



Factors Affecting Website Downloads

ABSTRACT

E-commerce has captured a significant market share and is expected to grow a trillion dollar business by 2005. Speed is the key to life on the Internet in general, and in E-commerce in particular. The connection speed, size of the web page, number of forms, frames, and Internet users influence the success of an individual website and eventually of the E-commerce. A typical user waits for no more than 8 seconds for the site to load. This paper also includes user expectations of websites and the post bailout behavior. We also suggest some ways to speed up the download time of web pages. Website designers and computer design engineers can greatly benefit from this article.

and their
economic
implications

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INTRODUCTION

E-commerce has been making a big impact for the last several years and is expected to grow increasingly and become more important during the next decade. According to Zona Research (1999), 20% of Internet users spend \$200, on an average, each month to buy products. This leads to approximately \$32 billion spent on online commerce per year. This amount is just in the consumer market. On the other hand, the Business-to-Business (B2B) e-commerce market is much larger and is expected to grow exponentially according to Forrester Research (1999). The B2B e-commerce market was approximately \$250 billion in 2000 and is expected to be over \$1.8 trillion by 2005 according to the authors' forecast.

To realize the growth potential of e-commerce, websites need to be loaded quickly, understood easily, and should guide the user to the information he/she needs with a minimum number of clicks, and must have a low rate of disconnections. The users must be confident of having secure, reliable, and quick transactions.

When users surf the web, they download web pages and images from a web-hosting server, which is a computer whose function is to serve web pages to requesting users. Summarily, the speed at which web pages download is determined by the "size of files," "the speed of the web-hosting server," and "the rate at which they are traveling over the Internet." Almost all websites are made of several files: an HTML file which has the text and all formatting language, and image files for that page. Suppose a web page has three files; namely, home.htm of size 10k, logo.gif of size 15

k, and chart.gif of size 25k. To download this web page, three separate files are downloaded, that is, browsed and assembled on your desktop. Total size of this download would be 50k. The job of the web designers is to keep the file sizes of web pages small enough to download quickly. Web designers do their job by using the latest software and image compression technology.

An example of how badly things can go when the above criteria are not met, one needs only to consider what happened to FTD on February 14, 1998. FTD's web site, ftd.com, lost millions of dollars of revenue and an incalculable loss of brand loyalty when its website became sluggish and eventually, unresponsive. During the early part of the day, sales indicated a record-breaking day. However, later on higher traffic slowed response time at the site. Transactions began taking 30 seconds to respond, often not responding at all. By 11:00 a.m. the website was completely unreachable even by FTD's development staff. In addition to losing millions of dollars of revenue due to the number of lost orders, online customers were lost to other flower vendors with a resulting loss of confidence in the FTD brand loyalty. Of course, this kind of loss is much more difficult to quantify and may far exceed the direct losses.

Several researchers have attempted to describe the importance of website downloading and to determine the key factors that affect the download time (Fonseca et al. 2002). Bhatti, Bouch and Kuchinsky (2000) describe attributes of website design that help reduce website download times, and Moss (2004) suggest ways to speed up download time. Emarketer (1998) forecasts growth of E-commerce and predicts the market share it will capture in the future. What factors are essential for web-user satisfaction are communicated by Otto, Najwadi, and

Caron (2000), whereas Williams et al discuss about the removal policies in Network Caches. In this paper, we discuss and describe factors that affect download times and its economic impact.

FACTORS THAT AFFECT THE DOWNLOAD TIME OF WEBSITES

Speed is the key to life on the Internet. Every user expects to do his/her work in a shortest possible time whether the user is on a high-speed connection or a low-baud rate dial-up modem. The faster things move, the more work gets done, especially when it comes to e-commerce. Both e-commerce vendors and web users indicate that download time for web pages is one of the most important factors in determining the success of a website. The download time of a website depends on the following factors:

The speed of the:

- * Configurations of all enabling hardware
- * Internet service provider
- * Local server, if involved
- * Forms processing

The size of the:

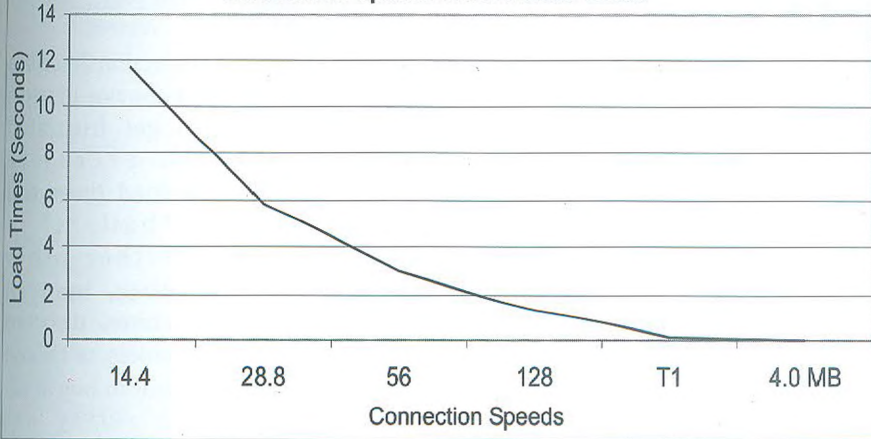
- * Home page
- * Tables and their quantity
- * Graphic images
- * Text usage per page

The number of pages within the Website:

- * Frames
- * Forms
- * Number of users on the Internet

at a given time. A typical relationship between connection speed and load time is shown in Figure 1. Although the load time is also dependent on other factors as enumerated above, Figure 1 represents a typical website in a large U.S. metropolitan area (Zona Research, 1999). Many researchers

Figure 1
Connection Speeds Versus Load Times

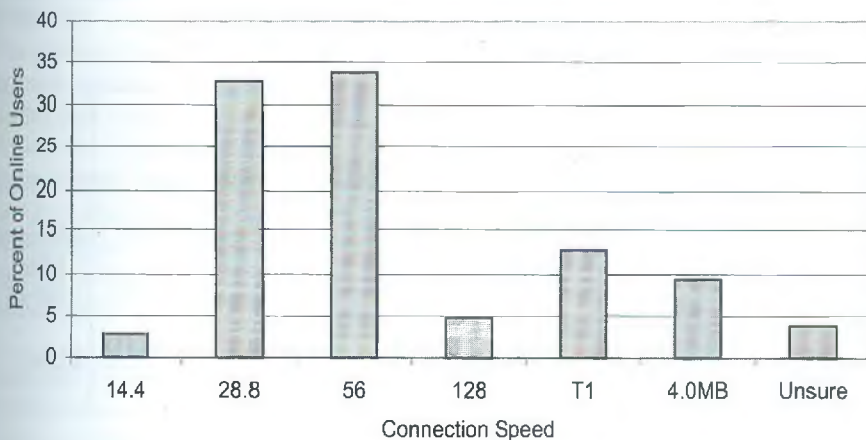


(Galbraith and Davidson, 2000; Selvidge, 1999; Lee, 1999) have observed that the longer a person has to wait for a web page to load, the higher the probability of "bailout" to another website. Website performance testing tools give results that are subjective to interpret. For example, Nielsen (1996) reports that "if a web page takes longer than 10 seconds to download then a user is likely to lose interest." Whereas, Zona Research (1999) reports that a typical user waits

Internet users get frustrated when a website takes too long to download and that range is 8 to 10 seconds.

Figure 1 provides important information for our analysis. For a connection speed less than 28.8 kbps, most websites will not be loaded because they take more than the eight seconds, thus violating the "8-Second Rule." Since most Internet users in the consumer market use modems of 28.8 kbps through 56 kbps, the "8-Second Rule" limits the opening page of the

Figure 2
Percentage of Users Versus Connection Speeds



for no more than eight seconds for a website to load, and is in favor of the "8-Second Rule." There is only two seconds difference between the above two statements. Nevertheless,

website to 35-40 KB's. This is based on the calculation of an effective download rate of 5 KB per second.

Download times are also dependent on the backbone connection. The carrying capacity and coping capabilities of any particular backbone and or any affiliated Internet service provider varies widely with web traffic volume, technical sophistication, engineering competency, service area, capitalization, etc. An average backbone speed of 5 kbps has significant implications for Web page designers and e-commerce vendors.

Consumers and e-commerce users with less than 28.8 modems experience a high degree of frustration due to long download times. This has a significant effect on cutting-edge vendors. Furthermore, increased traffic volumes, failure rates, increased web complexities, and unacceptable download speeds can quietly turn into serious financial impacts even for those vendors with relatively fast connections.



PERCENT OF USERS VERSUS CONNECTION SPEED

The authors conducted a survey in 2003 to determine the type of connections and connection-speed used by Internet users in a metropolitan area. Figure 2 presents a graphical percentage of users who use different connection speeds. This bar chart is bimodal where the first modal value is use 56 kbps modems, and the second is the use of a T1 line.

The bar chart shows that about 65 percent of users use a connection speed of 28.8 kbps through 56 kbps modems and about 30% use a higher speed connection. Although these numbers are changing steadily as more users are changing to high-speed Internet, a good proportion of users will continue accessing the Internet through traditional phone lines.

WEBSITE DOWNLOADS

This information leads us to conclude that the complexity, larger websites, and a higher traffic volume, etc. would seriously affect fifty percent or more of the consumer e-commerce users at any given time. Therefore, web designers need to ensure that websites can download rapidly regardless of connection type.

Applying the "8 seconds" rule helps us to indicate that websites preferably be less than 40 kb, including all images, content, and other media elements.

Figure 3 illustrates the relationship between the level of sales and the speed of the modem used. It is quite evident from the graph that the sales from users of a 14.4 modem are at a very low level.

From what has already been presented, we conclude that use of such a modem is too slow to allow users to purchase goods or services easily or desirably at such a speed. The graph shows that the users of 28.8 and 56 kbps modems make high purchases, about a billion dollars each. This may also be due a high correlation between the proportion of users and connection speeds. Nevertheless, Figure 3 helps us to predict clearly that the higher speeds would have larger sales resulting from their use, if more individuals had access to them for purchasing over the web.

Figure 4 presents a graphical relationship between the estimated loss of millions of dollars in revenue versus failures that results from connection speeds and problems of slow content loading. As one can surmise, the slowest modem (14.4) has

trouble loading the content of the home page after connecting. Since the page cannot be loaded, there is no loss because of problems with loading the contents, since the user has probably already abandoned the site.



POST "BAILOUT" BEHAVIOR

This section describes the behavior of users who get frustrated with excessively long download times and "bailout" behavior.

either other sites, brand stores, discount stores, or choose not to buy at all. A survey was conducted in 2003 by authors to understand the post bailout behavior of Internet e-commerce buyers. Table 1 lists the demographics of 208 respondents and their purchases from

other sources after they abandon the on-line search. As shown in Table 1, about a third of all bailouts do not buy

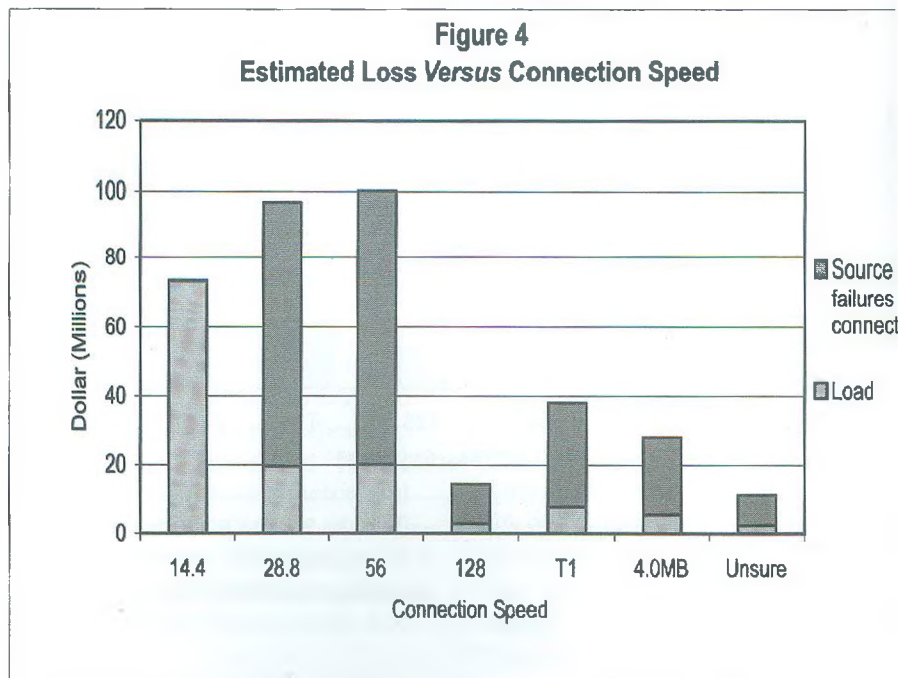
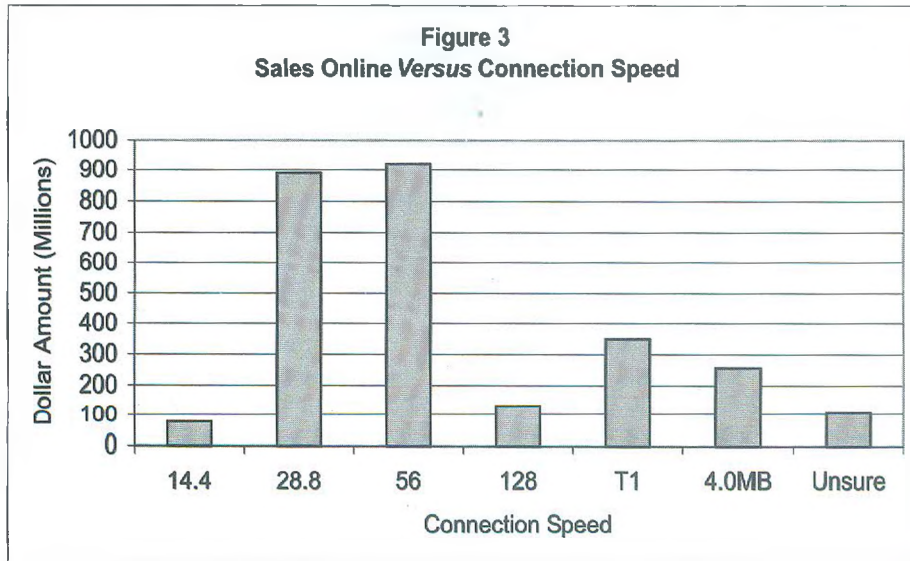


TABLE I
Actions Taken After Abandoning Online Search for Products

Demographic (N=208)	Did Not Buy Item	Bought Item at Brand Store	Bought Item at Different Web Site	Bought Item at Discount Store	Bought Item from Paper Catalog
All	34%	24%	14%	13%	7%
Age < 25 years	27%	40%	13%	13%	7%
Age 25 to 34	43%	20%	15%	10%	2%
Age 35 to 44	27%	30%	14%	13%	11%
Age 45 to 49	39%	18%	7%	25%	11%
Age 50 to 54	31%	23%	15%	12%	4%
Age 55+	33%	7%	20%	13%	13%
Male	29%	24%	15%	19%	5%
Female	41%	21%	13%	7%	9%
Annual Income <\$35k	38%	16%	19%	16%	5%
Annual Income \$35k-\$49k	37%	34%	10%	7%	5%
Annual Income \$50k-\$74k	44%	19%	14%	9%	7%
Annual Income \$75k-\$99k	21%	21%	18%	32%	7%
Annual Income \$100k+	27%	24%	12%	12%	12%

the product at all, about a quarter of them purchase the item at a brand store, about one seventh make their purchase at different Web sites, about the same amount purchase at a discount store, and only about seven percent make their purchases through printed catalogs. The above five responses vary according to age, gender, and income level with large variations with each group.

WHAT USERS EXPECT TO FIND ON A WEBSITE

The primary goal of Internet vendors is to have users of their site behave in useful and profitable ways within an interactive, virtual environment. The users should be involved in clicking and entering their choices rather than being static watchers. The level of success is based on the level of user satisfaction.

Research by Selvidge (1999) and Lee (1999) indicates that users with a high level of enjoyable experiences use the Internet more frequently, buy and sell products more often, and tell family and friends about their web use. This helps to expand the use of the Internet and web commerce. The following list

that shows what users enjoy and do not enjoy about their web experiences:

- * Users do not enjoy getting lost, having systems lock up, or being tricked.
- * Users like to be able to click anywhere at any time and get what they want.
- * Users enjoy being in control and having easy navigation and multiple choices.
- * Users demand fast-loading pages and go elsewhere if they do not get them.
- * Users often cannot see image maps or graphics due to technology limitations.
- * Users often dislike clumsy frames and bothersome drop-down menus.
- * Users like hypertext links but hate entry tunnels like "click here to enter."
- * Users often do not have 256 colors so many graphics look bad in just 16.
- * Users say they return to sites that treat them well as a Web customer.
- * Users prefer to click through multiple short pages than wait for one long one.

- * Users love pictures but prefer being told how big they are so they can decide whether to load them or not.
- * Users have little idea about how Internet magic works but know instantly which sites they prefer and which they will bookmark for later viewing.
- * Users know the Internet is not television, but still expect the web to grab their attention in Engaging and interactive ways.
- * Users enjoy being part of an online community so chat features bolted on to a site can triple session lengths, double Kb-per-user and page-impression downloads per session, bolster visit frequency by over 50 percent, and work a site's servers a great deal harder.
- * Most web users are simply not "cookie monsters" and are turned off if they are constantly being bombarded with them.

While some users tolerated sites that performed poorly as recently as a year ago, today's users have little patience for sites that simply do not get the basics right-fast, easy "click-throughs," dependable fulfillment, customer service, etc.

Given such user preferences, the real question is how do unacceptable download speeds impact online behavior. We analyzed the "bailout rates," i.e., the percent of users who simply do not wait around for pages to load and instead go to other sites. For example, on one site with a 70 Kb home page to load, log file showed that over half of the visitors bailed out before the first page finished loading. At another site with an opening page of 40 Kb, a three month log file review showed that the opening page had a 30% bailout rate while every other page at the site had rates in the 6% to 8% range. The other pages were in the range of 32-35 Kb. Given the average connection speed of 5 Kbps cited

above, we wanted to determine whether just a single second of web waiting account for this difference? To test the assumption that it could make a difference, the site tweaked its opening page down to roughly 34 Kb. Remarkably, we found that the bailout rate fell immediately from 30% to 6-8% just because of one tiny second of load time.



WAYS TO SPEED UP DOWNLOAD TIME

Adding graphic, audio, and video files to a website

adds to the download time for site visitors when they access the website. Web designers must consider must consider the size, type, and number of files contained in a website. The following are some ways to speed up the download time:

- * Cut out unnecessary HTML such as comments, font changes, and table elements that are not needed.
- * Use Cascading Style Sheets (CSS) to control appearance rather than changing fonts and appearance on every page.
- * Always use correct width and height attributes in image tags.
- * Resize and resample the graphics.
- * Lower the quality setting of JPEG files.
- * Use GIFs instead of JPGs when possible.
- * Lower the resolution of a high-resolution graphic.
- * Display a low-resolution version of a graphic while downloading.
- * Create a thumbnail.
- * Display ALT text.
- * Split content into more pages.
- * Avoid unnecessary use of multimedia content like Java Applets, movies, images, animation and other elements.

CONCLUSION

Based on the foregoing, it seems abundantly clear that slow download speeds are simply unacceptable for a sizeable percentage of the online population. This situation has enormous economic implications for websites and e-commerce vendors. As it turns out, the Internet is not just capable of moving information and ideas at incredible speeds, it is also able to make and lose money at various web speeds as well. We also suggest several ways to speed up the download time. This paper is equally useful for Internet users especially when they are deciding on Internet Service Providers and connection speeds.

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