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CURRENT TECHNOLOGICAL IMPEDIMENTS TO BUSINESS-TO-CONSUMER ELECTRONIC COMMERCE

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ELECTRONIC COMMERCE

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ABSTRACT

Internet and World Wide Web technologies provide the infrastructure for the Electronic Commerce (e-Commerce) revolution now taking place. As a result of these technologies, even the smallest organization can afford to market its wares to hundreds of millions of potential e-Consumers. However, these technologies also pose threats to the very electronic commerce which they enable.

For managers to strategize and implement e-Commerce effectively in their organizations, these impediments need to be recognized and understood. While hundreds of articles identify problems with Internet computing or conducting e-Commerce, no unified framework of technological impediments specific to e-Commerce yet exists.

The goal of this paper is to identify the primary technological impediments to e-Commerce. Six categories of technological impediments have been identified. Those which appear to pose the greatest threats to the development of e-Commerce are: (1) download delays, (2) limitations in the interface, (3) search problems, (4) inadequate measurement of Web application success, (5) security (real and perceived) weaknesses, and (6) a lack of Internet standards. Associated costs, threats, and limitations specific to e-Commerce are also identified and implications explored. The paper concludes with an assessment of ways to mitigate these obstacles, including design choices, workarounds, and emerging technological solutions.

A bibliography of 296 relevant trade press articles is included following the references.

Keywords: Electronic commerce, e-commerce problems, impediments to e-commerce, e-commerce technology, Internet, retail, strategy, World Wide Web

I. INTRODUCTION

Recent technological advances of the Internet and the World Wide Web (WWW) opened up a new digital world of commercial opportunities. Unlike prior incarnations of Electronic Commerce (e-Commerce) such as Electronic Data Interchange (EDI), business-to-consumer (B2C) Web-based e-Commerce brings organizations in touch with an enormous number of potential e-Consumers at the individual, retail level. Inexpensive access and the graphical and intuitive nature of Web technology provide opportunities for organizations to expand how they conduct business across their customer base. Unfortunately, opportunities are often offset by costs, threats, and limitations engendered by these same technologies.

Aspects of Internet and Web technologies that impact electronic commerce negatively, potentially impede the use of e-Commerce in organizations. Unless these impediments are identified and potential impacts known, managers cannot make appropriate choices in allocation of resources as they pursue new e-Commerce strategies. Existing studies and reports on Internet computing deal with only a single threat or a limited number of technological threats.

While hundreds of articles identify problems with Internet computing or with conducting e-Commerce, no unified view of technological impediments to Business to Consumer (B2C) e-Commerce yet exists. The goal of this paper is to identify the technological impediments and their associated costs, threats, and limitations specific to B2C e-Commerce Another goal is to present these impediments in a framework that will help managers and researchers see their relative importance together with the design choices, workarounds, and emerging technologies that will mitigate some of their deleterious effects.

It is important to note here at the beginning of this paper that technical limits are not the only obstacles to e-Commerce development. Social, legal, regulatory, and business hurdles also affect the adoption of e-Commerce. Among these hurdles are:

- Organizational fear of doing business over the Internet (Borenstein, 1998)
- Lack of firm experience in doing e-business (Stahl, 1997)
- Management/cultural problems in instituting e-business practices and ideas (Graves, 1998; Vizard, 1998)
- Migrating to electronic retailing from more familiar EDI (business to business) (DeCovny, 1998)
- Lack of significant penetration of the total market for specific products by companies
- Privacy concerns (Kovacich, 1998; Monahan, 1998)
- Fear of consumers in buying or transacting business over the Web (Muhammad, 1997)
- Lack of well accepted or understood e-cash (ter Maat, 1997)
- Ambiguous or hostile legal or regulatory environment for e-Commerce (Aalberts, et al., 1998; Adam, et al., 1997)

Clearly, many of these considerations are as crucial as the technological limitations discussed below. Nevertheless, serious technical issues remain. Before discussing the key technical barriers to progress, we need to define e-Commerce for the purposes of this study. This working definition indicates the underlying assumptions of our study. E-Commerce is an environment that facilitates business and organizational transactions over networks. Based on the TCP/IP protocol, the Internet, the World Wide Web (WWW), and international networks are increasingly being used for traditional, labor-intensive business processes. Termed electronic commerce, this computerizing of organization-to-organization, unit-to-unit, organization-to-consumer, and person-to-person transactions runs the gamut from requests for information, through ordering, shipment, and payment, to the delivery of "digital products" such as information services, insurance policies, electronic cash, (digitally) published documents, and software. While Electronic Data Interchange (EDI), Intranets, Extranets, and Web-sites are all encompassed by the term "e-Commerce," the focus of the current study is on Web-enabled retail businesses, that is, B2C (business-to-consumer) transactions where a consumer seeks goods and services over a network.

A review of trade press articles from 1994-1999[1] found six commonly recognized categories of technological impediments and limitations to Internet computing (Table 1) which appear to pose the greatest threats (or at least constraints) on the development of B2C e-Commerce. Each of the impediments listed in Table 1 are discussed in detail in Section II of this paper.

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[1] The original review of trade articles began in 1998 and included 206 found on ABI Inform with Keywords of "Web Page" and "Problems" or "Electronic Commerce" and "Problems" dating from January 1994-November 1997. Additional articles were reviewed subsequent to the original 206 based on comments during review of the paper. Articles that appeared in the press following the original review were added as they appeared as well. These additional articles reinforced the original six categories. The original 206 articles are included among the 296 listed in the bibliography following the references.

Table 1. Technological Impediments and Limitations

1. Download delays
2. Limitations of the interface
3. Search problems
4. Inadequate measurement of Web application success
5. Security (or perceived security) weaknesses
6. Lack of Internet standards

Management of these impediments and limitations is a large and complex challenge. Creating a strategy for managing impediments in general requires a classic cost/benefit analysis. However, estimating the costs and benefits are made difficult in an environment which is uniquely beyond the control, or even estimation, of the retailer.

B2C e-Commerce operates in a highly specialized medium. In this medium, disparate e-Consumer technologies are largely beyond the control of the e-Retailer. For example, in a given target population, client-side bandwidth (impacting impediment #1 and #2), e-Consumer search engine effectiveness (impacting impediment #3), and client-side software (impacting impediments #4, 5, and 6) are diverse, often unknowable, and essentially difficult or impossible for e-Retailers to change. As such, the Internet is a different technology from almost any which preceded it[2].

In the historical introduction of many technologies, the vendor supplied the equipment. Thus,

- for the telephone, AT&T supplied the phone and brought the connection to the home
- for the movies, consumers went to a central facility to see the film
- the electric and gas company bring their wire and piping to the home
- the cable companies bring fiber optics into the home

[2] We are indebted to Paul Gray, Claremont Graduate University for the details of this concept.

- for retail purchases, the purchaser goes to the department store or the grocery.

In each of these cases, companies provided the technology. In the second half of the 20th century, individuals began to own their own technology such as stand-alone TVs and VCRs. In these cases, there were few choices and vendors could offer only one or two (such as Beta and VHS) formats. Even in the case of PCs, there were relatively few formats, being dominated as they were by Intel and Apple.

Unlike the past, however, B2C e-Commerce technologies vary widely on the consumer end, are often beyond the control of the e-Retailer and are hard to predict or even to identify. Specifically, each person on the Internet is using different hardware/software configurations and e-Retailers are not privy to the specifics of those configurations. Management within this technological environment is significantly more difficult.

To develop a cost effective B2C e-Commerce strategy for overcoming technological impediments, the e-Retailer is faced with a need to *assume* the level of technology being used. And since vendor tactical choices depend on the equipment and skill sets the user possesses, e-Merchants make decisions as to how to market their goods based on their estimates of how many consumers they can reach with a given level of technical capability.

Strategic management of these impediments is required. To manage them, they must first be understood as must the conditions that create them. It appears that the evolution of Internet computing created many of these impediments, and these historical events left a legacy of technological barriers to B2C e-Commerce.

TECHNOLOGICAL INFRASTRUCTURE OF THE INTERNET FOR B2C E-COMMERCE

The technologies of the Internet and WWW help enable B2C e-Commerce. At its core, the Internet is a client/server network on a very large scale. Computers which request data or processing time for end users are known as clients. Computers that store data, respond to queries, transmit files and run applications are known as servers. An infrastructure of both cabled and wireless communication connects clients to servers. This infrastructure consists of specialized computers and software that are used to route messages from clients to servers and servers to clients. This architecture is illustrated in Figure 1.

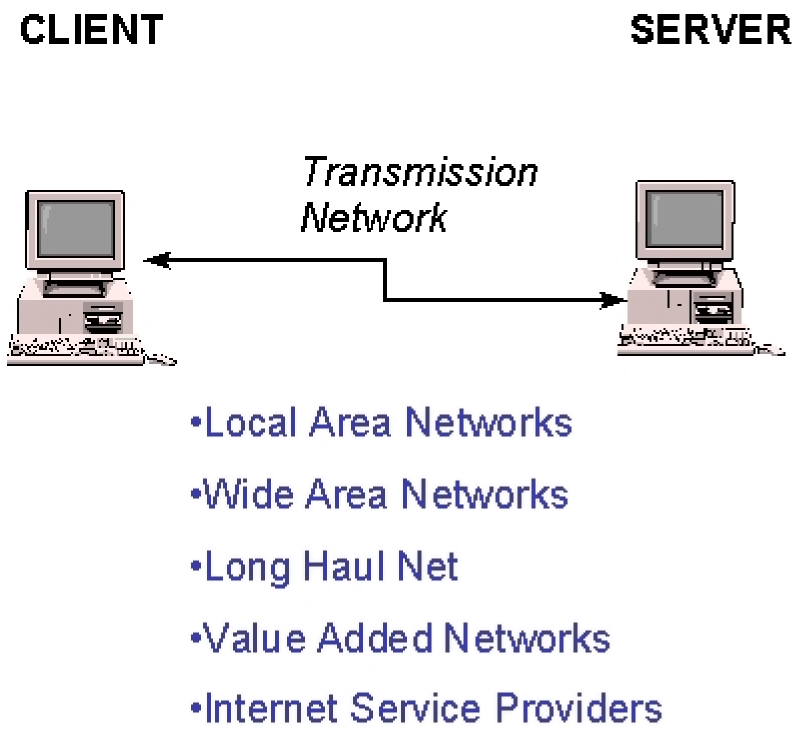

Figure 1. Basic Client/Server Architecture

The Internet is a collection of client/server computers and infrastructure that spans the earth. Millions of computers are indirectly connected to one another by routings over the Internet. In many cases (depending on the contract with the ISP), nearly unlimited numbers of files can be transmitted and received across the world for nothing more than the cost of connecting to the Internet.

This statement does not imply that the marginal costs for sending large numbers of data packets across the Internet is zero. These costs are hidden to those who purchase unlimited access to the Internet for a fixed monthly fee. One significant cost is in the infrastructure. These costs are paid by organizations in the telecom industry, ISPs, organizations who own Internet servers, and by the federal government. Excessive Internet traffic puts a burden on the infrastructure that drives up the costs for maintaining the global network. Other costs come in the form of lost productivity of packet recipients. Eventually, these costs will need to be recouped through such means as higher monthly connection fees, higher Web advertising costs, higher retail prices, higher taxes, or reduced services. Those who put an excessive burden on the Internet eventually pay for their actions.

The WWW is a specialized application of the Internet. Specifically, it is the use of Web client and Web server applications. The most notable distinguishing characteristic of World Wide Web clients and servers is in the information being shared among them. The Internet acts as a network infrastructure for many types of computing beside the World Wide Web (just as B2C e-Commerce can also take place without the Web). But the key to World Wide Web client/server architecture that makes it so germane to B2C e-Commerce is its use of hyperdocuments—the ubiquitous Web pages with text, colors, graphics, sounds, video and links to other pages.

Web clients and Internet connections are now commonplace. As a result, a global client-server network of Web-ready computers provides the mechanism for low cost communication between a Web retailer and millions of e-Consumers. While the infrastructure enables commerce, this same infrastructure also contains technological limitations and obstacles to growth and further development.

First, the Internet was originally developed for non-multimedia computing, and created by and for the US government and academic communities. It was specifically not for commercial use or for corporations (e.g., Forta et al, 1998). It was not until 1991 that the National Science Foundation lifted the restriction on commercial Internet use (Anonymous, 1999d). Prior to 1994, without commerce as an end goal, technological advances in both the Internet and Web technologies were not commerce-centric or commerce-sensitive. Moreover, the invention of Mosaic browsers in 1993 (Anonymous, 1999d) led to the Internet becoming Web-enabled. Before that time, the Internet was focused on non-multimedia computing. Multimedia Web technologies (those upon which B2C e-Commerce relies almost exclusively today) were all developed since then. Thus, B2C e-Commerce on the Internet really became part of the mainstream psyche in 1994 (Kobielus, 1994) is one of the earliest appearances in the trade press). Many technological deficiencies are likely the result of developing academically focused technologies and applications at the future expense of B2C e-Commerce. Furthermore, without the needs of B2C e-Commerce to drive development, there was no demand for vital related technologies such as cash transaction security.

Second, much of the software of the Internet was not developed for profit. Earlier users of the Internet created new technologies for use in a small, cooperative environment. This environment was replaced one which had to please many more people and where competition supplanted cooperation. As a result, the dynamics of how improvements are developed and introduced to the Internet changed.

Additional causes of technological impediments to B2C e-Commerce are likely. However, these two circumstances appear to be significant and have lasting impact.

II. TECHNOLOGICAL IMPEDIMENTS TO ELECTRONIC COMMERCE

DOWNLOAD DELAYS

Impacts of Download Delays on Internet Application Development and Use

Download time is the amount of time it takes for a Web client machine to receive and display a data file submitted by a Web server after that file was requested by the client. Download delays impede the development and use of Internet applications such as multimedia for B2C commerce. For example, technology exists to show a television ad on a Web page. However, the amount of wait time required before such an ad is downloaded and shown is prohibitive (Levine, 1996), and therefore is not often used. Download delays are responsible for the virtual absence of television-style 30-second audio and video advertising over the Web.

For the most part, practical limits of multimedia use are established by what users think is acceptable download time. Under normal computing conditions, end-users find it objectionable to wait more than a few seconds between computer processing cycles (such as the amount of time it takes to load a Web page upon requesting it). Waiting more than half a minute is considered intolerable (Shneiderman, 1998). As a result, there are limits to the use of multimedia communication which require long download times.

Download time is primarily a function of :

1. the size of the data files being transmitted; and
2. the technological configuration of nodes, the network infrastructure, and the bandwidth connection between nodes and infrastructure.

Compared to simple HTML pages (typically 1-10 Kb in size), many existing Internet multimedia technologies require relatively large data files to be transmitted and displayed. Examples of these types of media include:

1. video or pictures (which vary in size between 10 Kb and several Mb), especially those in color and especially those with a wide color spectrum,
2. video or picture files with a large display area,
3. sound files, and
4. files which contain applications or applets.

In addition, traditional desktop application data files, such as MSWord or MSExcel files are often shared in Internet client/server computing and can often be larger than 1 Mb in size. As a result, many of these types of communications become impractical on the Web, depending, of course, on the technological configuration. Furthermore, when considering the combination of multiple data files for use in one hyperdocument, compromises between optimal communication and reasonable download time need to be considered (Heath, 1997; Oberndorf, 1997).

Download time differences can be significant for even small file sizes. Table 2 shows test of delay data obtained for loading a 10.5 Kb file and a 6.3Mb file.

Table 2. Download Time at Different Communication Speeds

Communication Speed	**10.5 Kb File** (Source: Netmechanic 1998)	**6.3 Mb File** (Source: Ozer 1999)
14.4 Kbps	7.83 seconds	
56Kb	3.84 seconds	23 minutes, 13 seconds
ISDN line (128 Kbps)	2.66 seconds	16 minutes, 17 seconds
T1 (1.5Mbps)	2.06 seconds	
Cable(1.5 Mbps)		1 minute, 34 seconds
ASDL (1.5 Mbps)		45 seconds

Clearly, a delay over 23 minutes at 56 Kbps would be considered excessive by most people. Interface design requiring files of this size have to be carried out with this delay in mind.

Technological Conditions Which Increase Download Time[3]

As stated above, many multimedia technologies require prohibitively long download times depending on the node or infrastructural technologies in used to request, transmit, and display the files. A file that would be considered quite large under one set of conditions could be considered completely practical (i.e., sufficiently small) in another. Therefore, file size in and of itself is not an impediment to Internet computing. However, the technological conditions that increase download time are impediments. Delays in download time can occur at the server side, in transmission, or at the client side. Potential for bottlenecks in each of these areas are shown in Figure 2.

Server Side Download Time

Assuming that a request for hypermedia was sent via a URL to its appropriate server, the technological configuration of that server can increase download time in three ways.

1. in the connection between the server and the Internet.

   A server can be set up as either dedicated or non-dedicated and with a low or high throughput connection. If a server is not available to receive Internet requests at all times (i.e., it is a non-dedicated connection), responses from the server will clearly be delayed until the server can be accessed.

   If a server has a narrow bandwidth connection (such as a 56 K modem connected to a phone line), it can serve only a few client requests at a time and will have a difficult time transmitting very quickly even one request for files larger than a few kilobytes. Therefore, a server with a non-dedicated connection at 56 K will exhibit extremely high download times. By contrast, a dedicated T1 connection at 1.5 Mbps can theoretically transmit over fifty times more data than a dedicated 56 K modem and has the capacity to handle many requests for files many Mb in size.

2. In the processing capacity of the server itself.

   Even if the Internet connection can transfer 1.5 Mbps, sufficient numbers of requests, each only 1 Kb, can overwhelm the processing capacity of a server. Although a relatively small amount of bandwidth capacity would be used in this condition, the server would be unable to respond to any more requests and download time would be increased for all subsequent requests. Therefore, depending on the volume of individual requests, a higher capacity server or even multiple, parallel servers may be needed to meet demand.

[3] Except where otherwise noted, further and corroborating information in this section regarding download time and Internet technology can be found in (Kalakota, 1997)

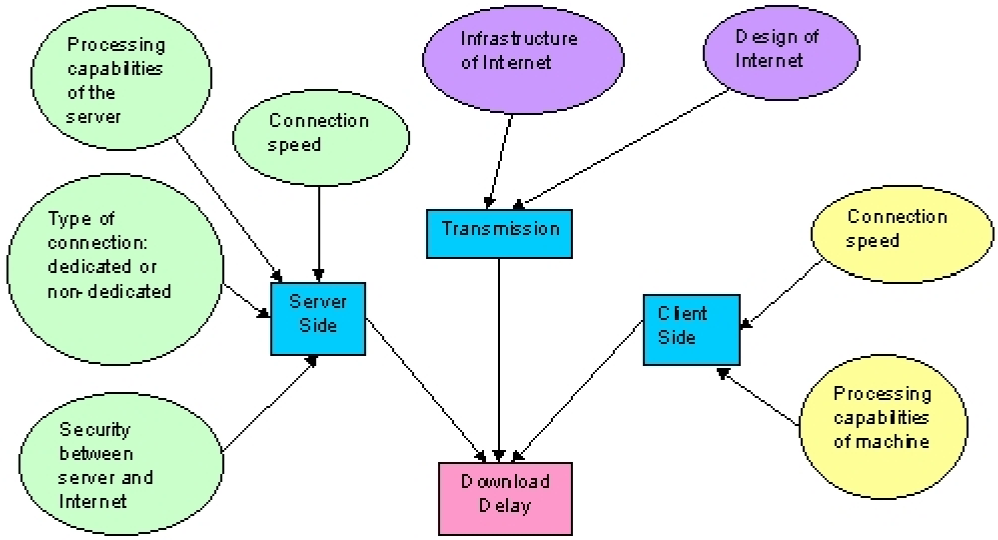

Figure 2. Sources of Download Delay

3. in the security system between the Internet gateway and the server that is processing requests and retrieving files.

This delay is by design. Security software and hardware can be set up as a firewall between a server and the outside world to restrict access to those clients or file transfers deemed acceptable. The very nature of this security process is to have the computer check requests, user domains, passwords and so forth. As a result, processing time is required to check these users and files against a specified list of acceptable users, nodes, or processes. As the number of requests increases, the amount of processing time also increases both for processing a user (to confirm their requests are acceptable and to provide the data requested) and for processing all subsequent users.

Any one of these three technical points related to servers has the potential to be a data transmission bottleneck and, therefore, a contributor to increased download time.

Transmission Download Time

The network infrastructure lies between the client and the server and carries the communication between them. Transmission delays, or limitations with regard to this infrastructural element, increase the download time of an Internet communication.

Some evidence is available about the limitations in the infrastructure of the Internet itself. Average download times for a sample 40 corporate sites were found to vary drastically between certain cities and certain weeks of the year (Anonymous, 1998c). Much of this variation is caused by infrastructure delays. Forecasts of Internet congestion can be monitored at sites such as InternetWeather (InternetWeather, 1999).

The public tends to assume that technological systems are perfect when they are not. The Internet infrastructure is generally considered to be robust and reliable—and it is expected to improve as router technology improves (Guy, 1997). However, shutdowns do occur, albeit rarely. Much as an occasional power or telephone disruption, regional sections of the infrastructure have shut down (Wagner, 1997; Wagner and Gaudin, 1997). In one case, the entire state of Minnesota went down (Reinbach, 1997).

Slow transmission across the Internet may be a product of its design. Especially when dealing with large files, the very nature of the Internet can lead to communication difficulties. By design, the Internet and TCP/IP breaks up large data into small packets. Individual packets do occasionally get delayed (and, less frequently, lost (Sprout, 1996)). Naturally, the larger the file, the greater the number of packets. A consequence of having many packets is that the larger the file, the greater the chance of having one piece of the total file delayed or lost in transmission. This limitation in the infrastructure for handling very large data transmissions in fact, inspired the creation of Internet 2. Internet2 (see sidebar for details) is a project to develop a parallel Internet which would allow for high speed transmission of extremely large data files (Dixon, 1998). Examples of data files of this size would be corporate databases, virtual reality video, video conferencing, and television-style broadcasts or movies. Internet 2 is being projected as a pay-as-you-use system for business (Meredith, 1998). This approach differs from the Internet where no charge is levied for transmission of data packets between destinations within the US.

Currently, the only charges for e-Retailers and e-Consumers are for transmitting the message to and from the Internet itself. Paying for Internet

INTERNET2

- Internet2 was initiated in 1996 by 34 US research universities. Today, it has over 140 member universities working closely with corporate and affiliate members. It should be in use by the end of 1999 (Abernathy, 1999).

- The University Corporation for Advanced Internet Development (UCAID) was established in September 1997 as the organizational home for Internet2. Abilene project was undertaken by UCAID and its partner in April 1998 to support and develop advanced applications, in particular Internet2.

- Internet2 was created to meet three general objectives. (1)to create and maintain a leading edge network capability to further US leadership in higher education and research. (2)to exploit broadband network capabilities to enable new generation of Internet applications. (3)to transfer the technology developed to all levels of educational use and to the global Internet.

- To fund Internet2, member universities will commit $70 million a year to upgrade campus network, develop advanced applications, and connect to regional gigaPoP (which is the regional network aggregation points that are formed by Internet2). GigaPoP allows universities and affiliate members to connect to high performance networks. Funding is also being provided by corporate members. Total corporate pledges exceed $30 million over the course of the project. The purpose of having corporate members is to help diffuse advanced networking capabilities to industry.

- Some of the new technologies being developed and tested are Ipv6 and multicasting. This technology is hoped to enable a new generation of Internet applications. Another initiative is Internet2-Digital Video is a video network service for higher education. This network will allow application to be delivered live to institutions and also provide search capabilities for video libraries. The main goal is to have high-speed video, voice and data transmission, virtual laboratories, digital libraries and teleconferencing in the future.

- As proposed, Internet2 will run parallel to the general Internet without commercial applications and it initially will be used entirely to support higher education (Kornblum, 1997).

Unless noted otherwise, the source of information for the sidebar came from (Anonymous, 1999f). *See www.internet2.edu for more details.*

transmission will change the nature of Internet client/server computing but will allow for dependable and fast large file transfer.

Client Side Download Time

The client side of Internet computing suffers from the same two basic limitations as the server side: the connection and the processor. With regard to the connection, client machines in a typical residential computing environment in the United States consists of a 14.4 Kbps - 56.6 Kbps modem connection via the telephone. As a result, even if data is transferred out of the server through a T3 line (45 Mbps) and across the Internet at a brisk pace, these data cannot be accepted by the client machine any faster than what the modem being used allows. Consequently, client side connection bandwidth is often seen as the biggest source of download time in Internet computing.

In addition to bandwidth, plain old telephone service (POTS) is generally acknowledged to provide unreliable connection (Snyder, 1997). Problems can include busy and no answer signals, as well as failure with modem connections once the call goes through. Connection problems can also be an issue when the client has a dedicated line. Anecdotal evidence indicates that cable services are disrupted semi-regularly.

In spite of these limitations and the availability of such higher speed connection alternatives as cable modems, dial-up modem computing is the norm in North American households at present. Average residential users are extremely price sensitive. Dial-up access has fairly inexpensive monthly costs with no startup costs beyond the modem in the US. Costs are low because existing phone lines can be used at no additional charge and modems are very inexpensive (US$25 - US$100). In contrast, high-speed alternatives can cost several hundreds of dollars more initially, and ten to forty dollars more each month, than dial-up computing (Ozer, 1999; Freed and Derfler, 1999a; Freed and Derfler, 1999b; Freed and Derfler, 1999c).

Even if high-speed alternatives were the same cost as slower dial-up connections, these alternatives will not be universally available in the near term

(McChesney, 1999). In 1999, cable modems were available to only 20% of the US. Likewise, DSL connections were available to less than 8%. Further, only 60% of the US is projected to have either available by 2004. Therefore, 40% of US households will not have these broadband alternatives available to them at any cost. While in theory satellite connection is available to the remaining users, this service is currently available only to those with clear southern exposure and is seen as a lesser alternative even where available. Satellite is currently recognized to have more limited capabilities and drastically slower data transfer speeds than DSL or cable (Freed and Derfler, 1999b).

Regardless of price, however, the demand for high-speed access is not universal. A survey of users who are currently on-line found that fewer than half are very interested in having a high-speed connection (Anonymous, 1998). In addition, e-Consumers may be wary of using dedicated Internet connection for security reasons. Unlike dial-up connections, dedicated connections assign permanent Internet addresses to client machines. As a result, clients with dedicated lines are significantly more vulnerable to computer hackers (McClure and Scambray, 1999). Appropriate firewall software costs approximately $500 and cannot guarantee freedom from attack.

Whatever the reason, broadband penetration in the U.S. is not expected to be universal anytime soon. In 1999, fewer than 4% of households with access to cable modems and 1% of those with access to DSL used those services (Greene, 1999). Furthermore, only 20% of Internet users in the US are predicted to adopt a broadband connection by 2002 (Daniell, et al., 1998; Weaver, 1999). As a result, slow connection speeds for client-side computing at the residential level will very likely persist in the near term and beyond.

In addition to slow connection speed client side processing , limitations can increase download time. Older and slower machines do not have the processing capabilities or memory capacities to interpret and display large graphical or application files rapidly. Furthermore, under-configured machines may find it particularly difficult to open hyperdocuments while multiple browsers or other desktop applications are running. Clearly, the slower the computer processor, the lower the memory capacity, and the larger the number of concurrent applications being run, the longer the download time.

Apparent Threats to Electronic Commerce

Threats with regard to download time are most apparent on the client side in B2C e-Commerce. Server side download time limitations are completely within the control of the party that owns the server. With enough money and prudent server administration, there is no reason why the server side would have to be a bottleneck in B2C e-Commerce. Impediments to improved server delay are basically economic. A firm can make decisions on how to overcome these delays at a known cost. The decision, if made rationally, is affected by the estimate of the increase in business that faster response time would bring.

It is also unlikely that the Internet infrastructure will be the primary bottleneck in B2C e-Commerce in the near future. Improved routers and the forthcoming Internet2 may eliminate much infrastructure delay. Even with the traditional Internet, it is unlikely that a typical B2C e-Commerce application will have its primary download time difficulties occur within the Internet infrastructure itself. However, some predict that if broadband computing leads to larger files being transferred, the Internet infrastructure will become the source of significant download time (Pollack, 1999). But until broadband is universally adopted, the bottleneck should occur primarily at the client end.

Unfortunately, there is no way for a retailer to control the hardware configuration being used at the client side, short of buying equipment and connection bandwidth for customers. Since customers will vary in processing and bandwidth capabilities, it is difficult for retailers to accommodate every user effectively. For example, one test of high-speed connections across the US showed that cable, DSL and satellite connections were 4 to 30 times faster than 56K modems (Freed and Derfler, 1999d) downloading the same files. Moreover, telecommunications infrastructures and computer technologies are less robust outside the United States, especially in the developing world (Odedra, et al., 1993). If a retailer is trying to reach e-Consumers across global markets, the differences in download time may be even larger.

Data published in 1999 shows that over 83 million people in the US can access the Internet either at home or at work (Anonymous, 1999e) and approximately 42% engage in e-Commerce (Harrison, 1999). Currently, Web user connection speeds are disparate. One survey of Web users in 1998 found a wide distribution across a sample of 7670 people (Table 3). Subjects were asked about their primary connection to the Internet. Because the survey did not discriminate between home or work connections (where employers may restrict Internet use to business activities), the data may not be representative of e-Consumer connections in B2C e-Commerce. Presumably, actual connections would be slower for home B2C connections than for work connections.

Table 3. Distribution of Connection Speeds

Connection speed	**Number at that speed**	**Percent**	**Cumulative Percent**
Under 14k	15	.2	.2
14k	309	4.0	4.2
28k	1773	23.1	27.3
33k	1926	25.1	52.5
56k	1402	18.3	70.7
128k	316	4.1	74.9
1m	857	11.2	86.0
10m	204	2.7	88.7
4m	155	2.0	90.7
Over 45m	66	.9	91.6
Unsure	647	8.4	100.0
Total	7670	100.0	

Source: Anonymous, 1998b

As a result of disparities in download times among customers, retailers need to be careful in devising their B2C e-Commerce strategy. Hypermedia development needs to have the right balance of content and file size to communicate effectively to all e-Consumers without excessive delay. In addition, user-selectable versions of the same messages should be created to accommodate different capacities (Buschke, 1997). For example, some users may choose to reduce their own download time by selecting a text-only version of the hyperdocument transmission.

Currently, few retailers appear to be utilizing this option. A recent study across a wide array of Web sites for well-known retailers found only 2 in 50 were offering a low-bandwidth version of their pages (Needle, 1999). However, some companies adopted this dual strategy. 3M Graphics (3M, 1999a) provides an example of a page which clearly states that it is developed for users with high-speed connections. An alternative text-only link is also provided with an offer to have a physical brochure mailed (3M, 1999b).

TECHNOLOGICAL LIMITATIONS OF THE INTERFACE

Limitations of General Internet Computing

Even if practical limitations could be eliminated by improved download time, there are physical limits to Internet interface technology. While Web GUIs are generally seen as attractive and easy to use, they do fall short when compared to alternative communication media. The Web browser is one of the richest electronic interfaces ever developed. It allows for full-spectrum color images, video, and stereophonic sound. However, it has serious physical limitations.

One obvious problem with all electronic communication media is that an e-Consumer can not touch and feel a product over the Web. Marketing literature indicates that lack of touch is a problem with direct marketing of all sorts, electronic or otherwise (Rieck, 1998). Electronic communication also lacks a mechanism to transmit smell or taste. Both of these senses have been shown empirically to directly impact consumer buying behavior (Johnson, et al., 1985; Miller, 1991; Wilkie, 1995).

Another limitation of the interface is in three-dimensional imaging. Personal computer displays are not yet available commercially for holographic images, although there are prototype holographic display terminals in research universities (Negroponte, 1996). Technologies which simulate three dimensions on a two-dimensional monitor exist (see Tegarden (1999) for a summary on methods for simulating three dimensions in 2D). These technologies are not truly three-dimensional and are not yet commonly used in e-Commerce (Peek, 1997). Until electronic communication can replicate the five senses and produce three dimensional displays it will not be a one-for-one replacement for face-to-face communication or traditional commerce.

Apparent Threats to Electronic Commerce

Interface limitations to Internet computing pose special threats to B2C e-Commerce applications. In non-commercial applications, two interested partners are trying to share data. Toleration for problems in the interface should, therefore, be much greater than in a typical consumer/vendor relationship.

A B2C e-Commerce outlet cannot hope to compete against vendors in the physical world if a buyer requires a fully sensory experience in order to buy. Without a three-dimensional view, many products cannot be evaluated. Without the ability to hold an object, many products lack the ability to create an impulse purchase (Canedy, 1998). Under these circumstances, technological impediments are much more incapacitating for those attempting to conduct business over the Internet than for those using the Internet for non-commercial applications such as internal communication.

With regard to competition between e-Competitors, practical limitations in the interface create other difficulties. Since a vendor cannot hope to include a complete multimedia message within the limits of tolerable download time, some of the preferred message must be eliminated. Otherwise, the preferred message will send an additional, unintended message of delay and aggravation.

In an on-line retail application, this interface problem could create a bias against one company versus a competitor or simply send an unintended message to that customer. In either case, there is a potential for confusion in the message sent. Where confusion in a non-commercial application might lead to a follow-up question via an email, confusion in a B2C e-Commerce application could lead to purchase of a competitor's goods and services. As a result, finding the appropriate balance between media rich hyperdocuments and tolerable download times appear to be more difficult and important for those engaged in B2C e-Commerce.

SEARCH PROBLEMS

Creation of content and ability to transmit that content are not in and of themselves enough to communicate a message. Assuming limitations to hyperdocument content development and delivery can be overcome, communication will not occur without e-Consumers finding those documents. Current technological limits in Internet technology hinder requests for hypermedia.

Hypermedia are requested by Web clients through the use of URLs. URLs are typically invoked three ways:

1. by manually typing in the URL;
2. by recalling a URL from a list of bookmarks stored on the client machine; and
3. via a hyperlink embedded in another hyperdocument.

Hyperlinks are either hard coded into a hyperdocument or are generated dynamically from user input. Search engines such as Yahoo and Alta Vista are examples of user input creating a dynamic page of hyperlinks.

Bookmarks and manually typed addresses require that a user previously visited a page or recalled a Web address. Limitations affecting how people can hear about a Web address are mostly not technological. Word of mouth or promotional strategies create an awareness of URLs. Hyperlinking to invoke URLs, however, is often a product of existing technologies. As a result, limitations in these technologies can lead to a restricted ability to find appropriate URLs.

There are technological difficulties in finding URLs both with regard to hard coded hyperlinks and with dynamically created hyperlinks. When a URL is hard coded into a Web page, there are technological problems dealing with the persistence or existence of these links. Since the hyperlinks are static and written in HTML code, they can become outdated (click on the "Back" icon in

(Buckeye Marketing, 1999) for an example). As Web pages move, are replaced or deleted, the hard coded URLs can point to incorrect or non-existing content. This problem is chronic across banking Web sites (Hoffman, 1996). While technology such as client-pull (Greene, 1998) exists for forwarding browsers to new links from the original addresses, implementation of this strategy may become impractical for all but a few links such as those found on home pages.

Technology for finding outdated links across the Internet is not currently available. Thousands upon thousands of Web pages pointing to obsolete addresses reside currently on servers around the world. In addition, even if all of these outdated links could be found, they could not be updated by any single individual or organization. Servers where a user does not have security access would not allow outsiders to update resident HTML files.

Because technological security measures can themselves impede the maintenance necessary for maintaining accurate URL links, the ability of content providers to have their messages found is impacted by current Internet technologies. Even without such security and managerial limitations, however, the problem would still exist. Under the best of current conditions, with dynamic link creation and search engines, the task of updating Web links is untenable. Automated search engine robots with the power to scan the entire Internet, even those with security clearance, chronically suffer from inaccurate link data (Ward, 1998).

With search engines such as Alta Vista, dynamic links are created from databases of Web page locations. Large search engine databases are updated on a regular basis by search agent "know-bots," programs designed to find and report on the contents of Web pages. Intelligent search agents scour the Internet discovering Web pages and collecting content and corresponding URLs. Data about page content and address are stored in large databases. When a search is requested, the address in the database is used to create a hyperlink on a dynamic page.

By using search agents, existing pages can be reconfirmed periodically and data about those pages can be updated. As a result, a dynamically created page of hyperlinks will be typically more accurate than a static page of links. While this solution overcomes many of the limitations created by static Web pages, it is not without its own limitations. Over twelve million host computers were registered on the Internet in 1996 (Forta, et al., 1998). As a result, hundreds of millions of pages were likely to exist at that time. But even 1999 computing technology would find it impossible to collect and maintain a perfect database of Web page addresses and content for such a huge population.

Unfortunately, even if a perfect database could be created and maintained, the sheer number of pages make it difficult for client-side users to find appropriate pages. Search engine queries are not yet sophisticated enough to be effective (Gibson, 1997).

Current search queries are based on keyword searches. Keyword queries consist of a user entering a list of key words. The search engine uses this query in its database to search for pages containing those words. Often these searches result in hundreds of thousands of matching pages—far too many to be useful in finding specific information sought. Worse still, unknown thousands of other pages which could be applicable to the user are missed because they do not contain the particular keywords chosen by the users, but only synonyms of the keywords requested. In short, current search engine technology provides both too much and too little information. While it does aid in helping users find specific hypermedia, it is still severely limited.

One way to avoid difficulty with search engines is to acquire an intuitive URL. Web pages such as www.microsoft.com make it easy to find Microsoft without a search engine. Pages with less intuitive URLs are presumably at a disadvantage (Needle, 1999). Further difficulty comes from organizations which own URLs which would seem to be logical addresses for another organization such as www.delta.com. That Web page belongs to deltaComm Development, not Delta Airlines, as apparently 15,000 people per day believe. e-Consumer confusion is evident in the delta.com home page which states (Anonymous, 1999c,):

> We apologize for the lack of pretty graphics -- you'll find those within the links above. 15,000 of you per day are looking for an unrelated company, so we have been forced to make this page as sparse as possible to prevent server overload. If you are one of those, please use a search engine to find the travel company you were looking for. If you're looking for information about Telix, or our Internet services, please come on in.

While some similar name Web pages do provide links to the likely candidate page (such as www.bic.com (the Brookhaven Instruments Corporation) which gives a link to the razor manufacturer at www.bicworld.com), others like deltaComm Development do not. Goodwill cannot be relied on.

From the Delta example above, as well as the literature (Needle, 1999), it appears that e-Consumers experience difficulty in finding organizations without an intuitive URL. Retailers with URLs which cannot be guessed easily are presumed to be at an apparent disadvantage at being found because search engines are imperfect tools. Search engines, however, can be manipulated by retailers. Specifically, retailers can pay to have their pages appear closer to the top of search engine query results and in portal lists (Rich, 1998; Wildstrom, 1999)., With enough available resources, companies should be able to overcome some of the technological limitations.

To test the difficulty of finding pages for organizations with the greatest financial resources, a simple, limited experiment was conducted by the authors. Thirteen undergraduate senior students in a computer information systems program at our university volunteered to participate in the study. Ten Fortune 500 companies whose URLs which were not "www." + the company name + ".com". were chosen as a convenience sample.

The names of the companies and their associated industries were read aloud to allow subjects to misspell the names as they would naturally do in their own searches. Industry type was provided for use both as a search criterion as well as to allow students to verify that they had found the correct organization. Subjects were asked to spend up to five minutes trying to find each home page.

The list consisted of the following companies with their associated industries and correct URLs (Table 4):

Table 4. Search Experiment Company List

Fortune 500 Corporation	Industry	Home Page URL
1. Owens-Illinois	Glass and plastics	http://www.o-i.com
2. Procter and Gamble	Consumer goods	http://www.pg.com
3. H.F. Ahmanson	Banking	http://www.homesavings.com/home.shtml
4. Omnicom Group	Advertising	http://www.omnicommny.com
5. Dayton Hudson	Retail	http://www.dhc.com
6. Johnson & Johnson	Health care	http://www.jnj.com
7. AMR Corporation	Airline	http://www.amrcorp.com
8. Federated Department Stores	Retail	http://www.federated-fds.com
9. Minnesota Mining & Mfg	Consumer and industrial goods	http://www.mmm.com
10. United Technologies	Technology	http://www.utc.com

Findings of this study give a glimpse into what would be the lower bound of difficulty in finding Web pages. The results are considered a lower bound estimate for three reasons.

1. The subjects are senior level college students in a computer information systems degree program. They are required to make use of the Web extensively for research. They should be as familiar as any group with how to find information on the Web.

2. These corporations have great resources at their disposal. They have the opportunity to take advantage of all available strategies for creating easy-to-find URLs.

3. The target page was the home page. Home pages are the most likely pages to have corporate resources dedicated to them. There are search engines such as RealNames (RealNames, 1999) designed specifically for locating them. Therefore, they should be the easiest to find.

Results of the study reinforced the belief that e-Consumers have problems in locating Web pages on the Internet. Of the 130 total pages searched for in the study (10 pages and 13 subjects), 31 pages (24%) were not found after 5 minutes of search time. Of the remaining 99 pages found, an average search time of 1 minute and 37 seconds was required to find a page. Delays are known to cause anxiety (Guynes, 1988) and delays as little as one second are known to have significant negative impacts (Shneiderman, 1998). The results show that current technological and human search capabilities can be a threat to successful B2C e-Commerce under even the best of conditions.

Apparent Threats to Electronic Commerce

As was the case with the interface, the inability of clients to locate an appropriate URL is most difficult for those content providers involved in B2C e-Commerce. When seeking information, consumers generally stop looking for alternatives fairly quickly, i.e., after putting in a relatively limited amount of effort on each alternative (Capon and Burke, 1980). If a content provider's URL is buried among 100,000 other URLs, it is unlikely that an e-Consumer will be motivated enough to find a specific address. Furthermore, if e-Consumers receive a message indicating that a Web page does not exist, they are quite likely to seek an alternative vendor whose URL is readily retrievable.

Some B2C e-Commerce vendors, knowing that they are competing for the top spots on the search engines, use techniques such as “spam-dexing” (Livingston, 1997). Spam-dexing is a strategy to put keywords in HTML headers which will put that page up near the top ten listing for common search strings. A side effect is that individuals who do not attempt to manipulate the search engines, even those which are more legitimately related to the search string, are left out. A risk is that, if caught by managers of the search engine, spam-dexers may have their Web pages removed entirely (Ward, 1998). Therefore, it is difficult to say if spam-dexing is a good managerial design strategy.

Efforts to counteract these problems can be made. Strategies such as paid advertising on the Web allows vendors to pay for pages on other servers to have up-to-date hyperlinks. Because of these two limitations in Web metrics, the success rates of these advertisements is unknown. .

INADEQUATE MEASUREMENT OF WEB APPLICATION SUCCESS

It is currently very difficult to measure the success of a Web page or a Web site. The core issue is that we do not know what makes an appropriate metric of success for a hypermedia application (Hays, 1997). Commonly used measures, such as number of times a Web page is viewed (called “hits”), are considered failures (Picarille, 1997). Hits are used because they are easy to capture. While easy to capture, they are very hard to interpret as a measure of success, and, therefore, are very often deemed to be inadequate.

Why are hits hard to interpret? Aside from "hits" recorded by those who blunder onto the site and have no genuine interest in their content, search engines routinely add to site counters through their "know-bot" intelligent agents, discussed above. Moreover, multiple visits by individual potential consumers cannot be discriminated from separate visits by separate potential consumers. Each visit to the Web site is counted, irrespective of the client requestor. What is even more critical, however, is the fact that viewing a site does not clearly represent a level of interest. Interest will range from no interest whatever to highly interested, but the site owner has absolutely no knowledge of the nature of the frequency distribution of interest level through gross measures of "hits."

The metric content providers should be trying to gather is best described as: “Who is looking at my content? How many times are they visiting, and for how long?” Unfortunately, current Web technology does not allow servers to obtain a clear picture of who is looking at its pages. Typically, Web servers are only aware of the Internet gateway being used by a client. For example, a server can detect that numerous hits have come from clients attached to America Online (AOL; www.aol.com), but nothing more.

Furthermore, some gateway machines act as proxy servers for groups of clients. These proxies may capture a Web page once per day and show a copy of it to anyone else on the local network requesting that Internet page. In this scenario, 100,000 hits to a site would possibly be local to the proxy while indicating just one hit to the actual server where the original resides.

One final unwanted source of inaccuracy in hit data is from internal sources. Every time employees view a page for reference, maintenance, or updating, a hit is registered. Again, these hits should not be used in evaluating the success of the B2C e-Commerce implementation.

The final technological limitation with regard to metrics is the inability to measure how long a client is viewing a page. Web browsing is a client/server process in which the actual viewing is done on the client machine. How long a page is viewed could only be known by monitoring the client machine, which is not an option for most content providers.

Some of these limitations can be overcome by the use of "cookies." Cookies are data files that are placed by the server on the client hard drive. These files can keep track of data that has been entered on the Web page as it is viewed by the client browser. The cookie file can then be uploaded by that Web page's server. Such cookies are being widely used to monitor user preferences and keep track of demographic information (Cohen, 1997; Machlis, 1998; Stone, 1999). However, Web browsers can be configured to not allow cookies to be accepted by the client machine. There is no guarantee that all e-Consumers will be able to be monitored and tracked through cookies.

In addition to cookies, there is a markedly non-technological method for overcoming this technological impediment. Organizations such as Media Metrix and RelevantKnowledge perform sampling similar to the Nielsen Ratings for Web pages (Rowe, 1998). In addition to finding out who is visiting a Web page, they are able to find out the frequency of the visits, what parts of the page were viewed and clicked on, and times of day of the visits (Tedeschi, 1998). These data are critical for Web advertisers who are buying ad space and time on those pages.

Apparent Threats to Electronic Commerce

Limitations to measuring success are critical to those involved in B2C e-Commerce. One reason for this is that advertising — Web or traditional — is expensive (average costs of attracting a single e-Consumer has been estimated by one source at $34 (Machlis, 1999). If useful measures of success are not available, how can an organization assess gains due to advertising? Another reason is that startup and maintenance costs for Web server applications cost money. Without useful metrics, it is difficult to know how a Web-based strategy is performing relative to alternative strategies.

Alternatives to hits are feasible, although some have other disadvantages. Firms with a Web ordering capability are clearly able to measure the volume of sales generated by that Web site. Organizations that launch a Web site to develop a new line of business have an unconfounded source of metrics but those with a traditional ordering process in addition to the virtual ordering process cannot be certain whether the Web sales merely cannibalize their traditional sales process. This confounding affects many firms engaging in B2C e-Commerce.

There are alternative metrics available to hits, cookies, and Web sales revenues. As Armstrong (1996) suggests, Web businesses should seek to create e-Consumers whose loyalty to a firm and its products and services are akin to belonging to a community. Customer loyalty is an important metric of success. Feelings of community and attitudes can be monitored and evaluated using the Web itself if e-Retailers use the sales event as an opportunity to also gather customer opinion and demographic data. It is not necessary to gather large amounts of data during each contact. Data gathering can be accomplished in an incremental fashion that is less annoying to customers. This data allow a firm to profile customers and to determine whether the mix of e-Consumers differs in major ways from their traditional customer base. This information will, in turn, lead to new strategies to market to the changing customer profile.

SECURITY WEAKNESSES

Assuming contact between a client and server is made on the Internet and transmission of data is within acceptable bounds, threats to B2C e-Commerce still exist. The most commonly noted threat of this type is security. Security threats exist for both e-Consumers and for e-Retailers. There appears to be sufficient technology for secure B2C e-Commerce transactions on the networks between server and client. However, technological impediments exist in the security technologies that prevent hackers from attacking the client and server sites themselves.

Transaction Security

Transaction security concerns typically involve issues of either privacy or guarantees of knowing to whom one is sending or from whom one is receiving data. Much of anxiety over Internet security is either unfounded and not a result of actual technological flaws (Jeon, 1997). Primarily, weaknesses in Internet security are the failure to utilize existing security features of the Internet such as authentication (Elledge, 1997) and encryption (Radcliff, 1997).

Just as a phone line can be tapped, an Internet message can be overheard by various sources. Fear of privacy breaches over the Internet is a product of its design. One core problem is that the Internet is a very public and accessible communications network. Data transmitted can be intercepted fairly easily. If not scrambled or made uninterpretable during transmission, messages can likewise be easily read at any forwarding node on the Internet. Internet “conversations” are transmitted across a variety of links for each packet sent. Further, these packets may be relayed via some unscrupulous or poorly protected nodes

On the Internet, messages are being passed in a shared domain. Anyone with access to that domain can simply view all messages being sent through. Under these conditions, it is best to assume that unauthorized people are able to view any packet transmitted. Therefore nodes which seek privacy need to speak in a fashion analogous to using code words. As long as any eavesdroppers do not know the secret code, they can listen in, but cannot understand.

Internet technology is no better or worse than telephone technology in guaranteeing that the person on the other end of the line is who they claim to be. Short of having a guarantor analogous to a thumb print or a signature, one cannot be sure with whom one is dealing. To secure Internet computing, technology was created to conceal messages and guarantee the identity of people on each end of the transmission. Digital signatures, Secure Electronic Transaction (SET), and similar technologies can act as guarantors for the transaction, assuring interested parties that the signatories involved currently exist and are who they claim to be (see sidebar for details on transaction and identity security technologies).

With regard to concealing messages, two primary means are available. The first is to send non-text files; the other is to send text files which are jumbled via cryptography. Unencrypted "plain text" files are terribly insecure. Users sending text messages across the Internet should consider them to be no more secure than a post card. Anyone with access at any routing node can "listen in" to a text fragment and read that fragment without special software.

By contrast, a non-text file such as a picture file or an application data file (e.g., a MSExcel document) requires picture readers or other applications to interpret them. Typically speaking, files which require an application to interpret them cannot be read without the intact file. Furthermore, it is not necessarily clear which application is needed to read the file even if it can be captured. As a result, multiple hurdles stand between a would-be spy and confidential information.

While picture and application files are somewhat more difficult to read and interpret, they are far from entirely secure. A motivated snoop can still capture the entire data stream and analyze the files to find which application (typically off the shelf) is needed to interpret them. By contrast, encrypted messages, when used correctly, are far better protected against all but the most highly motivated criminal interceptor (Markoff, 1998). Encryption technologies would be even more secure were it not for US government regulations limiting the extent of encryption allowed (Markoff, 1998).

Transaction and Identity Security

Securing the Transmission Itself

Secure Socket Layer (SSL)
Practically all major on-line retailers use this protocol. Embedded in browsers, it scrambles or encrypts credit card numbers & other electronic data so that they are useless to unauthorized interceptors.

Secure Electronic Transaction (SET) 1.0 standard protocol. SET works much like SSL, except that the retailer never sees customers' credit-card numbers.
Supported by all the major credit card companies. Besides encrypting the transmission itself, under SET there are authorized agents (such as local banks) who can serve as Certificate Authorities (see sidebar below) to authenticate the transaction.

E-Cash
Works more like a withdrawal from an ATM than a credit-card transaction. To use, consumers must open an account with the bank and obtain the appropriate software.

SmartCard
Can act like a debit card. Next step: Download e-cash onto smartcard via the Internet.

Establishing Identity and Certifying Transactions & Payments (Authentication)

Mechanisms to allow e-Commerce to take place securely, that is, the parties have reason to believe that each is who they say they are, that will receive fair value in the exchange, and that the transaction is not fraudulent

Digital Signature
A uniquely identifying set of bits that are associated with an individual or a legal entity.
Transaction verified by a Certificate Authority (CA), a trusted third party — private sector or governmental entity — which verifies that the sender of the digital signature is who they say they are.

Digital Certificate
The CA issues a certificate that is attached to the transaction verifying the identity of the party (parties).

Encryption technology uses cryptography to scramble messages. Different strategies are available which can secure either or both ends of a data transmission. Furthermore, digital signatures use the same technology to assure that one is dealing with only the individuals one wants to be dealing with. Digital signatures are assigned by a sanctioned Internet authority. Unique passcodes of digital signatures identify individuals in much the same way as a physical signature or password. Of course, digital identities can be physically stolen.

However, mechanisms are available which make identity-theft extremely difficult. Examples include having identities hard coded onto a smart card and using biometrics such as retina scanners to confirm identities prior to authorization of use.

Using these technologies, transactions across the Internet can be more secure than many traditional transaction processes. If current technologies are in use, the biggest dangers to security occur after data is successfully transferred. Security threats exist even if a legitimate e-Consumer sends data to a legitimate e-Retailer without that data being intercepted.

Threats to Security from the Physical World and Hackers

Getting the transaction to the organization can be made safe, but the transaction information is less safe once it reaches the organization. Clearly, there are threats which exist in the intra-organizational electronic and physical worlds from rogue employees. Security on the Internet cannot prevent abuse within corporations any more than a secure phone line can prevent someone with access privileges at the telephone company from retrieving and publishing an unlisted number residing on the customer database. The security of the transactional communication medium in that case is not the issue. Threats occur from the wrong people accessing corporate databases from within, not on the way to the company.

Threats from rogue employees exist regardless of whether the retailer is conducting business on the Internet or not. However, unlike non-Internet commerce, B2C e-Commerce has many millions more people with potential access to those corporate databases. Hackers are a clear security threat to e-Retailer servers. Because many corporations store data which is accessible online, any hacker on the Internet has the opportunity to steal data from corporate databases.

While sophisticated firewalls and other security measures exist, hackers appear to be one step ahead of available security (Debreceny and Gray, 1997; Machlis, 1997). Risks are real and worrisome in their scope (Edwards, 1996; Henthorn, 1997). For instance, one survey of 1,700 corporate and government Web sites found over 60 percent had "serious potential security vulnerabilities" (Lohr, 1997). In addition, examples of successful computer hack-ins show just how potentially damaging these security breaches can be. In one instance alone, a hacker broke into a database of a San Diego ISP and stole 100,000 credit card numbers using well known hacking techniques (Gurnon, 1997). Besides inadequate utilization of available firewall features, a major technological limitation of most firewalls is that they must be equipped to physically identify a line as belonging to a particular IP address. If not, IP-spoofing can allow hackers access to internal networks (Higgins, 1997; Messmer, 1995).

Examples of security flaws on the net are provided by independent organizations such as Because We Can (Because We Can, 1999). Because We Can, "an informal organization of people with an interest in security" (Kelly, 1999, p. D3), has members who visit e-Retail sites and attempt to find security flaws. In one example, they successfully found flaws at e-Retailer auction house eBay (www.ebay.com). JavaScript code, known as Ebayla, was used to obtain user login names and passwords (Anonymous, 1999b). In spite of details of Ebayla being posted on the Web (see (Anonymous, 1999b)), eBay did not plan to correct their security problem (Kelly, 1999). Costs from lost functionality were deemed to outweigh the security risks.

Apparent Threats to Electronic Commerce

Transaction security is mostly a perceptual problem in B2C e-Commerce (see BBBOline (1999) for details). Retail customers are not yet comfortable with sending personal information across the Internet (Anonymous, 1999; Joch, 1997). The irony is that the Internet is at least, if not more secure than a phone transaction as long as encryption is used, the caveat being that a transaction is only secure if appropriate technologies are used. This issue extends beyond technology and represents a failure in the human and managerial domain.

The real threats to security lie outside the transaction. Threats exist because people are not utilizing the existing technologies. If people conduct business transactions with unscrupulous vendors or if sensitive information is stored on unsecured databases, security threats exist even where data is perfectly secure in transmission.

Whereas hackers can attack servers and steal sensitive data from outside the organization, client-side vulnerabilities are limited for the present. Currently, clients seldom have permanent IP addresses because these are dynamically assigned at the node or by the ISP. The threat of hackers will only grow worse when e-Consumers begin to have Internet clients with permanent IP addresses. Sensitive data will then be vulnerable to attack from the client side as well as the server side (McClure and Scambray, 1999).

In spite of existing technologies, it is estimated that 6 million Americans have been victims of e-Commerce fraud or related credit-card misuse (Harrison, 1999). In 1997 alone, there was an estimated $462 million (e-Commerce and otherwise) in credit card fraud worldwide with 96% attributed to identity fraud (Lucas and Rolfe, 1998). Experts estimate that 30% of all credit card transactions online are fraudulent (Lucas and Rolfe, 1998). What percentage of these problems could be eliminated simply by utilizing existing security technologies is not clear. What is clear is that security is a serious problem for B2C e-Commerce. Transactional security is mostly a managerial rather than a technological problem. However, such areas as firewall vulnerabilities, simplistic intrusion detection software, and server flooding problems (Higgins, 1997) remain as technical issues.

LACK OF INTERNET STANDARDS

The final technological impediment to Internet computing results from the absence of well established and agreed-upon Internet standards. Internet standards are used as guidelines for the development of Internet software which conforms to generally accepted rules for communication between applications. For example, by conforming to standard protocols, a browser developer can know the format needed to request, receive and interpret HTML files. Using this format allows that browser to communicate with all Web servers which also conform to the same standards.

Problems occur when there is either an absence of a standard or when an existing standard is augmented. In the case where standards are augmented, multiple parties are often augmenting the original standard in proprietary ways to meet a new perceived need. The difficulty is that many solutions to a single problem may coexist simultaneously without an agreed-upon standard.

The best illustration of this phenomenon is in extensions to HTML. HTML went through several accepted revisions. Between revisions, however, competing browser manufacturers extend HTML to perform new functions. Past examples have included displaying different types of graphics files. At one point in time, some browsers could display graphics files of type .gif, .jpg, .bmp, while others could only display .gif or .jpg files. Content developers could create pages which included .bmp files, but could not be assured of their being able to be interpreted correctly by all browsers. As a result, content had to be developed twice (one with and one without .bmp files), developed without this type of file, or developed with .bmp files which would be displayed as an error message on certain browsers. HTML is rife with examples of extensions which followed this pattern of differences between browsers which is ultimately caused by such lack of standards.

One recent troubling pattern is the seemingly purposeful divergence of certain competing standards. Netscape and Microsoft long waged a “browser war” to compete for the Internet software market (Delmonico and Rist, 1997; Kay, 1997). Part of the strategy in fighting this war included the creation of proprietary standards for each browser with the goal of differentiating one browser at the expense of the other. A significant instance of differentiation was applet and applet script standards.

Microsoft developed a set of standards (ActiveX) for running applets and applet script on its browser. ActiveX was put forth to compete with the Sun Microsystems Java language. Netscape adopted Java standards, and further extended them with a proprietary scripting language called Java Script for running on their browser. The implied and stated goals were to entice users to develop Web pages which adopted one standard over the other. Upon doing so, all clients which would communicate with those sites using that standard would need a compatible browser.

Apparent Threats to Electronic Commerce

Different standards and protocols for Web computing exist in such areas as encryption, electronic currency, and multimedia. Netscape and Microsoft use different standards for these functions critical for B2C e-Commerce. Purveyors of Web content for B2C e-Commerce need to be aware that the browser market is bifurcated; in 1997, approximately half of all browsers were Netscape and half were Microsoft (Sliwa, 1997) and those market shares are not terribly dissimilar in 1999.

e-Consumers further complicate things through the use any number of different versions of either browser. One reason for browser variety is that between 1996 and 1999 Netscape and Microsoft both rolled out several versions of their browser software. Furthermore, certain browsers are not compatible with older operating systems. Many of the latest browsers which contain the most recent HTML extensions can only be run on a 32-bit operating system. An e-Consumer running a machine with MS-Windows 3.1 is limited in what HTML code can be viewed correctly on their computer. Under these conditions, it is difficult to predict which browser application or version will be interpreting an e-Retailer's Web page at any given time.

Client technology is beyond the control of the content provider in B2C e-Commerce. Different browser protocols and standards are used by different browsers and vary as to which files they can interpret (an example of an e-Retail page which can be viewed by Internet Explorer 4.0 but comes up without any text for Netscape 4.0 can be seen at (Buckeye Marketing, 1999). Therefore, developing a firm Web site readable by all customers is difficult (Heath, 1997). Some commentators suggest that multiple versions of the same site be maintained (Gloede, 1998). The foundation of these problems lies in the lack of Internet technology standards

PRIORITIZING AND COPING WITH INTERNET IMPEDIMENTS

While a scientific study of the rank ordered importance of the impediments discussed in this paper is beyond the scope of the current research, it might be useful to practitioners and academics alike to be presented with such a prioritized list. These priorities, presented in Table 5 are based primarily on an interpretation of the literature we reviewed and our own judgments as to the underlying importance of each to the future of B2C e-Commerce. We believe that it might also be useful to have an assessment of possible managerial strategies and tactics for coping with these impediments, along with technologies currently in existence or on the horizon that may be able to deal with these problems.

An argument for a deeper discussion of the categories just mentioned is as follows: Web-based B2C e-Commerce is intimately tied to the Internet. As powerful and transforming as this infrastructure is, we showed that technological limitations can affect the advancement and development of commercial activities taking place over the Web and the Internet. Knowledge of these and other possible impediments allows managers to make some design choices that can undoubtedly minimize effects on customers. In other cases, this knowledge is useful in scanning for emerging technologies that address the threats. Finally, when a limitation is built into the Internet itself or beyond managerial control, managers can determine how to work around such limitations and continue to respond to customer interests. But while all this is true enough, it is critical to keep in mind that Web-based systems can never replace the need for managers to understand their clientele and design both human and computer-based systems to service those needs.

Table 5. Prioritizing and Coping with Impediments to B2C e-Commerce

Impediment	Relative Importance	Design Choices that Minimize Impact	Workarounds	Emerging Technologies that Minimize Impact
Security (Actual or perceived)	1	Encrypt sensitive information; stress security on Website (if retailer has it); fully activated firewalls	Offer bail-out parachutes for patrons, i.e., toll-free numbers, Faxes, mail; promote the fact that one's Website is secure	Improved firewalls; better intrusion detection software from deeper understanding of hacker psychology; better virus software
Download Delay	2	More and speedier servers; client giveaways; text only options	Push technologies working during lax times	Bandwidth improvements; Internet II; faster CPUs
Search Problems	3	Purchase company intuitive domain name at almost any cost	Buy related domain names; spiral branding; buy portal links	Intelligent agents
Measures of Success	4	Cookies	Nielsen opinion surveys (physical)	Pentium III ID tracking (if reactivated)
Limitations of Interface	5	Animation; VRML	Mail physical samples of products	New sensory-capturing and -sending devices; advanced virtual reality
Lack of Internet Standards	6	Drop down one generational level on Website; use lowest common denominators	Mail consumers plug-ins	New browsers able to work with different generations of technology

SECURITY

Reasonably good evidence indicates that security has been and remains the number one issue for the future advancement of e-Commerce (Oliveira, et al., 1999). With security awareness high as a result of major Internet security disasters like the Chernobyl and W32/ExploreZip.worm viruses (Markoff, 1999), managers may be more ready to invest in the considerable time and expense involved in securing the firm for B2C e-Commerce. One design tactic, for example, that can minimize actual security violations is encryption, which is available through Secure Socket Layer (SSL) encryption embedded in the browsers or through Secure Electronic Transmission (SET) now being promoted by a consortium of credit card firms. Encryption, if used, should eliminate essentially all hacker interception of the transmission itself. Managers also need to ensure that the firewalls they now have protecting their internal systems are fully functioning and robust to attack. If they are not, greater attention needs to be placed in this area.

Workarounds allow managers to deal with the impediment, even if the organizational systems themselves have not been designed to accommodate that particular impediment. In the case of security, for example, customers can be offered bail-out parachutes like call centers or Fax communications if they do not wish to trust their credit card data or other sensitive information to the Internet. Moreover, organizations need to promote safety features of their Website even if the site has not been thoroughly secured. If customers are willing to transact business with the organization even though they have been informed as to those features which have been activated (and, implicitly, therefore, those which have not), then they may be legitimately construed as giving informed consumer consent.

Technologies on the horizon will solve some of the current security problems. Firewalls are being given more and more intelligence and will eventually be able to duplicate many of the enlightened security decisions of a human monitor. Virus software is likewise improving, although it has proven to be hard to keep pace with the insidious inventiveness of hackers.

Finally, we need deeper insights into hacker psychology to improve technological solutions. Such insights can emerge from academic researchers with sufficient funding from sources like government and corporations and the deeper knowledge this research will produce can assist us in designing technology that prevents and detects computer abuse. This kind of software, called intrusion detection (Kerr, 1998), will, no doubt, advance from its current, relatively primitive state (Ranum, 1998) to a level of greater sophistication through deeper understanding of hacker motivation and behavior.

DOWNLOAD DELAY

Download delay is a major problem second only to security, in our view. Long delays for downloading multimedia and the simple inability to use certain Internet applications like telephony could turn off consumer buying inclinations and impede the evolution of Web-based B2C e-Commerce. We hypothesize, in fact, that long download delays will also impact consumer attitudes toward one's brands, which could produce a result completely counter to that intended by an e-Retailer trying to promote goods and services (see Rose (1998) for more details).

What are possible design solutions? On the server side, organizations can ensure that there are minimal delays in node access to the server and retransmission of Web pages. If processing on the server is called for, then delay can be minimized with sufficient investment in powerful server hardware, software, and telecomm gateways. More and speedier servers are the obvious solution to this problem.

The solution on the client side is complex. If consumers are not willing to rent cable modems, purchase faster clients, or download and install the latest generation of browser software, then companies are somewhat hamstrung. Text only options will reduce download delay on the client side, certainly, and this option should be made available on the home page. The only other immediately obvious solutions are client giveaways. Giving away PCs or NCs (network computers) may be an economically justifiable solution (Gross and Coy, 1995). Some firms are now doing this, under the assumption that free computers will generate enough Web business to more than cover the expense. Clients that are given away can be configured for minimal download delays and for automatically receiving new upgrades on-line as they become available. These qualities can be hard-wired so that users cannot reconfigure the units.

Workarounds can also reduce download delays. If consumers/ customers consent, push software can send information to them during off hours. These specialized circumstances apply to regular customers but not to the random Web-surfing consumer.

Over time, some download delays will be solved by wider bandwidth availability, such as Internet2, cable modems, etc. Faster CPUs will also reduce delay. But, ironically, as bandwidths increase, so do the requirements of Web applications. More and more firms will opt for livening up their Web pages with multimedia and with applets, animated gifs, etc., in such a way that added bandwidth may be absorbed as fast as it is created.

SEARCH

Search problems are endemic on the Web. If Web-consumers cannot find a company Web-site, then they surely cannot buy from it. Organizations will be well served if they can commandeer the domain name that most closely matches consumer's intuition about likely company URLs. If that domain name has already been purchased by another entity, it is probably desirable for the organization to purchase it at almost any feasible cost. Cyberspace will only become more valuable as time goes on.

Among possible workarounds are:

1. buying related domain names,
2. spiral branding, and
3. portal links.

Delta Airlines is pursuing the related name strategy. However, this strategy is not as good as a design as one in which they already own the intuitively obvious name. Spiral branding is the use of alternative media to advertise a firm's URL (Berst, 1998). URLs appear regularly on TV and radio as well as in print media. This approach, no doubt, has some effect on consumer's habits in accessing an URL. Portal links, costly as they may be, staked out heavily visited cyberspace and, therefore, positioning on their site is worth something. Some argue that the market value of Yahoo, Excite, and even amazon.com are directly attributable to their familiarity with e-Consumers and their ability to sell that space through portaling to other sites.

Technological solutions to search engine deficiencies are being touted everyday. Probably the most vociferous of these claims is intelligent agents.

When it works well, agent technology should be able to parse a natural language user request for information and determine sites most appropriate for that request. A request for physical shoe stores in Tokyo should not have high-up listings for virtual shoe stores or for anyone who lives in Tokyo and happens to mention shoes on their personal home page. As search engines improve, agent technology is likely to be at the heart of this change.

METRICS

Metrics involve critical business issues for all new ventures, but especially for business changes like B2C e-Commerce. If an organization cannot adequately measure its business benefits from a course of action, then it is extremely difficult to know how much of an investment is justified in this area. The Web is still relatively new and metrics are not as great a problem as they may be later when expenditures cannot be as easily justified on the grounds of experimentation or imitating competitors.

The WWW is currently severely limited in its ability to measure and track consumer cyber-patterns. Hits are nearly as gross a measurement as Internet sales. Other than post-hoc analysis of customer-entered data, the only marginally acceptable way to design measures to determine customer navigating patterns is through cookies. When and if browsers make the "disabling" of cookies the default (rather than the current default, which is "enabling" of cookies), the problems become even more difficult. For the moment, many consumers are not aware that firms are writing cookies to their hard drives and until such time as they are generally aware of this (and may rebel by disabling cookies), firms would be well advised to exploit the valuable information cookies provide.

Workarounds are not very inventive, but may be better than no action at all. Marketing research firms offer a service to measure consumer opinions about Internet sales. Ironically, this approach depends heavily on physical rather than electronic surveying techniques.

An emerging technology that could dramatically change the situation is the Pentium III ID chip. Although this PC-identifying chip ran into serious opposition from various groups, its activation would permit firms to recognize that a particular query or order was coming from a specific machine. This information would be useful in measuring success of various parts of the e-Commerce value chain.

INTERFACE

In our view, interface limitations are not as serious a drawback as the first four impediments. Inasmuch as consumers are not used to media conveying more than the senses of sight and sound, the ability of the Web to transmit other sensory signals is probably not a major shortcoming at present. Animation and Virtual Reality Modeling Language (VRML) exploit the capabilities of visual impressions, although they do not send 3-D images *per se*. Workarounds are rather restricted to what can be presented via the computer. Potential consumers can be mailed physical samples of products in certain cases. Rudimentary devices that send impressions of touch and taste are technically feasible and should eventually reach the marketplace. Advanced forms of virtual reality are also being explored by companies like Microsoft (Moeller, et al., 1999).

INTERNET STANDARDS

The final technical impediment discussed in this paper is the lack of Internet standards for hardware, software, and protocols utilized in B2C e-Commerce. While inability to standardize on a certain version of browser software, for example, creates inconveniences for Web-consumers, its impact is perhaps the least of the six obstacles. By design, firms need to reduce the sophistication of their Web sites so that they can be interpreted by most clients. Most clients can read frames, at this point in time, but may not accept XML. Firms would be advised to keep this in mind and to seek out lower common denominators to be able to reach the majority of consumers.

To work around this problem is not simple. Plug-ins can be mailed to consumers, either electronically or physically, but it is not clear that consumers want or would accept this service. Download delay for these plug-ins alone may be enough to deter e-Consumers from selecting an upgrade. As browsers and other hardware and software advance and knowledge of downloading new software becomes more widely known, some problems in this area may diminish.

IV. REMAINING QUESTIONS AND FUTURE RESEARCH

The present paper represents a start in identifying technical obstacles to Internet commerce. Each of the impediments identified can be explored in far greater detail. There are dozens of significant security issues that need to be resolved as soon as possible. What, for instance, are effective mechanisms for altering attitudes toward security? There have been modest beginnings in developing theory and informing practice in this crucial area (Goodhue and Straub, 1991; Straub and Welke, 1998), but much remains to be done before we can say that there is a deep understanding of this phenomenon. In the area of download delays, crucial work in the levels of delay that seriously impact consumer buying behaviors is needed. Furthermore, research into management of negative impacts is also needed. A basis in marketing theory and research would be appropriate for studies in this vein. As a final example, there are many metrics that would seem to apply more exactly to the paradigm that is emerging in B2C e-Commerce. Customer loyalty and satisfaction with the Web-site itself would seem to be reasonable metrics, but at the current time we have no true understanding as to whether this metric is better or worse in measuring B2C e-Commerce success than traditional measures such as sales and return on investment. It is not even clear that traditional measures can ever be used in this new venue.

B2C e-Commerce is developing in such a unique environment that it is extremely difficult to predict how long the impediments discussed here will continue to be important or if some will fade in importance and others will assume their place. What we do know, with a reasonable degree of certainty, is that technical impediments do appear to be critical for future development. For that reason alone, managers and academic researchers should carefully consider how these obstacles affect the use of the Internet and the deployment of B2C e-Commerce applications.

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LIST OF ACRONYMS

B2C – Business-To-Consumer: Transactions of goods and services between businesses and consumers.

CPU – Central Processing Unit: The core chip of a computer.

DSL - Digital Subscriber Line: One type of high-speed Internet connection.
e-Commerce – Electronic Commerce: Business transactions through the Internet.

EDI – Electronic Data Interchange: One way to deliver computer-to-computer electronic transactions.

HTML – Hypertext Markup Language: A language used to publish Web documents.

ISP – Internet Service Provider: A company that provides access to the Internet for a fee.

NCs – Network Computers: A thin client-side computer which has little or no capacity for stand-alone computing.

POTS – Plain Old Telephone Services: Telephone line connections from a home or business to the local telephone company's network and beyond.

TCP/IP – Transport Control Protocol/Internet Protocol: A communication protocol for the transfer of data packets between nodes on a network.

URL – Universal Resource Locator: An address used for finding a Web page.

VRML – Virtual Reality Modeling Language: A language used for 3D-type imaging in two dimensions.

WWW – World Wide Web: The sum of HTML and related applications on the Internet.

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