ZONA MARKET BULLETIN

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THE NEED FOR SPEED II

In this report, we expand on our original Need for Speed report to consider the changes in Web-based buying behavior over the past two years with an eye to examining how user site abandonment causes may have shifted from delays in the Internet plumbing to latencies experienced due to transactive Web applications. We review the so-called 8-second rule, assessing whether user patience is a variable factor that is fixed, or whether it changes as a function of the importance that the user assigns to the specific Web activity. In addition, we consider the impact of multi-page transactions, positing a new theory about cumulative impatience leading to site abandonment. Finally, we examine how bandwidth fan out has changed over the past two years, and calculate an overall cost of site abandonment using the new parameters. Overall, we found more than $25 billion in potential lost business due to Web performance issues.

While the basic tenets of site abandonment espoused in the original Need for Speed (July, 1999) are still valid, a number of factors influencing abandonment calculations have changed. Not surprisingly, there are more people on the Internet today and many more shoppers. The mix of 14.4/28.8/56kbps modems has changed, and at the same time there has been a rise in DSL, cable modem and other mid-band connectivity solutions as well as in the number of people using high-speed connections at

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their work place to do Internet shopping.

There has also emerged a new ability to study commerce transactions, with the establishment of commercial Web page transaction measurement services and industry benchmarking services. These have appeared from Keynote Systems as the Keynote Broker Trading Index in June 1999, the Keynote Transaction Perspective Service in October, 1999, and as the Keynote Retail Industry Benchmark in March 2001. Data taken from these services have enabled us, for the first time, to account for latency factors due not to network connection speed, but to the Web site applications themselves. This fine-grained data has also enabled us to define the first metric for calculating user tenacity or abandonment of transactions that are multi-page in nature.

This document is based upon data that was derived from a number of sources, including primary research conducted by Zona Research, Millward Brown IntelliQuest, public sources and both public and private measurements taken by Keynote Systems.

The Changing Nature of Internet Content and Connectivity

As the Internet has continued to evolve over the past couple of years, a significant portion of Web content has become dynamic, i.e. it is assembled on the fly. This change from static content has impacted Web site responsiveness, or latency, and has shifted from the bare mathematics of plumbing, where the smallest pipe size in the path and the bulk of the material to be passed were the determining variables, to the responsiveness of the Web applications themselves. As the network layer latency is addressed in part by the movement towards higher speed connections, users are often surprised to still find themselves up against delays due to the dynamic creation of complex Web pages. These delays are due to relative information processing from discrete sources as well as accessing information from outside organizations, such as credit authentication and authorization mechanisms.

The Transition from Plumbing to Transactions

From the user's viewpoint, delay is delay. Therefore, any delay due to server processing, and data access from multiple sources will have to be considered along with the traditional calculations in taxing the user's patience. For the purposes of this document, we lump factors such as networking overhead, server and middleware processing, and database lookup, etc. into the term "transactional latencies."

Transactional latencies can be isolated by using URL-to-URL measurement agents through a high-speed (100 Mbps) connection. This virtually eliminates the latency due to network connections. The network connection speed component can be isolated by subtracting these measurements from similar agent-based measurements taken using 56kbps modems. Measurements taken from Keynote's Retail Transaction Benchmark and Broker Trading Index reveal that, in order to compensate for the transactional latencies, Web site designers must cut an additional 0.5 seconds to 1.5 seconds of connection latency in order to stay at the same level of abandonment compared with static Web pages.

The Internet Shopping Population and Bandwidth

It should be no surprise the number of Internet shoppers has grown over the past two years, and that there has been an increase in the amount of bandwidth available to users through either 56kbps modems or higher speed access through DSL, cable modems and other mid-band connectivity solutions. The question is, how much?

In the Table 1, we account for both home-based and office-based Internet users, while eliminating duplication of users who have both home and office connections. It is clear from the table that, while higher-speed access has seen a significant upswing in the past two years, the 56kbps modem is the prevailing connection amongst Internet users who are buying online.

Table 1: U.S. Online Users by Connectivity Bandwidth		
	Total (in millions)	**Total (percent)**
14kbps	4.8	5%
28.8kbps/33.6kbps	23.0	22%
56kbps	59.5	57%
High Speed (DSL or better)	16.5	16%
Total	103.8	100%

From these numbers, we can begin to get an idea of the total number of online shoppers and the consequent pool of ecommerce dollars that may be at risk because of poor Internet performance. Two years ago, we estimated that 20% of all Internet users were purchasing goods or services over the Internet. Our current estimate is that 25% of Internet users are spending an average of $161 per month on goods and services purchased over the Internet. This translates into dollars at risk, segmented by user bandwidth in Table 2.

Table 2: B2C Ecommerce Dollars at Risk/Month (2001)				
Connect Speed	**# Internet Users (in millions)**	**# Online Buyers (in millions)**	**Average $/Month Purchases**	**At Risk$/Month (in millions)**
14kbps	4.8	1.2	$161	$193
28.8kbps/33.6kbps	23.0	5.8	$161	$926
56kbps	59.5	14.9	$161	$2,395
High Speed	16.5	4.1	$161	$664
Total	103.8	25.9		$4,178

This comes to roughly $50 billion in online consumer spending that may be at risk during 2001. How much of this will actually be dollars lost due to site abandonment due to unsatisfactory performance is the subject of the set of user patience criteria discussed in the following sections.

How has User Patience Changed?

In light of the changing demographics of Web content and connectivity, it is important to remember that not only has technology changed, but so has user's expectations of their interaction with technology. Just as all connection devices, network and commercial Web sites are not created equal, so too, do we find variability in user mindsets and their approach to the various buying activities performed online. Overall, some old and some new factors contribute to site abandonment, including:

- Individual user attention span (very impatient, normal, very patient)
- Cumulative frustration manifested by multi-page buying processes
- Type of buying task (shirts, cars, stocks, credit card application, etc.)

- Alternatives, in both terrestrial and cyberspace to the given buying process
- User-experienced delay times due to:
  - Geographic variability
  - Backbone variability
  - Page download failures
  - Individual Web site transaction times
  - Number of concurrent users on Web site
  - Connection speed latencies
  - Backbone connection failures
  - Page download failures

Patience, User Tenacity and Importance of Transaction Affect User Abandonment

Human behavior across populations tends to follow a given distribution. For our purposes we assume that about 25% of the Internet buying population will be quicker to abandon than others, about 50% will exhibit normal patience and about 25% will be slower to abandon than the rest. We also believe that users have a different tenacity in pursuing a purchase that is expressed as a function of the type of purchase being made and the availability of alternative suppliers that are offering the same goods and services.

Consider, for example, the difference in tenacity that users might exhibit in buying a music CD, making a stock trade, shopping for a big-ticket item or finding a specialty item. In the case of a music CD, comparable priced alternatives exist, so the user's tenacity level is low. This is countered somewhat in that users tend to be sticky, but not loyal. That is, once they have selected a vendor they will stay with that vendor, until something disappoints them, and then they will stick with the next vendor that they settle upon.

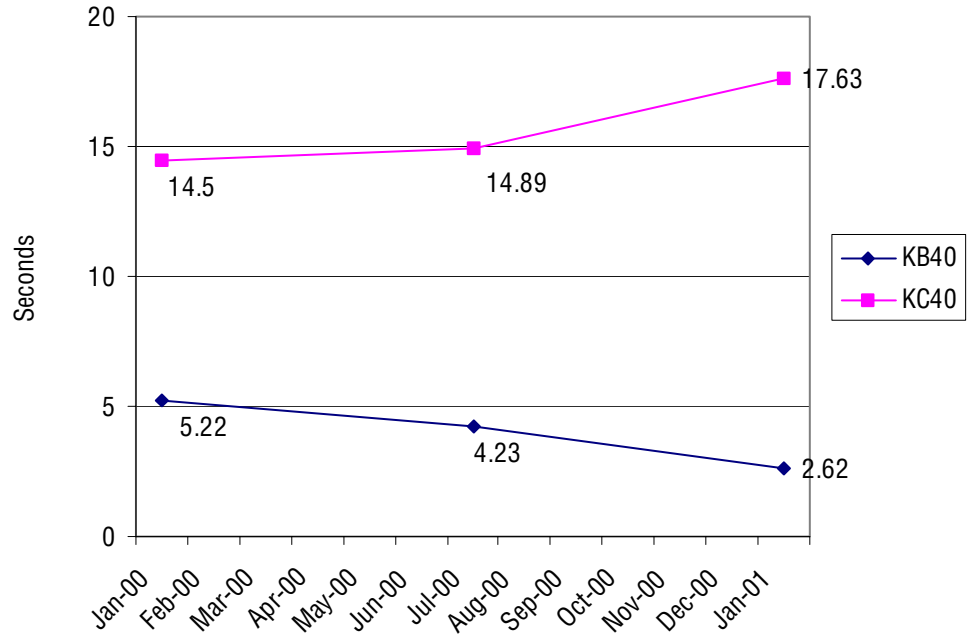
In the case of harder-to-find specialty items such as bowling shoes or mountain-climbing equipment, the tenacity level increases. In the case of stock brokerages, it goes way up, but individual trades are very time sensitive, so abandonment of an individual trade has a much, much lower tenacity factor. Although the market conditions that make a trade worthwhile can change in a matter of seconds, the pain level created by transferring one's brokerage account assets to another brokerage is high, so we assign a tenacity level of two or more to the brokerage sites. Table 3 gives an indication of how the aggregate of the Keynote Brokerage Indices appears when measured on a high-speed connection (100Mbps), and how a selected brokerage appears, on the average, to a user with a 56kbps modem.

Table 3: Keynote Brokerage Indices

Brokerage Latencies (sec)	56kbps	100Mbps
Home Page	15.83	1.47
Login	8.35	0.75
Quote Entry	17.45	2.24
Quote Return	6.34	0.76
Order Confirmed	10.27	2.18
Logout	8.20	0.88
Total Latency	66.44	8.28
Source : Keynote Systems		

Because of the market conditions factor, stock brokerages have applied significant effort over the past two years to make their sites more responsive, while retailers have been focused instead on using traditional TV marketing techniques by loading up their Web sites with complex graphics, dynamic banner ads and motion. Figure 1 shows the average performance of Web site home pages on the Keynote Consumer 40 (KC40) and Business 40 (KB40), respectively.

Figure 1: Keynote KC40 and KB40 Average Home Page Latencies (KB40 at 100Mbps, KC40 at 56kbps)



Note that in both cases, we are just looking at the home pages of the Web sites. The B2B sites have cut their average page response times in half over the past year, while the consumer Web sites have actually increased their latency times by over 20%. It is a clear sign that retailers are placing too much emphasis on snazzy presentations and banner ads, and not paying enough attention to the limitations of the 56kbps modem and the patience of their users. They may excuse themselves as having to compete against glitzy competitors and as provisioning for the future of high-speed connections, but it does not change the effect on abandonment from 56kbps-based customers.

Another factor that plays into multi-page buying processes is cumulative frustration with the arrival of successive pages in the process. It may be that each of the first, second, or third pages is only incrementally late in comparison to the user's expectations, but the frustration is cumulative, so an abandonment threshold is reached.

Albert Savoia, the Chief Technologist for Keynote Systems, created the first work that we have seen on the multi-page cumulative abandonment factor. He developed the theory for load-test simulations on ecommerce Web site applications and the "dissatisfier" thesis for Web load testing, which triggers abandonment based upon cumulative demerits, or dissatisfiers. We have modified Savoia's Law for our purposes to the following:

For every second of latency over normal expectations of that page, a Web transaction accumulates a demerit. We posit that accumulating ten demerits over the course of the multi-page transaction results in purchasing abandonment.

Site Abandonment Calculations

Overall, we define site abandonment as a ratio of the user's experience of Web page response time, divided by the user's patience and offset by transmission errors. Transmission errors are the Internet infrastructure abandoning the user rather than the other way around, but the net result is the same: the purchase does not happen. We formulate the equation as follows:

Abandonment = Transmission Errors + (Response time)/(Patience)

We calculate the site abandonment cost of transmission errors in Column B of Table 4 (*see next page*). The mathematically inclined will put subscripts next to response time, one for the type of bandwidth connection being used in the measurement, and another for the specific Web site being measured. One can also add a subscript for the geographic location of the user and another subscript for the specific backbone(s) being used for that particular measurement.

Patience, as we indicated earlier, also has multiple cases. One can add subscripts for the tenacity and assigned importance of the type of shopping transaction, as well as for the natural personality type of the user. Our familiar 8-second rule is the constant in this equation:

Patience = (8 seconds) x (Tenacity) x (Importance) x (natural patience)

We set normal importance at 1.0 and define it as those set of transactions for which users may be most inclined to hop to a competitor, e.g. the purchase of a commonly available music CD. Where the items are harder-to-find specialties, we assign importance of up to a factor of two. We also give stock trades an importance factor of two, but assign individual trades a low level of tenacity, because the validity of trades are dependent upon constantly-changing market conditions.

Tenacity is set at a minimum of 1.0, with increments granted for special circumstances. Users with 14.4kbps modems, for example, know they are using a slow medium and psychologically adjust for it, but not completely. We assign a tenacity of 2.0 to 14.4kbps modem users, putting their abandonment rates on par with those of 28.8kbps/33.6kbps modem users. We note that this group is not just users of older modems, but also wireless device users who are limited in transmission speed. Although not articulated in this document, there is also a matrix of constraints that can become an important factor upon occasion. A constraint matrix would account for a change in overall patience driven by circumstances such as "absolutely must sell this stock now," or when "gotta-have-it" mania is applied to a particular item that is not available elsewhere.

Natural patience is the aforementioned 25%-50%-25% psychological distribution, where we assign the impatient 25% to the 8-second abandonment rule, and increment normal and very patient users at additional four-second intervals.

Transmission errors are still a significant factor in site abandonment, as they comprise timeouts that cannot be adjusted by making a Web application more robust or by streamlining the content of the Web pages. According to millions of measurements made by Keynote Systems on retail sites in its

Keynote Retail Industry Benchmark, the current aggregate error rates for accessing retail sites averages 7.9%, with about 0.9% variance on either side.

Combining that factor with the consumer dollars at risk from Table 2, we arrive at the results in column B of Table 4, which represent nearly $4 billion per year in lost business due solely to transmission errors.

Table 4: Revenue at Risk Due to Site Abandonment ($millions/month)

	A	B	C	D	E
Connection Speed	**At Risk/Month**	**Loss Due to Transmission Errors (7.9%)**	**Loss Due to Excessive Delay, Single Page**	**Loss Due to Multi-Page Cumulative Frustration**	**Total**
14kbps	$193	$15	$137	$2	$154
28.8kbps/33.6kbps	$926	$73	$656	$10	$739
56kbps	$2,395	$189	$952	$14	$1,156
High Speed	$664	$52	$6	$0	$58
Total/mo	$4,178	$330	$1,750	$26	$2,107
Total/yr	$50,135	$3,961	$21,005	$315	$25,281

The lion's share of performance-based abandonment, however, comes from excessive delays in awaiting the combination of Web page assembly at the server end, plus the transmission of that Web page to the user's end. From the user's standpoint, this combination is a single experience, and its resultant abandonment implications are seen in column C. We note that in compiling the numbers in column C, we assigned an importance factor of two to approximately one-third of the retail Web sites that we examined, and an importance factor of one to the remaining two-thirds.

In the column C calculations, the 56kbps modem users are the most dominant factor, followed closely by the combination of users with lower-speed modems. Users of 56kbps modems, who make up 57% of all Internet buyers, account for $952 million per month in abandonment, or about 55% of the total. Users of 28.8kbps/33.6kbps modems are more disproportionately affected, as they are only 22% of the buyer population, yet contribute more than a third of the delay-related abandonment. Slowpoke 14.4kbps modems, likewise, are only 5% of the buying population, but contribute 8% of delay-related abandonment. In startling contrast, those users with high-speed connections show a dramatic drop off in delay-related abandonment, constituting one-sixth of the buying population, yet contributing only a small amount to this type of abandonment.

Losses Due to Geographic and Backbone Variance

To find out how much of a factor geography and backbone together play in daily Internet-based buying, we made a detailed examination of geographic data from the Keynote Consumer 40 Internet performance Index, which included measurements of 40 major retail vendor sites over 10 different geographies, plus a separate set of results for AOL. These 440 connection paths were exercised by ghost transaction agents at either hourly or 30-minute intervals over a typical weekday's activity, yielding thousands of data points.

We found a significant amount of variation due to local geographies and backbones. Since the ten different geographic regions each had either one or two different ISPs, we found it impossible to

cleanly sort out the difference between backbone and geographic variance, nor did we think that users would particularly care to sort them, since delay is, after all, delay. Whether it comes from the particular backbone in use or from the area's geography, the combined geographic/ISP backbone delay is directly additive to the minimum set of delays that the user would otherwise experience from the retail Website, connection speed, and the Web site's local network infrastructure.

On this typical day, we found that the variation of a given Web site across geographies was a minimum of 16% over the fastest path, and a maximum of 83% over the fastest path. The median site had a response time variation of 29% between its fastest and slowest geographic distribution points, and the standard deviation of those variations across all 40 Web sites was 14%. This represents an economic impact of between $7.4 billion and $11.0 billion in incremental site abandonment due to geographic and backbone latency factors. We do not give this calculation its own column, because we see geographic/backbone variance as a significant contributor to Column C, and do not want to double-count that economic impact. The economic calculation was based upon a trigger of a minimum of five seconds that errant geography and backbone data points added to already marginal single-page response times.

Column D totals represent the application of our formulation of Savoia's Law of multi-page transaction abandonment, applied to the transactional measurement data of the Keynote Retail Industry Benchmark companies. Multi-page transactions on these Web sites vary from three pages to six pages, depending upon how each Web site handled catalog lookups, order entry and shipping information pages. Across the board, we see about one and a half percent abandonment due to this cumulative frustration effect. We believe this calculation is extremely conservative, however, as most of the data that we saw was from Web sites that had already undergone some significant tuning to reduce transactional latencies. A random sampling of Web sites that had not undergone a great deal of tuning revealed that as many as one-third of the transactional Web pages had latencies that violated our 8-second rule, even when viewed with a 100 Mbps connection! Because of this, we expect future calculations of Column D to escalate dramatically. We also note that single-page transactional latencies are part of the count in Column C.

What Does it All Mean?

If one looks at the big picture of Web site abandonment, including both performance and non-performance related abandonment, one sees that the top 20 retail Web sites show an average of 9% to 10% in the ratio of successful Web purchases to unique Web site visitors. This indicates that there could be, and likely are, a host of reasons other than performance-related issues that can contribute to Web site abandonment.

Nonetheless, when the numbers are all added up, this amounts to a stunning condemnation of the Web site content design practices of many of the largest electronic retailing sites in the country. With an average page response time of more than 17 seconds running across the group (as seen by 56kbps modem users), it is clear that retailers are much more concerned about delivering fancy graphics and dynamic banner ads to Internet buyers than they are with delivering acceptable performance levels to potential buyers. The huge bulk of dialup modem users will continue to abandon nearly one out of every two buying attempts on retail Web sites. The total dollar value of that abandonment could mount to over $25 billion this year.

Does this mean that the calculated $25 billion is lost forever to all retailers? No! We view this huge number as the amount of potential churn among Web site competitors and their brick-and-mortar counterparts. Those buyers who abandon a given Web site due to performance problems are quite likely to immediately try again with a different retailer's Web site, or upon occasion return to the original Web site at a different time, hoping that different Web traffic conditions will produce a better result. While retailers should definitely view pieces of that $25 billion as potential lost revenue due to their own poor performance, they can also view it as the total cross-industry potential for picking up revenue from competitors with clumsier Web sites than their own.

Going forward, we see that transactional latencies will eventually become the dominant factor in Web site abandonment, even though their effect is currently partially masked by the dominance of the 56k modem among the buying public. As those modems are replaced by high-speed connections, the user experience of commercial Web sites will become critically sensitive to the tuning of that Web site's transactions, as well as to the provisioning of that Web site's hardware and software to handle large volumes of concurrent users.

