at length, defining three main catalog elements. The supplier element provides information about the supplier that may be of use to the buyer. The index element describes the supplier's stock of goods and services. The contract element describes the negotiable data between buyer and supplier. RosettaNet provides catalog functions by defining PIPs for subscriptions, new product introductions, updates, and so forth. OBI specifies that the supplier maintain the catalog and present customized views of the catalog to users. The eCo and BizTalk frameworks do not specify how a catalog is created and maintained.

The five frameworks, which evolved to address B2B interoperability, have done a fairly good job of meeting their initial goals. Still, they have a long way to go to handle the anticipated volume and diversity of B2B e-commerce.

The frameworks miss out in several important aspects of B2B—for example, pre- and post-sale processes such as bidding, tender evaluation, quotation handling, service contracts, and warranty handling. International processes such as currency conversion, taxation, and customs duty are crucial for a global framework. A global framework also requires semantic conversions of ontology. That is, because a global framework must encompass all the standards, it requires schema conversion from one framework to another. Also important to the success of an evolving framework is its integration of legacy systems and enterprise applications. The frameworks we have described do not address these issues sufficiently.

In our opinion, none of the frameworks are universal. The e-commerce community still needs an all-

encompassing, robust, universal framework that integrates the various facets of B2B transactions. We hope our analysis will contribute to the development of such a framework. ✷

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