MARKET PLACE AND TECHNOLOGY STANDARDS FOR B2B. ECOMMERCE: PROGRESS AND CHALLENGES

Conan C. Albrecht
Marriott School of Management and
Rollins eBusiness Center
Brigham Young University
540 TNRB, BYU
Provo, UT 84602
Phone: (801) 422-1792
Fax: (801) 422-0621
conan_albrecht@byu.edu

Douglas L. Dean
Marriott School of Management and
Rollins eBusiness Center
Brigham Young University
540 TNRB, BYU
Provo, UT 84602
Phone: (801) 422-1224
Fax: (801) 422-0621
doug_dean@byu.edu

James V. Hansen
Marriott School of Management and
Rollins eBusiness Center
Brigham Young University
540 TNRB, BYU
Provo, UT 84602
Phone: (801) 422-2308
Fax: (801) 422-0621
james_hansen@byu.edu

ABSTRACT

This paper identifies and defines standards required for successful eCommerce (EC) architectures. It evaluates the strengths and limitations of current and past systems that have been developed to support EC in relation to these standards. We conclude that there remains an unfilled need for systems that can reliably locate buyers and sellers in electronic marketplaces and also facilitate automated transactions. The notion of a ubiquitous ecommerce network does not currently exist. Such a network would 1) enable sellers to choose to publish product related information in a consistent, predictable way, 2) enable automated agents working on behalf of both buyers and indexing services to find desired information published by sellers without reliance upon human intervention, and 3) enable autonomous agents, when authorized by management, to evaluate products, negotiate prices, and conduct transactions. In the context of these desirable characteristics, this paper evaluates the strengths and weaknesses of the following EC architectures: EDI, company websites, B2B hubs, e-procurement systems, and *web services*. We identify where each of the architectures fails to provide requisite capabilities. Significant attention is given to the strengths and weaknesses of the web services architecture, since if supported by appropriate standards, has the potential to overcome some limitations of other approaches.

Keywords: B2B ecommerce, standards, procurement, EDI, web services, electronic markets, Information Infrastructure, Strategic IS.

INTRODUCTION

For more than three decades, businesses have been using electronic mechanisms to exchange transaction data. Standards have played an integral role in the success of different eCommerce (EC) architectures. In this paper, we propose and discuss a set of standards required in any EC platform and evaluate past and current architectures against these standards.

The development and implementation of standards and technologies has accelerated over the past fifteen years. A seminal event in this evolution was the development of EDI, whereby trading partners established standard formats for the exchange of electronic documents in order to facilitate electronic transactions (Truman 1998). Today, the emerging set of technologies collectively referred to as *web services* has the potential to extend the reach of EC.

Web services offer many advantages not found in earlier technologies, but they have yet to realize their considerable potential because of the lack of industry-wide technology standards. Should suitable standards be developed and adopted, web services could meet the needs of a broader range of EC transactions, including business-to-consumer (B2C), business-to-business (B2B), consumer-to-consumer (C2C), and peer-to-peer (P2P).

This paper focuses on B2B, which accounts for the largest dollar volume of EC, with about $700 billion in transactions in 2001. The Gartner Group estimates that all types of EC transactions will exceed $8.5 trillion by 2005, ninety percent of which will be B2B transactions (McCall 2001). Similarly, Jupiter Research estimates that the combination of B2B and B2C EC transactions will surpass $7 trillion by 2005 (Grover et al. 2001).

Businesses have been engaging in a form of EC known as EDI for a number of years. EDI occurs when one business transmits computer-readable data in a structured format to another business. Standard formats used in EDI afford the same information that businesses have traditionally included in their standard paper transaction documents. Yet EDI was designed to support business transactions between limited sets of known trading partners. Because of this paradigm, EDI does not facilitate discovery of new potential vendors that sell products and services, a significant limitation for firms that wish to extend their reach to participants in the broader marketplace.

Of more recent genesis, the World Wide Web (WWW) has enabled businesses to share documents across a generalized, global network. In several ways, the WWW has been a step forward in facilitating EC. Most notably, sellers have been able to publish company and product information via their web sites. To some degree, search engines have allowed buyers to find and analyze this information. Yet such searches are not reliable because of the diverse systems and data presentations used by various organizations. Moreover, sellers on the WWW generally do not use industry-wide standard transaction templates for accessing product information and for executing purchase transactions. This limits the ability of automated services to reliably find sellers and to conduct automated transactions.

Notwithstanding these limitations, the evolution of EDI and the WWW together with a new set of emerging technologies has the potential to provide a more robust and powerful platform for EC than exists today. However, we argue that these technologies must be supported by appropriate standards to enable automation to effectively and efficiently support buyers and sellers. The combination of currently existing technology, if supported by appropriate commerce-supporting standards, has the potential to provide three automation capabilities not available with past approaches:

First, the platform would enable potential buyers and sellers to reliably find each other. For this to occur, sellers must publish product information in a consistent, predictable way. This will allow automated agents to working on behalf of both buyers and indexing services to reliably find information published by sellers without requiring reprogramming or user intervention. This would help buyers and sellers to efficiently and effectively exchange information on product and services.

Second, the platform would enable automated agents to play a more significant role in ecommerce. With reliable information on products and services and organizations, automated agents, when authorized by managers, could act in the place of buyers and sellers to negotiate deals and evaluate options.

Third, the platform would support a variety of automated transactions, including but not limited to requests for information on products and services, price requests, purchase orders, and sales. This portends a ubiquitous generalized marketplace that will have desirable attributes of EDI, the WWW, and other evolving EC technologies.

This paper addresses the following research questions: First, what automation-supporting standards are required so support ecommerce and autonomous agents? Second, what role do these standards play in terms of supporting ecommerce? And, third, how do existing ecommerce platforms succeed or fail in terms of adoption of such standards.

The objective of the discussion that follows is to identify the essential features of systems that have been developed to support EC across the Internet and to evaluate their capabilities and limitations. This is done with the intent to help clarify how future research and development can improve these systems.

First we define six fundamental standards that must be present in any EC system if it is to support widespread, efficient B2B transactions on a network. Next we examine the extent to which the following EC platforms have succeeded in defining and adopting commerce enabling standards: EDI, company web sites, B2B Hubs, e-procurement systems, and finally web services. We conclude with a discussion on standards that need to be developed for the web services EC platform.

ECOMMERCE-ENABLING STANDARDS

Standards are essential to EC because adherence to uniform presentation allows heterogeneous computers to exchange information reliably and rapidly across a network. Standards are the key to interoperability between EC systems (Pincus 1999). When this occurs, human operators can focus their efforts where they provide real value: specifying search parameters, evaluating options, using judgment to make decisions, and approving transactions. Useful standards, adhered to by all participants, allow computers to better accomplish their supporting role of finding possible suppliers, gathering comparative product and company data, and executing transactions.

Two mechanisms can be used to achieve compatibility between automated systems: standardization and conversion (Farrell et al. 1992; Katz et al. 1994). Standardization requires that all participants use the same technologies or data formats. Standardization may be achieved through independent actions of market participants, through formal coordination of participants in voluntary industry standards committees, or through government action. In contrast with standardization, converters change a format from one form to another (Katz et al. 1994).

Farrell and Saloner (1992) note that standardization and adaptation have different costs. Standardization requires time and coordination expense during the creation and refinement of standards. Standardization also imposes costs on entities that have sunk investment in legacy technology that is incompatible with an emergent standard (Chircu et al. 2001). Thus, standards require high upfront costs. Conversely, the development of converters results in high backend costs, especially when many converters are required because of the existence of many incompatible formats and systems. Each conversion between each pair of incompatible formats requires a converter. And when a system's format changes for any node (system) multiple converters must be updated. Figure 1 illustrates a reason behind the high cost of creating and maintaining converters. Conversion among five formats requires ten two-directional converters.

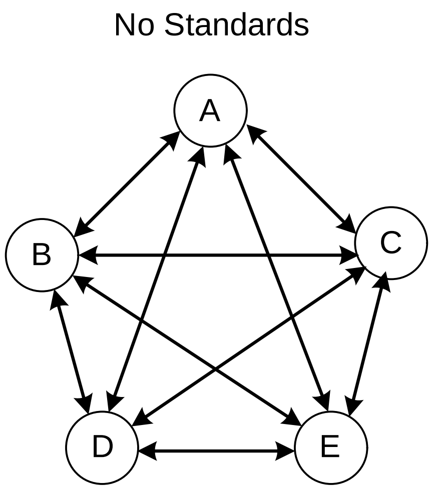

Figure 1: n-way Converters

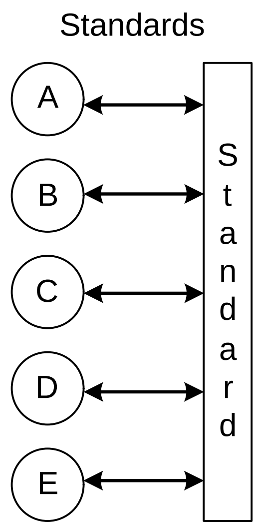

Figure 2: 2-way Converters

When any system's format changes, each related link must be updated accordingly. The cost to develop and maintain converters quickly becomes prohibitive.

Importantly, the existence of standards dramatically reduces the costs of developing and buying converters. Figure 2 reflects the fact that only one two-way conversion is necessary for each system when all systems translate to a shared standard. Examination of the history of EDI reveals another related benefit of a standard. Because of the existence of EDI standards, software firms had an incentive to develop converter software in accord with the standards. Organizations wishing to adopt EDI had greater choice among converter products that now had to compete on the basis of ease of use, ease of implementation, and cost.

In this paper, we describe six EC-enabling standards shown as the bottom two levels in Figure 3. The six standards can be usefully grouped into two areas: foundation technology standards and marketplace standards. We also discuss the implication of these standards for the two application technologies, shown on the top level of Figure 3, that rely on these standards: discovery applications and transaction applications.

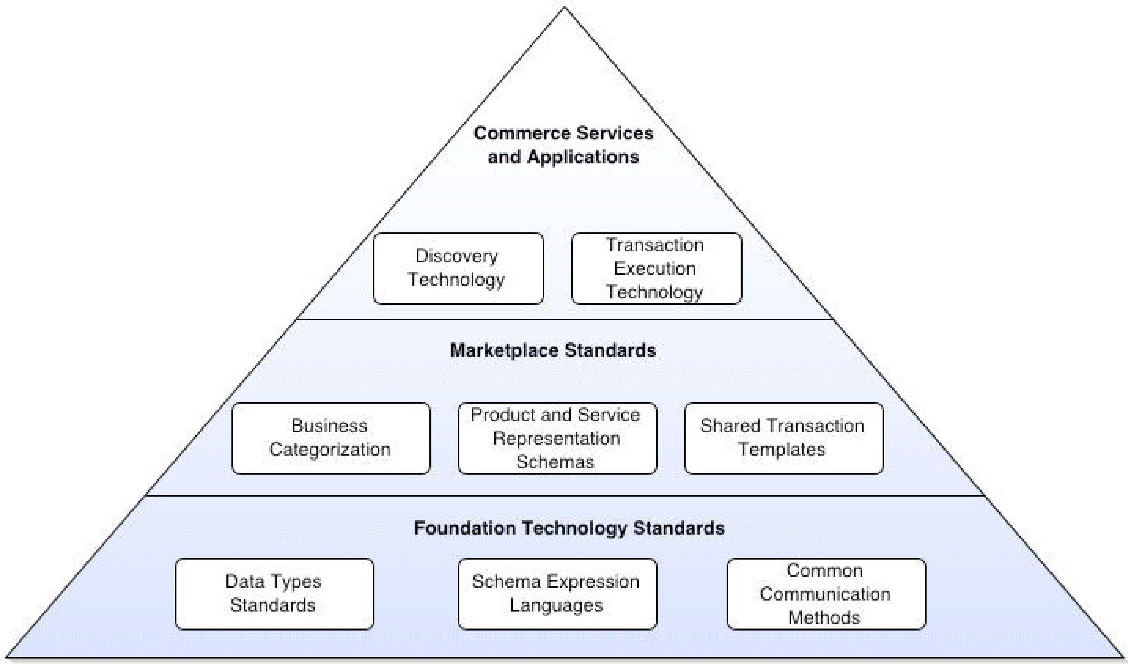

Figure 3: Required Standards and Applications for Generalized Ecommerce

Foundation Technology Standards

Technology standards are foundation standards that serve as building blocks for standards higher in the pyramid in Figure 3. The following three technology standards are the foundation of reliable, predictable EC communication:

- *Data standards* define the possible data types in a system. Participants must share a common definition of string, date, integer and real numbers, and other simple and complex data types.

- *Schema expression languages* (SEL) define rules for data representation. For example, in the XML SEL data is delimited with hierarchical (Walmsley 2001). Conversely, in the CSV (Repici 2002) SEL, fields and records are delimited with commas and hard returns. SEL may be used by designers and standards bodies to define data patterns in forms that enable computers to communicate in predictable and robust ways (Coyle 2002).

- *Common communication methods* define how data is physically transferred from one machine to another across a network. Traditional methods include hypertext transfer protocol, file transfer protocol, and Internet Inter-Orb Protocol.

Marketplace Standards

Marketplace standards include product and service representation schemas, transaction templates, and business categories. The creation and widespread adoption of useful standards for these three areas would have a powerful effect on improving EC efficiency. However, these standards are difficult to define and adopt. Powerful organizations sometimes compete to control the definition of standards, leading to competition among multiple existing standards as to which will be most widely adopted (Shapiro et al. 1999a; Shapiro et al. 1999b). In addition, the diverse needs of participants complicate the adoption of standards. Despite these complexities, definition of the following three standards significantly benefits EC systems:

- *Business categorization schemes* allow discovery technologies to index participants by type and name. Example business categorizations include the North American Industry Classification System (NAICS) (NAICS 2002) and the United Nations Standard Products and Services Code (UNSPSC) (UNSPSC 2002). While a ubiquitous business categorization system is difficult to create because of diverse industries, discovery services must rely upon some type of categorization scheme. Moreover, because organizations are sometimes involved in multiple business lines, an organization must be able to be listed in multiple categories.

- *Product and service representation schemas* allow businesses to describe attributes of the services they offer and of the products they sell. Known schemas are the basis for discovery of specific products and services. Inconsistencies in representation makes it very difficult for computer applications to find and evaluate sellers of specific products and services (McAfee 2000). EC systems become increasingly searchable when organizations within industries describe their services using common schemas. Schemas include field names, field definitions, and data types. For example, fish suppliers need useful schemas to describe the types of fish they sell, whereas accounting firms needs schemas to describe the different accounting services they provide. Many industries buy and sell commodities and quasi-commodities that are well suited for standardized product description formats (Dai et al. 2002; de Figueiredo 2000).

- *Shared transaction templates* group data fields into meaningful combinations to form transactions. The existence of standard transaction templates enables developers of heterogeneous systems to write converter software to translate data to and from the standard transaction format. Because of this, buyers can exchange transactions with many sellers rather than having to write translation routines unique to each seller. Thus, at the transaction level, specific buyers can be decoupled from specific sellers. As noted above, definition of transaction templates was a major focus and contribution of the EDI effort.

Commerce Services and Applications

Discovery service applications and transaction execution applications are necessary to complete a highly-efficient EC architecture. Discovery services would index businesses by type and product offerings. Transaction execution programs on the seller and buyer sides would allow sellers and buyers to execute transactions.

- *Discovery technologies* are market indexing and search applications, enabled by standards. These applications are at the heart of any ubiquitous EC network. Discovery technologies are especially important when buyers and sellers are not known, when offerings from different suppliers need to be found and evaluated, and when markets are fragmented (Bakos 1997; Bakos 1998). The usefulness of a discovery technology fundamentally depends on two factors: First, whether network participants use standard means to make market related information available; and, second, whether a large proportion of participants in the overall market choose to participate (Shapiro et al. 1999b).

- *Transaction execution technology (TET)* supports transactions among organizations. In terms of automated support for EC, two categories of transactions are important: First, *informational transactions* help buyers and sellers evaluate organizations and products. These include transactions that access product features, cost, and availability. Without information transactions, markets are less efficient. Second, *consummation transactions* relate to the actual consummation of purchase. These include transactions that buy, coordinate delivery, and remit payments. It is important to integrate TET with an organization's internal systems. For example, research on EDI systems suggests that a high degree of integration between EDI systems and the organization's internal information systems increases EDI performance benefits (Choudhury 1997; Iacovou et al. 1995; Mukhopadhyay et al. 2002; Riggins et al. 1994; Srinivasan et al. 1994; Truman 2000). TET should support decoupled connections of two types: ad-hoc connections with potential and new trading partners, and privately negotiated agreements between established trading partners (Jap et al. 2002).

CURRENT TECHNOLOGIES: STRENGTHS AND LIMITATIONS

In previous sections we have described and discussed a set of standards and applications that can dramatically increase the efficiency of EC. In this section we examine current EC technology platforms including EDI, Websites, Hubs, e-procurements systems, and web services in relation to how well they currently support B2B. Figure 4 illustrates the architectures of the respective platforms.

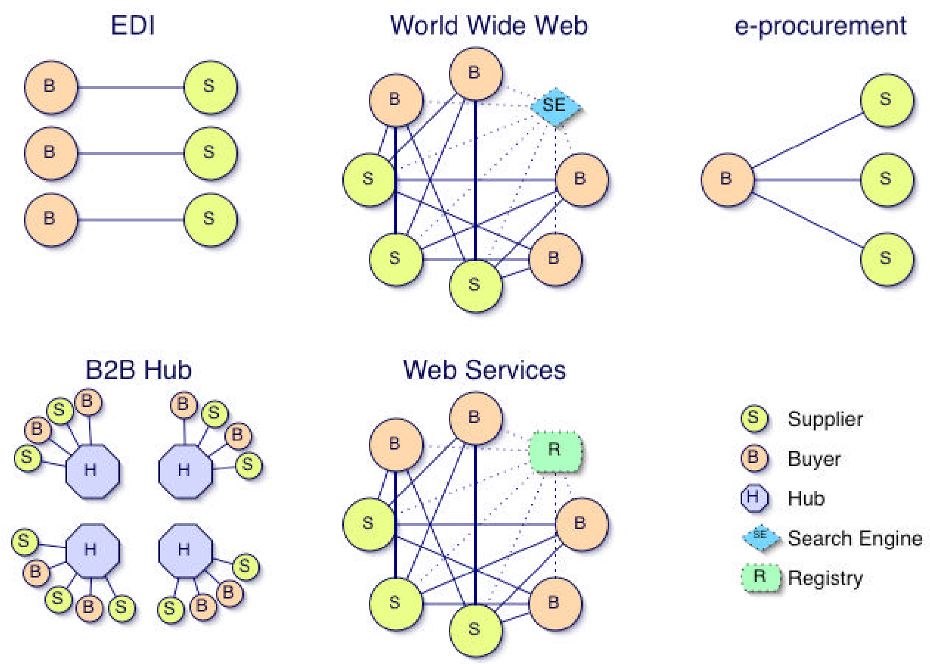

Figure 4: eBusiness Architectures

As noted above, each of these EC platforms has strengths and weaknesses.

Standard	EDI	WWW	e-procurement	B2B Hubs	Web Services
Data Standard	X12	No standard	Proprietary	Proprietary	Limited, basic types
Schema Language	Tags, delimited text	HTML	Proprietary	Proprietary	XML
Communication Method	VAN	Standard HTTP	Standard HTTP	Proprietary	SOAP
Business Categorization	No standard	No standard	None	Proprietary	Several supported
Product/Service Representation	Moderate	No standard	Proprietary	Proprietary	WSDL
Transaction Templates	X12	No standard	Proprietary	Proprietary	No standard
Discovery	No standard	Search engines	Vendor catalog or 3rd Party Catalog	Proprietary	UDDI
Transaction Execution	No standard	CGI forms	Proprietary	Proprietary	J2EE, .NET, others

Table 1: Summary of eBusiness Architectures

Table 2 provides a more detailed summary of these strengths and weaknesses by EC platform. These are described in the following sections.

Platform	Market Reach by Sellers	Entity that sets Data and Transaction Standards	Rigor of data and Transaction Standards	Index Mechanism for Discovery Services	Adequacy of Index	Type of Search Client	Degree of Support for Machine Executable Transaction Services
EDI	Limited to EDI partners	Industry consortium	Good	None	Index is specific to company. Not organized for external market place access.	EDI Software generates price and availability requests exclusively to EDI partners	Good
Company Website	Greater than EDI but hampered by lack of standards	Multi-company standards do not exist	Very Poor	Search Engines (e.g., Yahoo, Google, etc.)	Keyword-based indexing exists but there are no efficient business, business type, or product and service indexes	Browser	Low
Hub	Limited to entities connected to the hub	Hub developer. Standards are not common to other hubs	Varies in quality by specific hub	Hub index	Some categorization by the hub. The hub creates and maintains the index	Hub specific client enabled through browser	Good, but are not loosely coupled
e-procurement Systems	Limited to e-procurement Partners	E-Produrement software provider	Quality varies for different e-procurement systems	e-procurement system	Categorized within the e-procurement system. Sellers maintain product catalogs	e-procurement system client enabled through browser	Good, but are not loosely coupled
Web Services with UDDI	Large Companies who list themselves on UDDI	UDDI Consortium	Data and transaction standards need further development	UDDI index	Multiple business category indexes, product category indexing, no indexing and comparisons for specific product and services	Browser	Low

Table 2: Ecommerce Platform Comparison

EDI

EDI did not originate with the Internet, but was motivated by the need for electronic data standards between trading partners. In particular, EDI was developed to reduce the cost, delays, and errors inherent in the manual exchange of transaction documents. This effort was largely driven by large entities, such as General Motors, Sears, and Kodak in order to facilitate transactions with their many suppliers when buying direct materials to assemble into products. EDI is also used by some large retailers like Wal-Mart, to buy from wholesalers. A company's reach through EDI extends to only one trading partner at a time rather than the entire market (Table 2). Moreover, these trading partnerships between two firms are limited to relationships supported by legal contracts that typically specify trading partner obligations. Thus, market wide presentation of product information and use of indexing by discovery services has not been available through EDI (Truman 1998).

EDI standards for data interchange evolved from early proprietary agreements between pairs of trading partners, to industry-wide standards, to the more comprehensive and flexible ANSI X12 standards, which can support both intra-industry and inter-industry transactions. These standards focused on the Marketplace Standards denoted in (Figure 3). X12 Standards were flexible enough to accommodate the specialized information requirements of automotive, petroleum, transportation, and many other industries. Templates were designed for all the major transaction documents, such as purchase orders, and remittance advices, etc. A data dictionary was created that defines the field names and data definitions comprising each transaction.

Trading partnerships between two firms using EDI are well defined and generally stable. This stability means that EDI is sometimes used for automated replenishment and for the maintenance of efficient supply chains (Clark et al. 1996; Clemons et al. 1993). Since EDI predated the Internet, transport historically occurred over value-added networks (VANs), which served as the common communication method. VANs provided reliability, translation capability, security, and electronic mailboxes for trading partners. VANs could be very costly, however, with a fixed cost in the range of $250,000 for a mainframe installation and variable usage fees as high as $0.70 per transaction.

Today, the EDI telecommunications vehicle is changing from the VAN to the Internet. Indeed, some of the larger VANs now offer Internet services as well as their traditional connectivity methods. In addition, some industry groups are adopting XML as the language for communicating EDI transaction information via the Internet. Actual implementations of XML are few in number today, but substantial growth is expected in the future (Coyle 2002).

Table 1 depicts EDI standards in the four major areas. The strength of EDI stems from its well-defined data and transaction standards. With these standards, EDI software has been able to provide transaction services so that it has been possible to execute viable commercial transactions among two firms. EDI has been limited however, because EDI does not scale easily to include new participants, nor is it well suited for operating in efficient electronic markets where buyers would like to be able to search for products, prices, and related information from all sellers in a dynamic broader market.

Company Websites

Although an increasing number of companies have a presence on the Internet, their sites lack standard product and service representations. They also lack standard transaction templates.

Web pages lack standards for field names and field definitions used to provide information for specific products and services. This means a computer cannot reliably search multiple vendor sites for the same or similar products, nor can searchers use predictably specified product attributes to narrow their searches. For a system to compare information programmatically across multiple company sites, it must overcome this problem. Although improvements have been made in automation that can “scrape” web pages for information in limited domains (Embley et al. 1999), page scraping is not practical for application to the many diverse product types on the web (Bergmark et al. 2001). Consequently, humans must still conduct inefficient and often ineffective searches instead of using computers that could query and compile results from all possible sellers.

Search engines, such as Google and Inktomi, which provide discovery services for websites, are significantly limited by the lack of product and service schemas. Search engines use algorithms based upon co-occurrence of words to index information rather than consistently presented product attributes. Spiders, deployed by search engines, “crawl” and index diverse and incomplete HTML representations and therefore return incomplete and unreliable results. The lack of reach is another problem for search engines; not all potential suppliers and web pages are indexed (Glossbrenner et al. 2001).

Today's commerce web sites also lack the ability to execute standardized transaction templates. Once a site is found for a company that sells the desired product, human operators must search the site to find the desired product. Then, they purchase products through the shopping carts at the site or call the seller to arrange terms of the sale. Standardized data and transactions, common to EDI, such as requests for bids and purchase orders, are not commonly supported by company web sites.

Table 1 shows the standards the web provides for EC. Its use of free-text does not provide the needed level of standardization, representation, discovery, or categorization that is required for computer-to-computer interaction in general EC applications.

B2B Hubs

Over the last several years, some EC analysts and developers of B2B software expected that B2B hubs would radically reduce purchasing costs and provide comparability across vendors. As shown in Figure 4, B2B hubs bring buyers and sellers together and automate business transactions (Kaplan et al. 2000). B2B Hubs are electronic market places that play the role of *digital intermediaries* (Bailey et al. 1997; Bakos 1997). Ideally, B2B hubs facilitate product and information exchange and support product search, initial contact, negotiation, and settlement (Bakos 1997; Bakos 1998).

B2B hubs were expected to dramatically change commerce because they would be good for both buyer and seller. Hubs were expected to aggregate supplier’s product offerings, and help buyers search for desired products. Hubs offer their own catalogs or link to the product catalog of sellers, thereby providing indexing services (Baron et al. 2000). The ability to easily compare offerings from many vendors was expected to put downward pressure on prices (Jap et al. 2002; Kaplan et al. 2000). Sellers could achieve greater market reach and aggregate fragmented demand thereby allowing sellers to achieve greater sales and economies of scale. Hubs also represented the promise of reduced automation costs. Ideally, each buyer and seller would need only to incur the cost of connecting to one or a few hubs rather than sustaining the cost of developing links between individual market participants.

Figure 4 shows the contrast between the specific link between each buyer and supplier with EDI and the single link required by each firm for connection to a hub. Once buyers and suppliers were connected to the hub, the hub would be the instrument through which data would be shared on products and services. Hubs would also automate standard commerce transactions. These lofty expectations, however, have not materialized. Over the last few years, many hubs have failed, and those that survive have struggled to achieve critical mass. A number of factors have hampered hubs only some of which are directly related to the lack of standards. Non standards related problems were related to limited market reach and concerns about market information availability.

First, hubs are not built on common, ubiquitous standards. Diverse data definitions and transaction definitions hamper the adoption of hubs. Moreover, hubs typically do not connect to other hubs. As reflected in Table 2, data and transaction standards are specific to a hub, but are not universal across hubs. To connect to multiple hubs, companies have to incur the cost of implementing multiple translation pathways between their purchasing and sales databases and the hubs. Thus, the n-way problem described in Figure 1 still exists. It is costly to connect each business to multiple hubs.

Second, because hubs are proprietary, they have limited market reach. When a company connects to the hub, it has automated access only to other companies connected to the hub. Competition among hubs for subscribers results in market fragmentation (Wise et al. 2000). In addition, many suppliers and buyers are not convinced that hubs will reach critical mass, causing self-fulfilling expectations. Because of these limitations, the promise of broad market reach and the ability to easily compare offerings from many vendors often failed to materialize.

Third, some suppliers are reluctant to subject themselves to the price comparison that is possible in a hub (Jap et al. 2002) and others already benefit by lack broad market reach. Some hubs support public pricing, but do not support closed, secret price negotiations between specific buyers and sellers. This is unattractive to sellers who charge lower prices for large centralized buyers and higher prices for small decentralized buyers (Jap et al. 2002). This can be remedied by inclusion of public and closed pricing provisions in hubs. Some buyers like Wal-Mart have strategic sourcing and coordinated replenishment agreements with suppliers (Clark et al. 1996; Kurt Salmon Associates 1993). These types of buyers have already invested in automated EDI links to suppliers and therefore are more efficient than most competitors. This benefit could be somewhat lessened by more broadly available automation. Also, Clemons (Dai et al. 2002) notes that while some hubs focus on liquidity, many lack channel coordination ability. That is, they lack the ability to coordinates the production schedule of suppliers with the production schedules of buyers (Clemons et al. 1993).

These combined factors put pressure on the hub industry. For example, Ariba and CommerceOne, companies that were the focus of high expectations, have failed to achieve profitability and large market reach. These firms have subsequently refocused their efforts toward creating purchasing management tools rather than trying to become hubs in their own right. Not all B2B hubs have failed, however. FreeMarkets.com, for example, after years of significant financial losses, finally realized a net gain in the last quarter of 2001, largely because it was able to sign up enough supplier and buyers to provide savings to some buyers and market reach to some sellers.

E-procurement Systems

E-procurement systems have recently been adopted by a number of organizations to purchase indirect goods not typically purchased through EDI systems. A direct good is an item that becomes part of an end product, such as a motor used to assemble a washing machine. An indirect good is an item that is not part of the production process, but rather in other processes, such as operations, selling, maintenance, and administration (Eichler et al. 1999; Subramaniam et al. 2002). Examples of indirect goods include office supplies, computer equipment, cleaning solvents, and office furniture. E-procurement systems provide online product catalogs or links to vendors' catalogs. E-procurement systems enable organizations to distribute purchasing decisions to specific people across the organization. Moreover, automated linkages to suppliers allows buyers to reduce paperwork and overhead associated with the buying process and to shorten the time required to complete the purchasing cycle (Eichler et al. 1999; Subramaniam et al. 2002). While eProcurement systems can result in reduced inventory and consolidation of buying through fewer vendors which gives buyers more power to negotiate lower prices (Subramaniam et al. 2002). Like Hubs, eProcurement systems are subscription-based proprietary systems that lack a ubiquitous standards and wide market reach.

WEB SERVICES

Web services are a new approach that organizations can use to expose data and enable EC transactions over the WWW. While several evolving standards exist, such as RosettaNet (RosettaNet 2001) and ebXML (ebXML 2001), this section focuses on web services (WSDL/SOAP/UDDI) because of its wide industry backing. Web services is given its own section because of its likely acceptance as the new standard for EC over the next few years.

Web services attempt to solve some of the problems associated with traditional eBusiness technologies. The platform takes advantage of the ubiquity of the WWW primarily by using the HTTP protocol for transport, XML for data and service description, and UDDI for service discovery. Web services use open standards and has undergone submission to the World Wide Web Consortium (W3C) (W3C 2002), the primary organization that maintains WWW standards.

Web Service Components

The web services architecture is composed of three technologies: The Web Services Description Language (WSDL), the Simple Object Access Protocol (SOAP), and the Universal Description, Discovery and Integration registry (UDDI) (Bellwood et al. 2002). These are discussed in the following sections.

Web Services Description Language

The Web Services Description Language (WSDL) specification provides a set of rules for defining XML schema to describe the behavior, data, and bindings of different services. It was developed by Microsoft, Ariba, and IBM and has been submitted to the W3C. In short, a definition of a service in WSDL is a machine-readable fingerprint that describes an automated service and its attributes including method names, data field names, and data types associated with those fields. It is loosely analogous to an interface or header file used to describe the interface and behavior supported by a module in a computer program. Client software can query services for their WSDL definition. If the client software is prepared to make use of the methods and fields described in the WSDL, it can interact with the services accordingly through specific predefined calls to those services. WSDL data typing is superior to that specified for EDI. WSDL defines XML definitions for basic data types that are stronger and more specific than those defined by EDI. Whereas EDI standards defined specific field lengths, WSDL includes specific common data types (string, integer, decimal, date, etc.) that can be associated with specific data fields. As described earlier, standard data types associated with named data fields are essential for efficient and reliable communication among applications.

Simple Object Access Protocol

Simple Object Access Protocol (SOAP) is responsible for transferring XML-encoded information from one computer to another. Because SOAP uses standard HTTP, web servers allow it to pass through firewalls with relative ease, though companies are currently exploring ways to support SOAP and at the same time maintain adequate security (Albrecht, Forthcoming). SOAP also supports standard data types that can be used for requests made to services and it provides for asynchronous messaging and event notification to help the host and client programs communicate efficiently. Because of their use of XML for representation, WSDL and SOAP are widely supported in many different languages. Implementation libraries exist in languages such as Java, .NET, Perl, Python, Visual Basic, and many others (O'Reilly 2002a).

Universal Description, Discovery, and Integration registry System

UDDI, the Universal Description, Discovery, and Integration registry provides a central point for registering and finding services within the web services architecture. Currently, public UDDI services run by IBM, Microsoft, SAP, and HP replicate registrations and provide redundant lookup services for businesses using web services. Because of registration replication, participants only need register with one registry to be included in all UDDI servers. Table 3 presents the four components of the UDDI registry (Bellwood et al. 2002).

Type of Listing	UDDI Component	Description
Business Information	White Pages	Organizations list information about the organization such as name, address, and contact information.
Business Categories	Yellow Pages	Organizations can list themselves by one or more business categorization schemes.
Product and Service Categories	Yellow Pages	Organizations can list categories of the products and services they offer. Organizations cannot list specific product instances within product categories.
Service Description Listings	Green Pages / *tModels*	Organizations can describe the automated services and interfaces to those services that can be used by programs deployed by external organizations to access information on the organization and the product and service classes it offers.

Table 3. Types of Listings within UDDI

The UDDI system has been criticized because it relies too heavily on a centralized registry (Baker 2002). Moreover, functioning public directories, used to conduct business, may take several years to develop (Masood 2002). While there is considerable potential for this technology(Coyle 2002; Lawrence 2002), the lack of standards is a significant limitation. The next section describes how the lack of standards limits web services usefulness.

Limitations of Web Services

While the web services architecture represents a step forward, significant limitations still exist for automated services. 1) Business categorization is unreliable and variable, 2) product and service representations are nonexistent or inconsistent, 3) transaction templates are nonexistent or inconsistent, 4) discovery services are limited because of a lack of standards.

	Standard	Web Services Support	Comment
1	**Data Standard**	basic types	adequate
2	**Schema Language**	XML	adequate
3	**Communication Method**	SOAP	adequate
4	**Business Categorization**	Several supported	variable and unreliable
5	**Product/Service Representation**	WSDL	Different tModels exist, so it is impossible for search agents to infer meaning without human guidance
6	**Transaction Templates**	No standards	Variable and unreliable
7	**Discovery**	UDDI	Indexing is limited because of the lack of standards in items 4,5, and 6. The existence of such standards would support creation of superior indexes.
8	**Transaction Execution**	J2EE, .NET, others	A variety of implementations would work if based upon appropriate standards

Table 4: Web Services Weaknesses in Light of Framework Summarized in Table 1

Product and Service Representation and Transaction Templates

Together, WSDL and SOAP provide a framework for the definition and execution of remote calls on services, but standards for these calls and the methods that are called have not been agreed upon. This currently limits the usefulness of web services. For example, assume a seller wants to implement an automated service on the sellers' systems that can be used to both publish data and execute transactions. Standards for data and methods have not been defined and adopted by industry participants. Standards don't exist for field names, data types associated with field names, and names and definitions of automated program interfaces used to make calls to automated services. Because transaction templates have not been defined….

Field names to be used in these exchanges have not been standardized, such as "product code" or "product description." Moreover, standards have not been defined in terms of which of the WSDL data types will correspond to each field. For example, one service might use a string to represent product codes while another might use an integer. The lack of a standard for method names and what methods will do is also a significant limitation. As a specific example, if Amazon & Barnes and Noble do not use the same method names, parameter types, and return values, common access methods cannot be used by client applications. Because of different interfaces and methods, agents will not be able to communicate with new services without reprogramming. Amazon's hypothetical *getBookInformation(…)* method may or may not be synonymous with Barnes & Noble's hypothetical *queryBook(…)* method. These kinds of decisions and inferences require human knowledge and experience, resulting in the reprogramming or training of agents and client applications for each new service found.

This is industry problem. WSDL definitions don't exist for classes of products and services that should have equivalent or similar descriptive fields. WSDL definitions do not exist for automated services to access information on those product classes. Nor do standard transaction templates exist within web services to support common transactions such as purchase order and shipment requests. Rather, WSDL definition is left to each participant. While some industries may standardize their WSDL signatures or use existing WSDL from the existing "pool" of signatures, formal involvement with the UDDI system does not directly encourage participants to standardize or adopt standards that are being defined by other organizations (such as RosettaNet). This lack of standardization significantly impedes the usefulness of web services (O'Reilly 2002b).

Discovery and Indexing

The UDDI system finds organizations that belong to specific business type such as TV manufacturer, accounting firm, web hosting company, etc. However, since organizations can register with a variety of categorization schemes, such as such as a North American Industry Classification System (NAICS) code (NAICS 2002) or a Universal Standard Products and Services Classification (UNSPSC) code (UNSPSC 2002), the UDDI registry doesn't support economical and reliable searching for all businesses of a given type. Searchers must query according to the multiple different possible business categorization schemes to find businesses of a specific business type.

Jewell and Chappell (Jewell et al. 2002) have written the following about the anticipated limited market reach of the UDDI system:

> It's probably not realistic to expect software to dynamically discover and use new businesses on the fly in the near future. Realistically, human analysts need to browse a UDDI portal that allows customized searches and queries to discover the businesses they are interested in working with. It's more likely that software will contain the logic necessary to locate and integrate with web services for companies that have been predetermined. It's also likely that businesses will set up private UDDI registries that they can share with their approved partners to facilitate B2B integration.

Because of the UDDI yellow pages, the UDDI system can help searchers find businesses that offer a certain class of products or services, but UDDI does not support automated searches for specific products and comparisons of products and prices across vendors. For example, with UDDI it is possible to find registered companies that manufacture TVs, but it is not possible to find all vendors who sell high-definition, stereo, 27" color TVs.

Implications

There are important implications for these deficiencies relative to both the server (seller) side and the client (searcher) side. On the seller side, companies lack defined product and service representation schemas and transaction template definitions to guide their development of automated commerce support software. This significantly impedes the development of automation for both sellers and buyers. In effect, different sellers will expose different automation interfaces, even though they might wish to sell similar or even exactly the same products or services.

This lack of standards on the seller side leads to significant problems on the client side: namely, it is difficult to search and discover competing vendor services when different vendors offer heterogeneous interfaces. Without common field names and transaction templates for different products and service, search clients cannot be developed that reliably exploit these fields. Moreover, indexing services cannot use standard interfaces to collect product and service information across vendors to create a useful index that can be used to facilitate commerce.

Because of this heterogeneity, clients will need to be programmed specifically to interact with seller interfaces—effectively coupling the two which will make the network fragile and extremely difficult to maintain. Lacking standards, the goal of a single, simple client that can connect to many competing sellers (using the same interface), query for pricing and other information, and evaluate choices, is not possible.

While UDDI provides the *tModel* structure [UDDI Version 3], which can be linked by many different businesses, the structure allows any number of external schemes to be used for categorization. Since any registered entity can define *tModels*, many different specifications for the same business or product will still exist. For example, since not all tire manufacturers will publish under the same WSDL definition in the UDDI registry, it will be resource intensive to write search clients that will allow potential buyers to compare products across multiple vendors. Consider the problems a client application searching for tire suppliers will encounter using existing web services technology. First, it may not even be able to find all tire manufacturers on the network because they may be registered under different categorization systems. One supplier might register using the NAICS categorization system while another might use UNSPSC product codes. Still other suppliers might register only by their specific service APIs (*tModels*). Second, when the client application finds a tire manufacturer, it must query the service for the current tire price and availability. Since each tire manufacturer may be using a different method name with different data types, the client application must be programmed to communicate with each manufacturer's respective API, resulting in coupling between client applications and remote services. This approach is so resource intensive that it will limit the development of useful clients. This severely limits the general usefulness of the discovery mechanism.

In summary, the web services architecture provides emerging standards and technologies for most areas, but it still has significant limitations. UDDI supports business categorization schemes, but the diversity of these schemes makes it difficult for searchers to reliably find businesses within a category. The emergence of XML and WSDL has created a way to define product and service schemas, transaction templates, and automated service definitions in very specific machine readable terms, but industries still need to share WSDL and transaction signatures. Without these standards it will be difficult to develop clients that can economically search and execute transactions. It will also be difficult to develop comprehensive and effective indices that serve as the basis of discovery service.

CONCLUSION AND FUTURE RESEARCH

The overarching purpose of this paper has been to present evidence of the need for marketplace and technology standards through examining and contrasting the major platforms that have been developed to enable EC. To facilitate this investigation we have developed an evaluation schema (Figure 3) incorporating six fundamental standards that must be present in any EC system if it is to successfully support widespread, efficient B2B transactions on a network.

Using this schema, it is found that no single technology provides a complete solution for all components of a standardized, loosely-coupled marketplace. Each EC platform has strengths, but also weaknesses. EDI excels in transaction definition, but lacks market reach. The WWW has increased overall network (inter-network) connectivity and has provided a common, though limited, network indexing scheme. Development of B2B hubs has increased the feature set of useful web catalogs, but hubs have different data and transaction formats and limited market reach.

While the web services architecture is a major step forward technologically, the lack of required standards limits its usefulness and widespread adoption. The technology toolbox of today is sufficient to support EC, but the standards that must be developed are conceptual standards required for efficient technological implementation. This paper has helped clarify this relationship.

A shared set of APIs should support representation definition from top-down industry consortiums as well as bottom-up participants. It should enable a standard API for specific transactions and industries over time, while allowing evolution to meet individual and changing needs. Fortunately, standards efforts do not need to start from scratch. Future efforts should build upon the significant technical and standards work that has already been developed to support EDI, Rosettanet, and on other EC platforms. It should provide a semantically-meaningful set of terms that enable loosely-coupled, run-time connections between (Repici 2002) disparate clients and servers. Standards would also enable third party tool developers to economically create systems and converters that could be used by many organizations.

Since standards need to be developed, we recommend future research in three fundamental areas. First, research should be conducted in the area of incentives for industry participants. Different individual businesses and industries have varied incentives. Market reach is more important to some suppliers and buyers than others. The power of buyers and sellers also varies. Under what conditions can specific participants gain benefit from development and agreement upon a standard? Under what conditions do incentives and disincentives exist? Answers to these questions could help facilitate the development of standards. The recommendation of a standard set of APIs is not a trivial problem. Issues such as business compatibility, competition, and specialization complicate the solution. For example, one author recently spoke with a senior executive of one of the largest manufacturers in the world about EC with accurate, efficient, worldwide searching, connecting, and transacting of business by agents. The executive was less than thrilled with truly efficient platform because it provided the means to partially level the playing field for smaller and new competitors. This executive's business had already set up efficient EDI connections with preferred buyers and sellers, just-in-time agreements, and preferred pricing. Because of this the company recognizes that its private EC network is a significant competitive advantage.

Second, research should focus on efficient processes for developing standards. This includes who and how should players be involved in efficient ways. Lessons learned from research in the field of collaborative systems requirements definition (e.g., Dean, et al. 1998; Hickey et al. 1999) could be fruitfully applied to the area of standards development.

Third, the object-oriented paradigm provides insight into how standardization and specialization can be supported at the same time. An object library, such as the Java Foundation Classes or the Microsoft Foundation Classes, provides a standardized core of data types, methods, and relationships that all participants share and depend upon. Participants *extend* appropriate objects in the core system to provide specializations that meet their needs and yet maintain compatibility with existing applications. Applications programmed to the API of the super-service are still able to interact with the specialized service using the inherited methods. Over time, assuming the new specialization is accepted and adopted by others in the system, new clients increasingly take advantage of the new functionality of the specialized service type. We are researching methods of applying the base concepts of OO—most notably inheritance and polymorphism—to the web services architecture.

Our conjecture is that there are substantial research and application opportunities for loosely-coupled EC architectures, and we anticipate interesting developments from these efforts in the coming years.

ACKNOWLEDGEMENT

The Rollins Ebusiness Center at Brigham Young University helped fund this study.

REFERENCES

Albrecht, C.C. "How clean is the future of SOAP?," *Communications of the ACM*) Forthcoming.

Bailey, J.P., and Bakos, J.Y. "An exploratory study of the emerging role of electronic intermediaries," *International Journal of Electronic Commerce* (1:3), spring 1997, pp 7-20.

Baker, M. "UDDI v3 Announced; did anybody notice?," O'Reilly Network Weblogs, 2002.

Bakos, J.Y. "Reducing buyer search costs: implications for electronic marketplaces," *Management Science* (43:12), December 1997, pp 1676-1692.

Bakos, J.Y. "The emerging role of electronic marketplaces on the Internet," *Communications of the ACM* (41:8) 1998, pp 35-42.

Baron, J.P., Shaw, M.J., and Bailey Jr., A.D. "Web-based E-catalog systems in B2B procurement," *Communications of the ACM* (43:5), May 2000, pp 93-100.

Bellwood, T., Clément, L., Ehnebuske, D., Hately, A., Hondo, M., Husband, Y.L., Januszewski, K., Lee, S., McKee, B., Munter, J., and Riegen, C.v. "UDDI Version 3 Specifications Document," UDDI Working Group, 2002.

Bergmark, D., Phempoonpanich, P., and Zhao, S. "Scraping the ACM Digital Library," *Forum* (35:2), Fall 2001, p 7.

Chircu, A.M., Kauffman, R.J., and Keskey, D. "Maximizing the value of internet-based corporate travel reservation systems," *Communications of the ACM* (44:11), November 2001, pp 57-63.

Choudhury, V. "Strategic choices in the development of interorganizational information systems," *Information Systems Research* (8:1), March 1997, pp 1-24.

Clark, T.H.K., and Stoddard, D.B. "Interorganizational business process redesign: merging technological and process innovation," *Journal of Management Information Systems* (13:2), fall 1996, pp 9-28.

Clemons, E., Reddi, S., and Row, M. "The impact of information technology on the organization of economic activity: the "move to the middle" hypothesis," *Journal of Management Information Systems* (10:2), fall 1993, pp 9-35.

Coyle, F. *XML, Web Services, and the Data Revolution* Addison Wesley Professional, Boston, 2002.

Dai, Q., and Kauffman, R. "B2B E-commerce revisited: leading perspectives on the key issues and research directions," *Electronic Markets* (12:2) 2002, pp 67-83.

de Figueiredo, J.M. "Finding sustainable profitability in electronic commerce," *Sloan Management Review* (41:4) 2000, pp 41-52.

Dean, D.L., Lee, J.D., Pendergast, M.O., Hickey, A.M., Nunamaker, J.F., Jr., "Enabling the Effective Involvement of Multiple Users: Methods and Tools for Collaborative Software Engineering." *Journal of Management Information Systems*. (14: 3), winter 1998. pp. 179-222.

ebXML "ebXML Technical Architecture Specification," 2001.

Eichler, B., Evans, K., Parks, N., Alaniz, S., Roberts, R., and McCarver, B. "E-Procurement: a Guide to Buy-side Applications," in: *Stephens Inc. Internet Research Industry Report.*, Stephens, 1999.

Embley, D.W., Campbell, D.M., Jiang, Y.S., Liddle, S.W., Ng, Y., Quass, D., and Smith, R.D. "Conceptual-model-based data extraction from multiple-record web pages," *Data and Knowledge Engineering* (31:3), November 1999, pp 227-251.

Farrell, J., and Saloner, G. "Converters, compatibility, and the control of interfaces," *The Journal of Industrial Economics* (40:1), March 1992, pp 9-35.

Glossbrenner, E., and Glossbrenner, A. *Search Engines for the World Wide Web: Visual QuickStart Guide*, (3rd ed.) Peachpit Press, Berkeley, CA, 2001, p. 348.

Grover, V., and Teng, J.T.C. "E-Commerce and the information market," *Communications of the ACM* (44:4), April 2001, pp 79-86.

Hickey, A.M., Dean, D.L., and Nunamaker, J.F., Jr., "Establishing a Foundation for Collaborative Scenario Elicitation,"*The DATA BASE for Advances in Information Systems.(30:3-4),* summer-fall, 1999 pp. 92-110.

Iacovou, D.L., Benbasat, I., and Dexter, A.S. "Electronic data interchange and small organizations: adoption and impact of technology," *Management Information Systems Quarterly* (19:4), December 1995, pp 465-485.

Jap, S.D., and Mohr, J.J. "Leveraging Internet technologies in B2B relationships," *California Management Review* (44:4), summer 2002, pp 24-38.

Jewell, T., and Chappell, D. *Java Web Services* O'Reilly Press, Cambridge, 2002.

Kaplan, S., and Sawhney, M. "E-hubs: The new B2B marketplaces," *Harvard Business Review* (78:3) 2000, pp 97-103.

Katz, M.L., and Shapiro, C. "Systems competition and network effects," *Journal of Economic Perspectives* (8:2), spring 1994, pp 93-115.

Kurt Salmon Associates *Efficient Consumer Response: Enhancing Consumer Value in the Grocery Industry* Food Marketing Institute, Washington DC., 1993.

Lawrence, A. "Vitual Formations," in: *Web services has the power to revolutionise B2B commerce. But suppliers are wary of making grand claims.*, Infoconomy, 2002.

Masood, S. "UDDI: Better on the Inside," Infoconomy, 2002.

McAfee, A. "The Napsterization of B2B," *Harvard Business Review*), November/December 2000, pp 2-3.

McCall, T. "Worldwide business-to-business Internet commerce to reach $8.5 trillion in 2005," Gartner Group, 2001.

Mukhopadhyay, T., and Kekre, S. "Strategic and operational benefits of electronic integration in B2B procurement processes," *Management Science* (48:10), October 2002, pp 1301-1313.

NAICS "Complete Source of NAICS and SIC Information and Products," NAICS Association, 2002.

O'Reilly "Web Services Center," 2002a.

O'Reilly, T. "Amazon Web Services API," 2002b.

Pincus, A. "Hearing on the Role of Standards in the Growth of Global Electronic Commerce," Senate Committee on Commerce, Science, and Transportation Subcommittee on Science, Technology, and Space, 1999.

Repici, J. "Understanding the CSV File Format," Creativyst Docs, 2002.

Riggins, F.J., and Mukhopadhyay, T. "Interdependent benefits from interorganizational systems," *Journal of Management Information Systems* (11:2), fall 1994, pp 37-57.

RosettaNet "RosettaNet Background Information," 2001.

Shapiro, C., and Varian, H. "The art of standard wars," *California Management Review* (41:2) 1999a, pp 8-32.

Shapiro, C., and Varian, H.R. *Information Rules* Harvard Business School Press, Boston, 1999b, p. 352.

Srinivasan, K., Kekre, S., and Mukhopadhyay, T. "Impact of electronic data interchange technology on JIT shipments," *Management Science* (40:10), October 1994, pp 1291-1304.

Subramaniam, C., and Shaw, M.J. "A study of the value and impact of B2B E-commerce: The case of web-based procurement," *International Journal of Electronic Commerce* (6:4), summer 2002, pp 19-40.

Truman, G. "An empirical appraisal of EDI implementation strategies," *International Journal of Electronic Commerce* (2:4) 1998, pp 43-70.

Truman, G.E. "Integration in electronic exchange environments," *Journal of Management Information Systems* (17:1), summer 2000, pp 209-244.

UNSPSC "United Nations Standard Products and Services Code," 2002.

W3C "Web Services Architecture Working Group," 2002.

Walmsley, P. *Definitive XML Schema* Prentice Hall, 2001.

Wise, R., and Morrison, D. "Beyond the exchange: the future of B2B," *Harvard Business Review* (78:6), November/December 2000, pp 86-96.

Authors' biographies

CONAN C. Albrecht is an Assistant Professor and Rollins Fellow at the Marriott School of Management at Brigham Young University. He researches computer-related fraud detection, collaborative computing, peer-to-peer architectures, and network programming. He has developed three groupware systems to research group dynamics, and he is currently creating open source software to make fraud detection within corporate systems more available to auditors and fraud detectives. His work has been published in *Decision Support Systems*, *The Journal of Forensic Accounting, The Communications of the ACM, and Expert Systems with Applications*.

DOUGLAS L. DEAN is an Assistant Professor and David and Knight Fellow at the Marriott School of Management at Brigham Young University. He is also the research coordinator at the Rollins eBusiness Center at Brigham Young University. He received his Ph.D. in MIS from the University of Arizona in 1995. Dr. Dean's research interests include electronic commerce technology and strategy, software project management, requirements analysis, and collaborative tools and methods. His work has been published in *Management Science*, *Journal of Management Information Systems*, *Data Base*, *Group Decision and Negotiation*, *Expert Systems with Applications*, and *IEEE Transactions on Systems, Man, and Cybernetics*.

JAMES V. HANSEN is Glen Ardis Professor in the Information Systems Group of the Marriott School of Management at Brigham Young University. He received his Ph.D. from the University of Washington, Seattle. Professor Hansen serves on the editorial boards of *IEEE Intelligent Systems, Information Systems Frontiers*, and *Intelligent_Systems in Accounting, Finance and*

Management, and is listed in *Who's Who in Science and Engineering*. His research interests are in machine learning and agent-based systems, with recent publications appearing in *Computers & Operations Research, Genetic Programming and Evolvable Machines, IEEE Transactions on Neural Networks,* and *Journal of Experimental and Theoretical Artificial Intelligence*.