

The Evolution of E-commerce Websites:

A Conceptual Framework and Analysis

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Abstract Prior to the 1990's, business information exchanged digitally was achieved using EDI, where connections between businesses had to be pre-arranged. In the early 1990's, with the commercialization of Internet and the advent of open computer technology, connectivity becomes affordable not only for businesses but also for individuals. The interconnections have formed the World Wide Web (WWW). Here, WWW evolves from merely an information resource to become a virtual place for commerce activities. As e-commerce activities extend across businesses, enterprises, and industries, this opens up the challenge for a genre of websites that can provide online integrative management of business processes – e-business processes. In this paper, we provide an evolutionary perspective of e-commerce websites. We propose that there have been four eras: Pre-Web (prior to 1990), Reactive-Web (early 1990's), Interactive-Web (mid-1990's), and emerging Integrative-Web (end of 1990's to early 2000's). To be able to chart the evolution of e-commerce websites, a conceptual framework is developed to characterize such websites. We first characterize the elements of e-commerce websites using a syntactic representation. It is proposed that the principal elements of an e-commerce website comprise of a host, participants, and a website core consisting of core functions, core technology, and information base. We analyze the elements individually and examine their historical development collectively. We provide observations and insights on the interplay between e-commerce activities, website functions and web technology. Emerging e-commerce developments are identified.

[Keywords: E-commerce, E-business, Evolution, Syntactical Representation, Web Technology]

1. INTRODUCTION

The beginning of e-commerce can be traced all the way back to when businesses first use telex, telegram, telephone and fax to conduct commerce activities. During the 1980's, a major effort to standardize business information exchanged digitally was achieved using EDI. Here connections between businesses had to be pre-arranged, normally based on a value-added network. This improves the efficiency of conducting business but has limited commercial viability because of the high cost of connectivity. In the early 1990's, with the commercialization of Internet and the advent of open computer technology, connectivity becomes affordable not only for businesses but also for individuals. The interconnections have formed the World Wide Web (WWW). The powerful search engines and the proliferation of websites turn the WWW into a rich information resource, attracting browsers on a global scale. Businesses begin to reach their potential customers through the Internet and provide them with marketing information and/or product catalog online.

During the mid-1990's, WWW evolves from merely an information resource to become a virtual place for e-commerce activities, which in turn require a more secured and interactive environment. The secured and interactive features transform e-commerce activities from a single buyer-seller connection to a multiple buyers-sellers exchange. Additionally, websites can be customized or even personalized. Businesses also begin to adopt wireless technology to the Internet. The more recent e-commerce need is to enable business-to-business exchange, which requires interoperability across businesses, as well as within a business enterprise [3, 9]. As e-commerce activities extend across businesses, enterprises, and industries, this opens up the opportunity and challenge for a genre of websites that can provide online integrative management of business processes – e-business processes.

In this paper, we provide an evolutionary perspective of e-commerce websites. We refer to the period prior to 1990 as the pre-web era, the early 1990' s as the Reactive-Web era, the mid-1990' s as the Interactive-Web era, and the period towards the end of the century as the emerging Integrative-Web era. To be able to chart the evolution of e-commerce websites, we need a systematic and comprehensive conceptual framework to characterize such websites – as simplistic characterization such as B2B and B2C fails to capture the essence of differing e-commerce websites. Such a framework must be based on a fundamental understanding of the elements of a website, as well as their inter-relationships.

In the ensuing sections, we first characterize the elements of an e-commerce websites using a syntactic representation. Here, we propose that the principal elements of an e-commerce website comprise of a host, participants, and a website core consisting of core functions, core technology, and information base. We then provide an analysis for each of these elements. With respect to the aforementioned Web-eras and concentrating on three principal elements – the host, core functions and core technology, we postulate on the historical development of e-commerce websites and identify the emerging future development. It should be pointed out that this research does not address the hardware aspects of an e-commerce website or the design aspects of a website' s architecture; such issues are addressed in Fraternali [2] and Storey et al. [7].

2. ELEMENTS OF A E-COMMERCE WEBSITE

In general, the principal parties of an e-commerce website are the participants and the website management body, referred to as the *Host* (Figure 1).

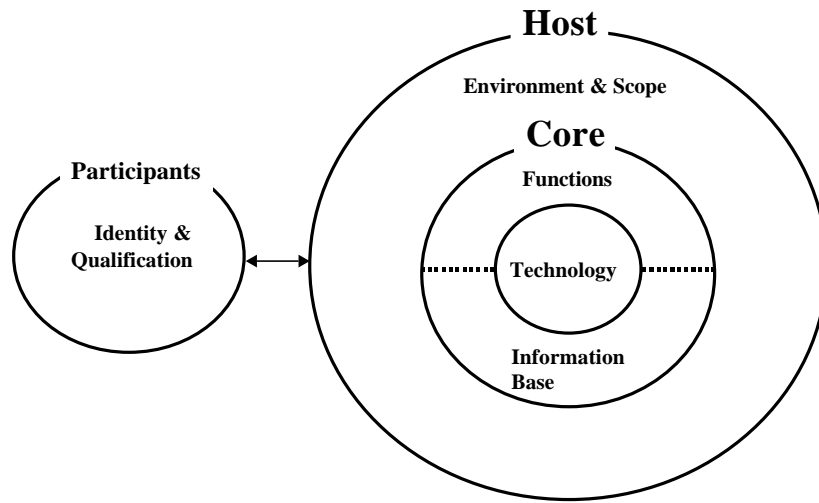


Figure 1. Elements of a E-commerce Website

2.1 Participants

Participants can be buyers or sellers, whether they are individuals or businesses, who utilize the website to engage in commerce activities. Depending on the website design, participants may be registered members or licensed members, who may have access to each other or may be stand-alone. Referring to the descriptors of the participants as *participant objects*, we propose that the participant objects consist of two components: *identity objects* and *qualification descriptors*. The identity objects (e.g. individuals, businesses, buyers, sellers, etc.) profile the participants of the website. The qualification descriptors (e.g. registered, licensed, selected, etc.) describe the status or the conditions of participants. With identity objects and qualification descriptors, we may characterize participants using such terms as registered sellers, licensed buyers, spot customers, etc. It should be pointed out that participants could be characterized using multiple identity objects or qualification descriptors.

2.2 Host

The website management body, *Host*, co-ordinates all the activities in the website. The descriptors of *Host* are referred to as *Host objects*, which are stipulated to have two components: *environment objects* and *scope-structure descriptors*. The environment objects are the attributes that define the boundary of the website, outlining the general business nature of the e-commerce website. Examples of environment objects are merchant, broker, mall, portal, etc. Within the environment, commerce activities may be structured according to certain relationships or properties between participants and the Host. Examples of such properties are cooperative, collaborative, neutral, etc. The attributes describing such relationships or properties are referred to as *scope-structure descriptors*. Using environment objects and scope-structure descriptors, one can characterize a host using such descriptions as a neutral portal (e.g. yahoo.com), a third-party exchange (e.g. oraclexchange.com), a first-party distributor (e.g. lifung.com), a vertical exchange (e.g. globaltransportexchange.com) and a collaborative horizontal exchange (e.g. e2open.com). Similar to participants, a host may be characterized using multiple scope-structure descriptors or environmental objects.

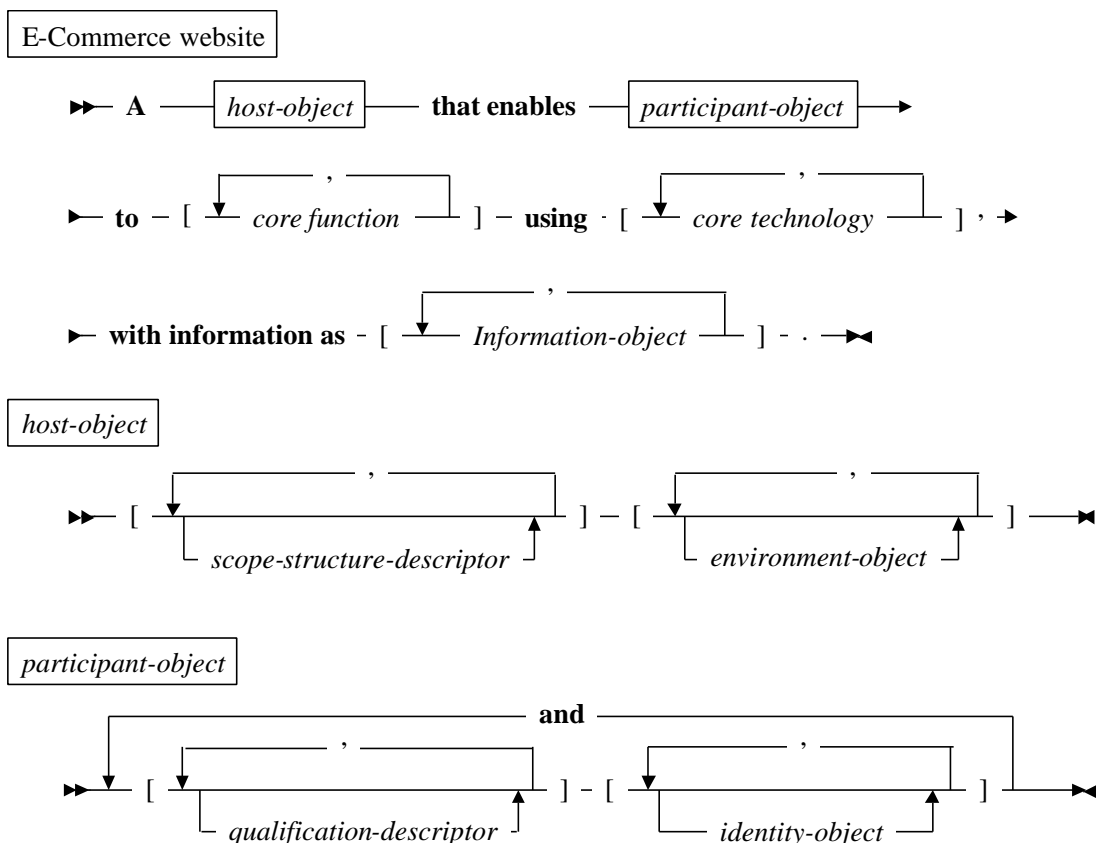
2.3 The Website Core

At the core of the Host is the management system, which is broken down into *core functions*, *core technology*, and the *information base*. Core functions (e.g. registering, browsing, matching, etc.) are the set of functions that essentially define the capabilities and intelligence of the website. Depending on the business model of the website, these functions collectively define how participants are admitted into the website, how negotiations are performed, and how transactions are established as well as fulfilled. The core functions are supported by the core technology, which can be organized into four areas: information presentation & representation

(e.g. HTML), communication (e.g., HTTP), business logic programming language (e.g. Java), and information storage & retrieval (e.g. DBMS). The information base is the information content of the website, which includes persistent and transitional data as well as information that facilitate all prescribed e-commerce activities. The data and information are carried in various information objects such as text, audio, video, etc.

2.4 A Syntactic Representation of an E-commerce Website

To depict the general relationship between the elements of an e-commerce website, we use a syntactic representation defined in the following syntax diagrams:



As an illustration, we can describe an information portal site such as the Library of Congress (www.loc.gov) as:

*A [neutral, generalized][portal]
that enables [individual][visitors] to
[browse, search]
using [HTML, Perl, GIFS],
with information as [document, image].*

As another illustration, consider a buy/sell fulfillment broker such as Travelocity.com. Here we can characterize the website as:

*A [vertical, personalized][broker]
that enables [registered][individual,buyers] and
[selected, licensed][business,sellers] to
[browse, search, select, contract, fulfill]
using [XML, ...,etc.],
with information as [document, video].*

In the syntactic representation, each square bracket contains a list of descriptors or objects. Where two sets of brackets are used adjacently, it implies any combinations of descriptors or objects between the two sets of brackets. For instance, the participants of the above e-commerce broker can be registered individual and registered buyers as well as selected and licensed business, and licensed sellers. Next, we analyze the individual elements of a website.

3. ANALYSIS OF WEBSITE ELEMENTS

The objects for information base are document, file, and video, and should not require detailed analysis. Also self-explanatory are identity objects for participants, which can be buyers, sellers, individuals, business, etc. Their qualifications can be open, selected, registered,

community, licensed, etc. The remaining elements (host objects, core functions, core technology) are considerably more complicated and are discussed in the ensuing sections.

3.1 Analysis of the Host Objects

Host objects characterize the boundary and the nature of the website (using environment objects), as well as the structural relationships between participants and the host (using scope-structure descriptors). Environment objects can be organized into a) information-based entities such as webpage, portal, classified, advertiser, platform, b) market-based entities such as marketplace, distributor, broker and exchange, and c) organization-based entities such as company, enterprise, store, mall, industry and hub. Scope-structure objects could define the host's role in the commerce relationship such as third-party and fourth-party, and could also characterize the host-participant relationship in such terms as neutral, generalized, specialized, and personalized. The following provides a description of relevant environment objects and scope-structure descriptors.

<i>Environment Object</i>	<i>Definition and Example</i>
<i>Information-based</i>	<i>Webpage</i> A document on WWW. (personal webpage)
	<i>Portal</i> A website that provides a search engine. (google.com)
	<i>Classified</i> A website that provides listings of items for sale or purchase. (classifieds.lycos.com)
	<i>Attention-Advertiser</i> A website that provides contents and services, to draw customers' attention on advertising messages. (cybergold.com)
<i>Market-based</i>	<i>Platform</i> A website that provides on-line facilities with which participants can perform on-line operations. (aol.com)
	<i>Broker</i> A website that draws buyers and sellers together and facilitates transactions. (travelocity.com)
	<i>Distributor</i> A catalog-type website that connects a group of product manufacturers with the retailers. (necx.com)
	<i>Marketplace</i> An open market for buyers and sellers. (b2b.yahoo.com)
<i>Organization-based</i>	<i>Exchange</i> A website that provides a market for products and services between anonymous parties. (aerexchange.com)
	<i>Company</i> A website for a company. (intel.com)
	<i>Merchant</i> A website that advertises and sells products. (walmart.com)
	<i>Mall</i> A website that hosts many online merchants. (mall.com)
	<i>Enterprise</i> A website for a company, its subsidiaries, and its partners. (disney.com)
<i>Industry</i> A website that provides a range of products and services within an industry. (transportweb.com)	
<i>Community</i> A website that provides services to a business community. (polysort.com)	
<i>Hub</i> A website that hosts many marketplaces and uses various market-making mechanisms to mediate any-to-any transactions among businesses. (e-hub.com)	

<i>Scope-Structure Object</i>	<i>Definition and Example</i>
<i>First-party</i>	A website provided by and in the interest of the seller(s). (amazon.com)
<i>Second-party</i>	A website provided by and in the interest of the buyer(s). (aerexchange.com)
<i>Third-party</i>	A website without particular interests in any parties. (shopping.yahoo.com)
<i>Fourth-party</i>	A website that provides services to the third-party service providers. (nte.net)
<i>Neutral</i>	An indifferent website that is not engaged in either side. (britannica.com)
<i>Generalized</i>	A website that provides diversified contents and services. (yahoo.com)
<i>Personalized</i>	A website that customizes the contents and services to meet the customer's personal needs. (my.yahoo.com)
<i>Specialized</i>	A website that provides a theme. (nba.com)
<i>Fellowship</i>	A knowledge website with information contributed by users and professional experts. (askme.com)
<i>Vertical</i>	A website that involves products in vertical markets. (globaltransportexchange.com)
<i>Horizontal</i>	A website that involves products in horizontal markets. (oraclexchange.com)
<i>Cooperative</i>	A website aims to allow cooperative relationships among participants. (auto-xchange.com)
<i>Collaborative</i>	A website aims to allow collaborative relationships among participants. (e2open.com)

3.2 Core Functions of a Website – A Transaction-based Hierarchy

A website's e-commerce activities are based on many core functions, which are defined as the manipulation and transformation of information without reference to any particular objects – that is, core functions are not object-specific. It is important to distinguish a core function from an e-commerce activity. For example, buying is not a core function but rather an e-commerce activity, which requires a series of specialized functions (register, search, match, offer, contract, authenticate, etc.) and involves objects (buyer and seller) as well. Similarly, personalizing and brokering are examples of e-commerce activity and not functions.

The core functions of a website are essential to its conduct of e-commerce activities. These functions can be organized into the following hierarchies: transaction incubation, transaction negotiation, transaction formation, and transaction management (Figure 2). This framework is based on the developmental phases of preparing, negotiating, and forming of a

business transaction – and after a transaction is formed, the necessary functions needed for the various aspects of managing a collection of transactions.

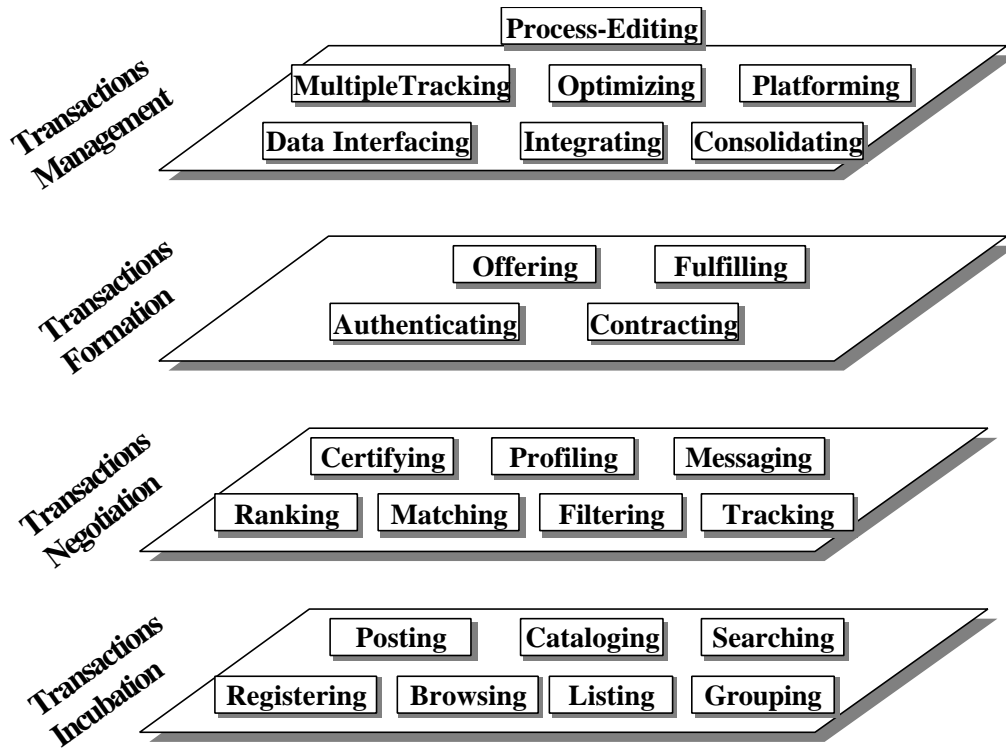


Figure 2. A Transaction-based Hierarchical Structure of E-commerce Functions

Transaction incubation functions. These are functions that prepare the participants and the host with basic information processing capabilities. These functions can be used to set up and validate the qualification of the participants, to respond to the request of participants, and to guide and/or organize the retrieval and storage of information. Collectively, they form the basis of such e-commerce incubating activities as broadcasting, advertising, information-searching, publishing, and aggregating. The relevant transaction incubation functions are:

- Searching – enable guided retrieval of specific information
- Registering – enable receipt and storage of requested information

- Browsing – enable unguided information viewing
- Listing – provide information in linear representation
- Posting – deliver selected information
- Grouping – enable guided association of selected information
- Cataloging – organize information in a specific structure

For example, an information-searching activity would involve functions such as registering, browsing, and searching; an advertising activity would involve browsing, cataloging, posting, etc. These core functions are essentially based on one-way information requests, originated from the participants to the host.

Transaction negotiation functions. These are functions that facilitate the negotiation of a commerce transaction. After the initial information search to narrow the focus, participants need certain negotiating functions to engage in the exchange of information before deciding whether a transaction should be made. These core functions collectively enable such e-commerce negotiating activities as personalizing, customizing, shopping, brokering, bidding, auctioning, etc. The relevant transaction negotiation functions are:

- Tracking – maintain/keep records of tracked information
- Messaging – send asynchronized information
- Certifying – establish the existence of specific information
- Profiling – create preference information
- Filtering – sieve through information
- Matching – search then link related information
- Ranking – sort information in accordance with specific criteria

An important aspect in the negotiation process is the system's ability to customize and personalize. Customizing requires the core functions of profiling, filtering, and posting; while personalizing is simply customizing with registering. To enable process continuity in the negotiation process in such activities as shopping and brokering, the system requires the core

function tracking, which is essentially for two-way interactivity. Typically, the activities of shopping, brokering, bidding, auctioning all requires some form of matching and ranking.

Transaction formation functions. Once the negotiation process is complete, the participants enter into the transaction-formation phase. This is the phase where transactions are finalized, where participants are typically authenticated for payment, and where digital products are fulfilled. The following core functions are required to conduct or conclude e-commerce activities such as buying, selling, paying, gaming, pay-per-view, fulfillment of digital products etc.

- Authenticating – verify by matching of certified information
- Offering – receive information within a prescribed range
- Contracting – accept then record offered information
- Fulfilling – transfer of requested or approved digital information

To form a commerce transaction, offering would first be confirmed, followed by the contracting step. Here, authenticating is typically needed for identity check as well as credit check. The subsequent fulfilling steps of payment and transfer of the digital product conclude the buying and selling process.

Transaction management functions. These are functions that enable online coordination of multiple interrelated commerce activities. They can be used to provide the online management of business processes – enabling integration, consolidation, optimization, and control of these processes – commonly referred to as e-business processes. The e-commerce activities and e-business processes that can be supported by these functions are online process design, e-collaboration, e-procurement, e-supply-chain-management, e-reengineering, e-customer-relationship-management, etc. The relevant transaction management functions are:

- Platforming – set up exchange of dynamically shared information from multiple sources
- Data Interfacing – standardize representation of shared information from multiple sources
- Multiple tracking – link multiple tracked information
- Process-editing – search and group multiple tracked information
- Consolidating – combine matched tracked information of multiple sources
- Integrating – combine consecutively ordered information
- Optimizing – select best process-edited information

These core functions collectively provide an online integrative capability to the website. Platforming sets up the structural framework for communication among multiple sources. Data interfacing allows sharing of information between any participants. Process-editing provides the basic mechanism for designing and editing multiple processes online. Consolidation is used to achieve the online merging of component tasks across processes plausibly to share the same resource; while integration is to achieve the linking of component tasks across processes to realize potential operational and/or economic efficiency. Optimization is to attain the best process design among alternatives. These management functions are essentially complex and have not been pervasive among websites. More detailed discussions are provided in Section 4.4.

3.3 Core Technology

The evolution of e-commerce website is closely related to the evolution of website core technology. Core technology is crucial in enabling core functions, allowing e-commerce activities to be conducted in cyberspace. This enabling core technology – web-based information technology – is broken down into the following four major areas: Communication, Information Presentation and Representation, Language, and Storage and Retrieval. Figure 3 depicts the four areas along with representative examples. We will first discuss the nature of

such technology; the evolution of core technology within the context of e-commerce websites and activities will be covered in Section 4.

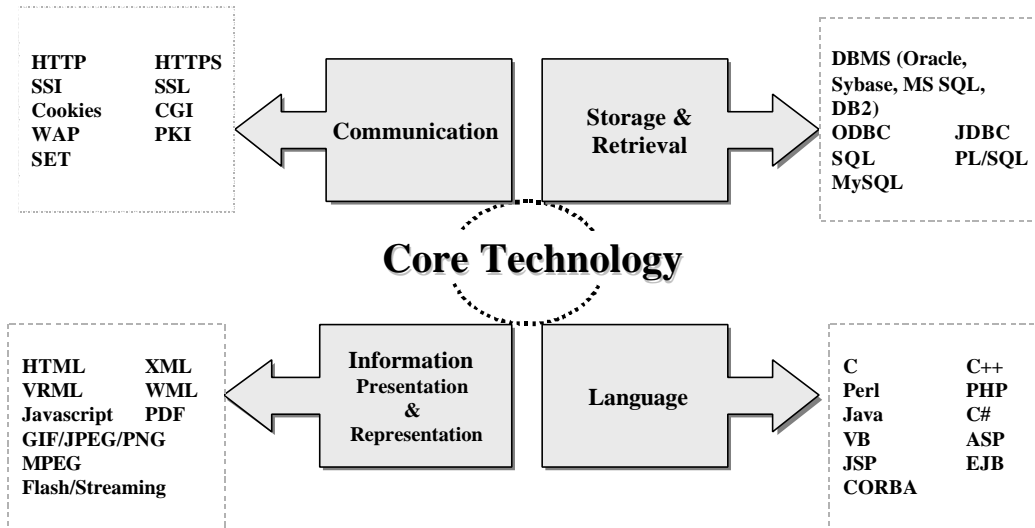


Figure 3. The Core Technology Areas

Communication. It establishes a virtual channel for any two parties to exchange digital data by following prescribed procedures. For participants to initiate or take part in e-commerce activities, communication must first be established. HTTP (Hyper Text Transfer Protocol) is a set of procedures that provides a request-response mechanism, which allows the requesting party to receive information on the network using the URL (Universal Resource Locator) reference. The communication channel is established per exchange and is always initiated by the requesting party. Data can be attached according to the interface standard, CGI (Common Gateway Interface). The responder can use cookies, a data item that stores the requestor's footprint at the requestor machine, to keep personal information of a requestor or the environment where the

communication should be carried out. For secured data transfer, protocols using encryption such as SSL (Secured Socket Layer) and PKI (Public Key Infrastructure) can be used. The Wireless Application Protocol (WAP) is a communication technology that creates an added channel for information exchange using wireless devices.

Information Presentation & Representation. It specifies how information should be organized when presented, as well as the corresponding presentation format; and defines how the information should be organized for exchange. A website must present information in a format viewable by participants using required tools. Information can be represented as simple text, graphical images, sound and video or a combination of them. HTML (Hypertext Markup Language) is a language that formats the information for presentation, which is viewable by a commonly available browser. A HTML page also has the capability of including multimedia information and links to other external document, as well as providing a form structure to accept data from the participant. XML (eXtensible Markup Language) captures the essence of HTML while adding data structure and data markers to the content, thus providing an information structure for efficient processing and storage. For delivery of content to wireless devices, WML (Wireless Markup Language) specifies a different information structure suitable for wireless usage.

Language. It expresses and formulates precise logical steps to manipulate data and computing resources. Language is the critical component that forms the building blocks in a website's intelligence capabilities. Programming languages that exist before WWW include COBOL, FORTRAN, and C. These languages lack networking interface mechanisms to acquire data via the Internet as well as direct querying capability of databases, both of which are necessary features of e-commerce. For some existing languages (e.g. PERL, C++, Ada, VB),

web-based capabilities are incorporated to collect data from remote websites, retrieve stored data or information from external databases, and to generate HTML or XML pages. Further improvements are provided by PHP and Java to dynamically manage information delivered to participants. Java also provides interactivity and functionality for the participant.

Storage & Retrieval. It provides system structure for the recording and retrieval of data and information. A website requires the capability and the capacity to store and retrieve information. Before the web, DBMS (Database Management Systems) has been used for recording and retrieval of shared data and information for many years. Proprietary access – the proprietary ability to query databases – is the principal obstacle for traditional DBMS to adapt to an open Internet environment. ODBC (Open DataBase Connectivity) is a standard interface for accessing a database. Any database that is ODBC-compliant can be accessed using a simple query language, e.g. SQL (Structured Query Language), along with most programming languages. This interface arrangement format has been adopted by many websites. JDBC (Java Database Connectivity), a special feature for Java, incorporates the functionality of both SQL and ODBC, thus allowing direct connectivity between programming languages and databases.

4. EVOLUTION OF E-COMMERCE WEBSITES

In this section, we provide a detailed evolutionary perspective of e-commerce websites. Our discussion focuses on the evolution, individually and collectively, of the three principal website elements, host, core functions, and core technology. We refer to the period prior to 1990 as the pre-web era, the early 1990's as the Reactive-Web era, the mid-1990's as the Interactive-Web era, and the period towards the end of the century as the emerging Integrative-Web era (Figure 4).

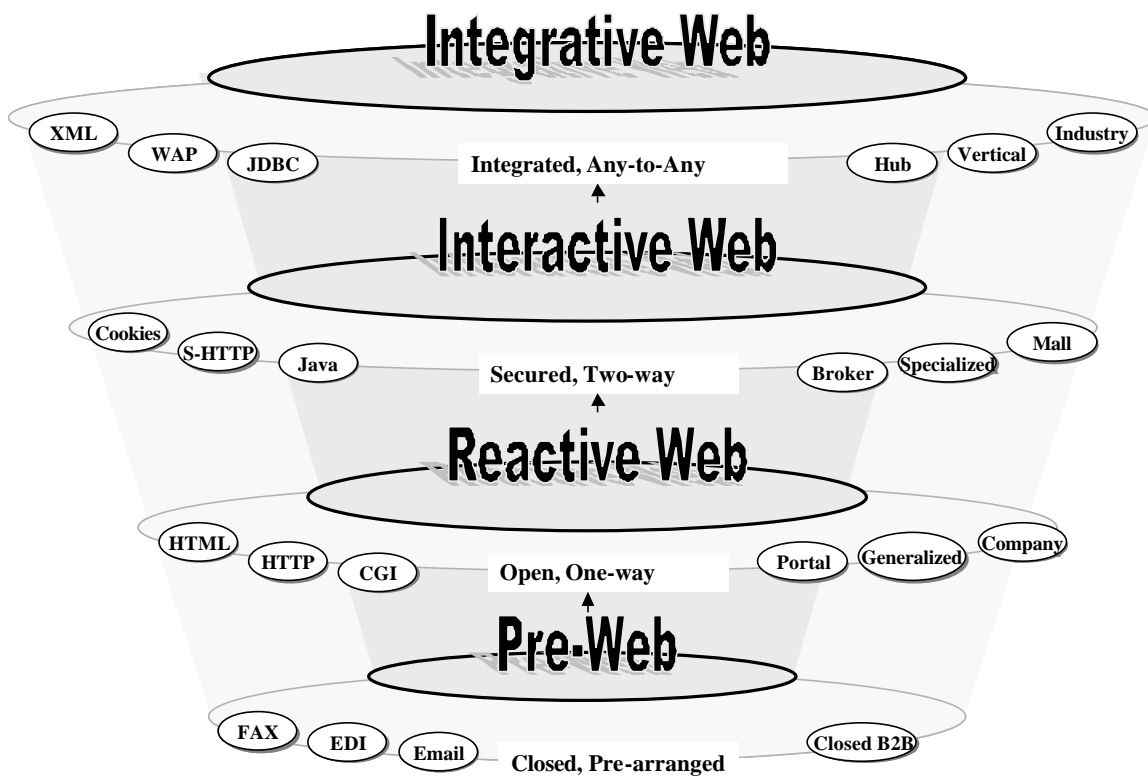


Figure 4. Evolution of E-commerce Websites

4.1 Pre-Web Era

Prior to the WWW, commerce activities can be characterized as closed in that businesses can only communicate with each other using specific communication mechanism. To engage in business activities digitally, the channel of communication must be prearranged. There are no standards in communication protocols to exchange business information, thus limiting business activities to be conducted on a one-to-one basis. While Internet provides connections between any two parties, however, open communication cannot be established because a common message format for encoding business activities has yet to be developed. This means that

commerce activities can only be participated by designated parties, typically by selected businesses and not open to the general public.

Designed for a network environment, but not web-based, EDI is a standard to define a syntax for interchanges between business partners. However, EDI is rigid and is difficult for general use by the public – even a simple function such as browsing is not possible. In this era, there are no discernable web-based business functions as individual business functions are accomplished according to their own set of formats. As for the core technology, they can be characterized as stand-alone with no interface built-in features. The relevant core technology is:

Communication	Representation & Presentation	Language	Storage & Retrieval
FTP, Telnet, EDI, SET, EFT	ASCII	FORTTRAN, C, Perl, C++	DbaseIII, SQL

The four areas of core technology are developed with no consideration or motivation to create interface between them. The technology in this era simply does not have web-based capabilities to take advantage of the full potential of the Internet. This pre-web era is largely a period of closed, pre-arranged, one-to-one, business-to-business commerce.

4.2 Reactive Web Era

At the beginning of the 1990's, commerce activities on the Internet evolve from a closed environment to one that is open and easily accessible. Internet has become a virtual place where information can be easily shared. The WWW is formed, marking the beginning of web-based e-commerce. The open access is due to the development of a simple effective communication protocol HTTP, enabling exchange of information in HTML. Sharing and viewing of information become much easier with the unified URL identifier and freely available browsers. Communication between users is no longer prearranged.

The proliferation of websites follows. Primitive websites such as webpage and classified begin to populate the Web. Together with the development of powerful web-based search engines, WWW has become an effective channel for businesses to reach potential customers. The powerful search process is enabled by CGI, which identifies what users want, and by the core language technology, which efficiently locate matching information. In this era, the websites are typically information resources. Generalized portals – with core functions such as listing, cataloging, posting, and grouping – are most common during this period.

While communication is open, the request for information remains one-way. Business can only react to requests by customers, creating a reactive website environment – from hosts to participants. This means difficulty in personalizing a response. Further, the information represented in HTML cannot be extracted, thus not permitting interoperability between website users. Without interactivity and interoperability, e-commerce activities are limited to online searching of products and services, with any transactional steps thereafter having to resort back to pre-Web dealings. Furthermore, e-commerce activities are impeded by the lack of secured transmission of confidential information. The features of the reactive Web era are summarized in Table 1.

Table 1. Reactive Web Era - open, one-way -				
E-commerce Activities: Browsing, Information-searching, Broadcasting, Cataloguing, Advertising, Publishing, Aggregating, etc.				
Host	Scope-Structure		Environment	
	First party, Second party, Neutral, Generalized		Webpage, Portal, Classified, Company	
Core Functions	Transaction Incubation Functions: Listing, Posting, Browsing, Grouping, etc.			
Core Technology	Communication	Presentation & Representation	Language	Storage & Retrieval
	HTTP, CGI	HTML	C, C++, Perl	DbaseIV, Access, Oracle, SQL

The reactive Web has opened up communication channel for the general public, with websites continuing to build up their contents. It has become important for existing DBMS to have better interface with common languages that implement the business functions – yet many websites do not possess the necessary interface, due to the restriction of proprietary language to its database.

4.3 Interactive Web Era

In the Interactive-Web era, e-commerce activities evolve from predominantly a simple one-way browsing activity to a two-way commerce process of transaction negotiation and formation. As e-commerce websites take root in the Web, the need for interactive two-way negotiation of buy-sell transactions becomes imminent. Interactivity is achieved primarily due to the emergence of the core technology, cookies. By tracking the footprint of a participant, cookies enables interactivity, a necessary feature for the continuity of a transaction-building process on the Web.

With process continuity, many new e-commerce activities can now be conducted. Online shopping, a negotiation process consisting of a series of shopping-cart steps, is now a viable e-commerce activity – a shopping cart is essentially a cookies-driven recording scheme. Personalization and mass customization are also achievable due to the interactive process. Both personalization and mass customization are accomplished using new language technology (e.g. JSP and PHP), the former is based on the participant's identity and the latter is derived from the website's information base. Here, new online shopping environments of various scope-structures emerge – an example of which is a personalized mall, where a shopper can engage in a personalized shopping process involving a variety of products. Online brokering, a transaction negotiation-and-formation activity, is also created largely because of interactivity. By

developing online linkages of participants, websites can now match sellers and buyers of products and services [1].

Both shopping and brokering are steps towards buying and selling. To complete buy-sell activities, agreements must be reached between buy-sell parties. However, WWW is a public domain. Thus, for online buying and selling activities to flourish, the problem of secured information exchange on the Web must be resolved. Here, well-established cryptography systems are used to develop SSL on the Web, guaranteeing confidentiality and integrity between two parties. The secured transfer of information is essential for closure of a contractual agreement, which concludes the dual activities of online buying and selling – two online activities that would not be possible in prior eras.

Buying and selling can also be practiced with auctioning and bidding, thus extending the buy-sell coverage to groups of participants. An exchange website is an online marketplace with auctioning and bidding by buyers and sellers anonymous to one other. With buying and selling comes the e-commerce activity of online paying, which requires websites to check the participant's credit-worthiness and to authenticate the participant's identity. As host environment evolves from specialized malls to third-party marketplace for procurement, the online buying-selling paradigm extends into brokering of information. Gaming, a noteworthy e-commerce activity that has its genesis in this era, is a case in point. The principal features of the reactive Web era are summarized in Table 2.

Table 2. Interactive Web Era - secured, two-way -				
E-commerce Activities: Shopping, Personalizing, Brokering, Customization, Bidding, Auctioning, Buying, Selling, Paying, Gaming, etc.				
Host	Scope-Structure		Environment	
	Third party, Personalized, Specialized, Fellowship, Horizontal		Exchange, Marketplace, Merchant, Distributor, Broker, Mall	
Core Functions	Transaction Negotiation & Formation Functions: Tracking, Profiling, Matching, Ranking, Offering, Fulfilling, etc.			
Core Technology	Communication	Presentation & Representation	Language	Storage & Retrieval
	Cookies, SSL	Javascript, SSI, Flash (plug-ins), VRML	Java, PHP	ODBC, SQLPlus, SQLServer

To support the new e-commerce activities of shopping, personalizing, brokering, buying, and selling, a set of new core business functions are developed. In general, the core functions in this era are those of transaction negotiation and transaction formation (e.g. matching, ranking, authenticating, contracting). The Interactive-Web era makes personalized buying or selling possible. Interactivity solidifies buy-sell e-commerce on the Web, demanding different core technology areas to consider their impact on one another. Core technology continues to evolve to handle heavy website traffic, to provide sophisticated interface to databases such as ODBC, and to improve language interface to databases.

4.4 Emerging Integrative Web Era

As new and old e-commerce activities are made in the previous eras, the management of these transactional-based activities becomes an imperative evolutionary impetus. Towards the end of the century, the new dimension – interoperability – is beginning to emerge in some websites. Coupled with interactivity, websites seek to develop capability to integrate processes online. No longer are websites used merely for online trading activities – e-commerce activities, but also for the online management of business processes – e-business processes. This is the era

that witnesses the emergence of e-business processes such as e-supply-chain-management, e-collaboration, e-reengineering, and e-procurement. Here, e-commerce activities and e-business processes are intertwined online, creating a genre of websites that are both marketplaces and management platforms. Management of business processes can be conducted concurrently with commerce activities to achieve online concurrence in design, marketing, and business-process management. Such websites facilitate collaborations, strategic alliances and provide one-stop business services. In essence, websites have evolved from a two-way interactive environment to an any-to-any integrative platform of business management and commerce.

Interoperability – the ability for multiple parties to mutually use and share information – is supported by data interfacing, which addresses three principal needs. First, identification needed for information extraction must be established. By providing an identification syntax, XML – a new information representation scheme introduced in this era – achieves such extraction. With XML, information exchanged can now be usable for immediate processing in legacy systems, or by software from different vendors within a website. Second, standardized identification is needed to support communication between any participants, allowing management of business processes across different websites, intranets, and extranets. Information representation using one-for-all DTD (Data Type Definition) with XML provides this core data-interfacing functionality [6]. Third, cross-website access of databases is necessary for online management of business processes, requiring that knowledge be obtained from different information bases on demand. Such online cross-website information retrieval can be enabled by using JDBC with Java – a vendor-independent interface to databases.

An operating environment is also needed for online integration. The provision of such an online mechanism – typically a platform – is referred to as platforming. The platform is where

e-business processes are tracked, linked, edited, and displayed. Each e-business process is designed dynamically, with information interoperability as well as interactivity from participants and the host website. Another major evolution during this era is the need for online decision support systems (DSS) [5]. As the decision-making for the management of e-business processes is complex, the need to develop online decision support systems is imminent. The core functions for an integrative website must be able to analyze complex processes with differing objectives and constraints. During the process design, it is important that the website can provide relevant decision support to identify consolidation and integration of component tasks across business processes, as well as the capability to perform optimization of business processes [4].

Integrative websites are well-suited to handle vertical integrative management of e-business processes, managing such processes within a company, within an enterprise, as well as across different companies and enterprises of an industry. These features are particularly useful for cross-company processes such as e-collaboration, e-supply-chain-management, e-customer-relationship-management, and e-procurement. Websites that integrate cross-company processes are essentially third-party agents. Fourth-party websites, which manage e-commerce activities and business processes of third-party service providers, have also emerged. The integrative websites may continue to evolve to provide integrative management for horizontal companies. It has been suggested that a website could function as a “e-Hub” that hosts many marketplaces and uses various market mechanisms to mediate any-to-any transactions among businesses [3]. The principal features of this era are summarized in Table 3.

Table 3. Integrative Web Era - integrated, any-to-any -					
E-commerce Activities and E-business Processes: E-Collaboration, E-SCM, E-Procurement, E-CRM, E-Reengineering					
Host	Scope-Structure			Environment	
	Vertical, Cooperative, Collaborative, Fourth-party			Platform, Enterprise, Community, Industry, Hub	
Core Functions	Transaction Management Functions: Data Interfacing, Platforming, Process-editing, Consolidating, Integrating, Optimizing, etc.				
Core Technology	Communication	Presentation & Representation	Language	Storage & Retrieval	
	WAP, PKI	XHTML, XML	ASP, JSP, JavaBeans, EJB, ColdFusion	JDBC, SQLJ	

It is quite clear that motivation to integrate complex process online has also meant the need to integrate the four areas of core technology. Prior to 1990, the four areas develop largely independently. Since then, language and storage have worked together (e.g. Java with JDBC); communication, information representation and language are featured together in SOAP (Simple Object Access Protocol). The merging of the four areas is likely to continue.

5. CONCLUSION

In this paper, we have charted the evolutionary of e-commerce websites. We propose that there have been four eras. We first characterize the elements of e-commerce websites using a syntactic representation. With respect to the four eras, we then examine collectively the historical development of the principal elements – host, core functions, and core technology. Observations and insights on their interplay are provided.

The pace of e-commerce evolution has been phenomenal. During the decade of 1990, e-commerce website has evolved from a simple browsable site of static information to that of cross-website integration of dynamic business processes. It has realized connectivity,

interactivity, interoperability, and integrability. Along the way, the problems of protocol standardization, tracking, security, and data interfacing have to be solved. Websites can now conduct both commerce activities and business processes.

The ease of strategic alliances would mean that there would likely be a period of consolidation. It has also been suggested that exchange websites will consolidate into a relatively small set of mega-exchanges, and that a handful of independent but reputable solution providers will grow alongside such mega-exchanges [8]. Trust, especially between businesses, will remain a prevailing issue to be addressed in the new digital economy.

The four areas of core technology, as we define them, will likely to be integrated in the near future – that is, they will be tightly coupled. On the other hand, online decision support system is still at its infancy. We believe that online DSS is likely to play a significant role in the next phase of e-evolution. Particularly, DSS is key to the provision of online knowledge management and sharing, a critical e-business process of the future. As companies leverage the knowledge-rich Web to conduct effective e-business processes, websites with knowledge management capability will proliferate. Companies and industries will need to re-engineer their internal and external processes to tap into this powerful resource.

REFERENCES

1. Y. Bakos "The emerging role of electronic marketplaces on the Internet," *Commun. ACM* 41, 8 (1998), 35 - 42.
2. P. Fraternali "Tools and approaches for developing data-intensive Web applications: a survey," *ACM Computing Survey*, 31, 3 (1999), 227 - 263.
3. S. Kaplan & M. Sawhney "E-Hubs: The New B2B Marketplaces," *Harvard Business Review*, May-June 2000, 97 - 103.
4. L.C. Leung, W. Cheung, and Y.V. Hui "A Framework for a Logistics E-Commerce Community Network: The Hong Kong Air Cargo Industry", *IEEE Transactions on System, Man, and Cybernetics*, Vol. 30, No. 4, 2000, 446-455.

5. R. M. O'Keefe and T. McEachern "Web-based customer decision support systems," *Commun. ACM* 41, 3 (1998), 71 - 78.
6. S.S.Y. Shim, V.S. Pendyala, M. Sundaram, and J. Z. Gao "Business-to-Business E-Commerce Frameworks," *IEEE Computer*, October 2000, 40-47.
7. V. C. Storey, D. W. Straub, K. A. Stewart and R. J. Welke "A conceptual investigation of the e-commerce industry," *Commun. ACM* 43, 7 (2000), 117 - 123.
8. R. Wise & D. Morrison "Beyond the Exchange: The Future of B2B," *Harvard Business Review*, November-December 2000, 86 - 96.
9. J. Yang and M. P. Papazoglou "Interoperation support for electronic business," *Commun. ACM* 43, 6 (2000), 39 - 47.