Improving the Response Time of Online Buyers in Nigeria: The Way Forward

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Abstract

Though electronic commerce (e-commerce) is yet at its infancy in Africa and other developing countries, several factors such as lack of trust, technology infrastructure, funds and shortage of manpower can be attributed to this. However, the current model of web server response time as it pertains to developing countries will however hinder its general acceptability. The ability of E-commerce sites to satisfy and retain their customers will no doubt depend largely on the quality of their service delivery.

Existing Quality of Service (QoS) provisioning architectures for E-commerce placed emphasis on WWW server and bandwidth inadequacies. This study identified the necessity to include client's device limitation into e-commerce QoS frameworks especially for web applications to be deployed in Africa, if user-perceived QoS (usually measured by response time) is to be improved. As indicated in the study, client's device limitation is an important factor that should be given priority. Most computer users in Africa due to the high cost of ownership of PCs used outdated or cloned PCs whose performance could not be guaranteed.

Keywords: **response time; Quality of Service (QoS); E-commerce; limited bandwidth; research study; Nigeria**

INTRODUCTION

The growth of the Internet has caused a significant increase in the type and volume of network traffic and it has provided the biggest change to the way human beings communicate. From e-commerce to on-demand videos to web-based communications, the Internet has proven its strength. These applications give rise to workload patterns which bring challenges to the people involved in managing the performance and planning the capacity of the Information Technology (IT) infrastructures that support them. This is because the Internet, designed some four decades ago is straining to cope with technology changes and according to Ortiz, (2008), the Internet is struggling to support an increasing number of new uses it was not built for. Indeed, scientists in the developed countries are already looking at a large-scale overhaul of some basic Internet elements to eliminate the need to constantly create workarounds to meet challenges.

As the number of Web users and Web applications continues to increase, Web Quality of Service hereafter refers to as QoS, will continue to be a critical issue in the domain of e-commerce (Bhatti, et al, 2000). QoS simply put, is the ability of a network to provide better service to selected traffic over various technologies and according to (ITU-T), QoS is "the collective efficiency of service performance which determines the degree of satisfaction of a user of a service". The goal of any QoS mechanism should be to

maintain a good level of user-perceived QoS even when the network conditions are constantly and unpredictably changing. QoS is usually expressed by performance characteristics such as response time, predictability, and consistent perceptual quality. Olshefski, (2006) reported that response time is a key indicator of end user satisfaction in using web services. Hence, customers seeking quality online services have choices, they may either take their business elsewhere when response times exceed acceptable threshold or even reject such an application.

The Internet is based on a Best-Effort (BE) service model that does not provide any guarantee that a user is given a guaranteed quality of service level. At the same time, new applications and networked services have emerged, putting greater demands on the Internet. In order to offer a better service than best-effort Internet, new service models that offer better service to applications have been proposed. While several of these proposals are in place and many QoS enabled networks operating, the acceptable levels of quality as perceived by Internet users still need to be improved, most especially in developing countries where obsolete infrastructures as well as limited network resources such as bandwidth, unreliable computing devices etc. are being used. These limiting factors are due to problems which include: low income levels, lack of know-how and other social ills.

Electronic commerce has been predicted to be a new driver of economic growth for developing countries, (Kraemer et al, 2002; UNCTAD, 2004) and it will also present great opportunities to business organizations in developing countries to gain greater global access and reduce transaction costs (Humphrey et al, 2003). Findings have shown that developing countries have not derived the expected benefits from e-commerce, besides e-commerce in Africa has not been sufficiently researched (Molla & Licker, 2005). The major impetus of this study is to analyse the experience of online buyers in Nigeria, evaluate their response times, study the current e-commerce architecture, identify its areas of weakness, and to produce ideas to notably improve user's response time in developing countries. The research focuses on Nigeria because it is the most populous African country (CIA, 2006) and has a potentially lucrative market for e-commerce services.

OVERVIEW OF E-COMMERCE IN NIGERIA

In developed countries, the expansion of the Internet has been nothing short of phenomenal. The technology infrastructure, along with a high penetration of computers, has supported the growth in e-commerce without too many problems. Unfortunately, developing countries are being left out of the expansion and the move toward the concept of a "global village". Internet usage in Nigeria for instance, is still relatively low compared to developed countries and e-commerce is still at the elementary stage, notwithstanding there is growing awareness of the benefits and opportunities offered by e-commerce amongst Nigerians (Bamodu, 2005). E-commerce activity in Nigeria is steadily growing as a result of vast improvements in telecommunication services. The advances in the telecoms market, and the explosion in the number of subscribers, demonstrate the potential market for information communication technology services generally in Nigeria. Given Nigeria's sizable population it is a potentially lucrative market for electronic commerce services.

Internet banking is slowly and steadily gaining ground; banks have set up websites which publishes corporate information and allow customers to carry out some form of transaction which is often limited in most cases. There are sizeable organizations in Nigeria that have e-commerce site that places one core operational process, product or service on the Web and providing an offline payment mechanism for the online activity. Similarly, Internet access is fairly popular among the citizens due to the high number of cybercafés that offers Internet access for a fee.

RESEARCH METHODOLOGY

The overall goal of the study was to elicit the experience and expectations of e-commerce clients as well as the potential benefits of e-commerce in Nigeria. The outcome of this study would be to document and validate understanding of the current situation, problems (and solutions) people experience while shopping online. The following are the immediate objectives of the survey:

- To determine the average response time experienced by online shoppers.
- To determine the state or condition of IT tools (most especially, client's PC) used in carrying out electronic transactions.
- To review the current benefits, costs and risks associated with e-commerce.

The sample data was collected through the administration of self completion questionnaires to a sample of respondents using Internet for e-commerce (civil servants, businessmen, undergraduate and postgraduate students, managers, marketing executive, etc.) from the South Western part of Nigeria. The study focussed on e-commerce because it is considered as the most important activity that has resulted from the web (Thuraisingham, 2002). The respondents had complete and fairly easy access to Internet enabling technology (e.g. access to a PC and telecommunication connection to an ISP) and used Internet regularly for multiple purposes. Questionnaires were used because they provide access to geographically dispersed samples at low cost i.e. a large population can be surveyed relatively cheaply (Frankfort-Nachmias and Nachmias, 1996). In addition questionnaires provide a high degree of anonymity and respondents have time to think about their answers and consult other sources. Three hundred and fifty (350) questionnaires were administered and three hundred and twenty (320) were completed and returned. This represents 91% percent of the sample. In the study, respondents were asked to visit some e-commerce sites, create sessions (browse, search etc.) during peak and low traffic periods. The response times experienced by them vis-à-vis the loading time for video, graphics and the delay variation interval (e.g. video freezing and then starting again) were recorded. They were also asked to take note and evaluate features available as well as limitations of these e-commerce sites. The respondents were asked questions ranging from the form of Internet access, computer specification- processor's speed, memory capacity, resolution, the availability of a licensed anti virus programs, how often they change/replace components of their systems, the frequency at which they shop online, importance of e-commerce if any, the common e-commerce operations carried out, response times experienced when network traffic is either light or heavy etc.

The returned questionnaires were recorded and trans-coded for further analysis using data analysis software. The researchers identified the following features as the major

determinants to creating an acceptable response time that will not impact user productivity:

    (i)   The state of the client's system.
    (ii)   Bandwidth capacity.
    (iii)   Web Server capability.

In this study, more emphasis is placed on the state of the client's system. To determine the state of the client's system, system components such as the processor, the memory, resolution and the presence of licensed antivirus software were considered. Each component of the system was assigned a weight (between 0 to 1) based on its condition and quality. For instance, whether the processor speed is on the high side or whether the memory capacity is big enough etc., Table 1 illustrated how the weight assigned to a typical processor (Pentium IV, III, II, Intel 586, 486 and 386) was derived. It was obtained as the proportion of a given processor's average speed to the sum of the average speed of all the processor types considered. For Instance, from the literature, the speed of a Pentium IV processor ranged from 1.5GHz to 3.4GHz, hence, a system having Pentium IV processor was assigned a weight of 0.63 in the survey. The weights for other system components (memory, resolution, and the availability of antivirus program) considered in the study were derived using similar analogy.

Table 1: Determination of weights assigned to processors

Processor Type	Min. Speed (GHZ)	Max. Speed (GHZ)	Ave. Speed (GHZ)	Proportion (%)
PIV	1.500	3.400	2.450	0.629
PIII	0.600	1.260	0.930	0.239
PII	0.233	0.450	0.342	0.088
586	0.062	0.133	0.098	0.025
486	0.033	0.100	0.067	0.017
386	0.005	0.011	0.008	0.002
		Total	3.8937	1

The product of all the weights assigned to components was computed using equation 1 to give the rating of the client's system.

$$Rating = \prod_{j=1}^{m} W_j \quad ......(1)$$

Where $W_{j\ (j=1,n)}$ represents each component weight, j represent the number of components (processor, memory etc.) and variable *Rating* is the rating of each client's system.

The proportion of the value derived in equation 1 over all other systems was evaluated using equation 2 to give a ranking between 0 - 1 which established an indication of the state of the client's system.

$$Rate = \frac{Rating_i}{\sum\limits_{i=1}^{n} Rating_i} \quad ......(2)$$

RESULTS

In analysing the data obtained, it was discovered that the response time experienced while carrying out e-commerce operations is poor. The average response time during the low traffic periods was 13 seconds and that for peak load times was 34 seconds, which gave an average response time of 24 seconds. This is a sharp contrast to the ideal response time given in (Nielsen, 1999), which states that "1 second is the highest acceptable response time and a value that is above 9 seconds is unacceptable and annoying making it difficult for customers to buy products and pursue other goals".

Figure 1 depicts a relation between the response time which was experienced by the respondents in the sample and the system's rating. 84% of the systems used in the study had rating less than 0.05. The response time was less than 10 seconds for systems rated above 0.04. This revealed to some extent the influence of system capability on the response time. Processing more data (load) on client's processor will result in longer response time. Hence, to make clients experience a shorter response time, there is the necessity to reduce the load being processed at the client node.   60% of the respondents used low speed networks to connect to the Internet.

Common e-commerce operations performed as revealed in the analysis were: products browsing (74%), products selection (56%), online payment (15%), offline payment (82%), checking results online (43%). A shocking revelation of 82% of the respondents performing offline payment operation demonstrated that the Nigerian users are willing to pay for information service delivered to them using the Internet. One of the reasons the Internet/e-commerce is still at its prime in Nigeria is the lack of a nationally acceptable payment method for online goods and services.

The reduced transaction and communication costs, expanded market potential, goods and services offered to customers 24 hours a day in every time zone and the creation of delighted customers whose lives are made more effective were identified as the potential benefits of E-commerce.

DISCUSSION

The results obtained from this investigation showed that certain factors can inhibit user's response time in terms of QoS of e-commerce perceived by clients in the developing countries. Some of the factors include:
1. Bandwidth limitation, which plays a significant role in application performance. Most networks (60%) are low speed networks such as dial up and frame relay that range in speeds from 56 Kbps to 2 Mbps and have many endpoints. Bandwidth prices have not declined as rapidly as expected and networks have been unable to keep up with application demands
2. The condition/state of the system- about 88 % of the systems used in the study

had no licensed copy of anti virus programs installed. This is attributed to the cost of acquiring a genuine (licensed) copy which runs into millions of dollars per copy. 62% of the users used free copies of anti virus programs downloaded from the Internet, an option that is not effective and safe, while 18% of the sample data had the usage period of their free downloaded anti virus program expired. Further investigation revealed that 30% of those using free antivirus programs had their systems infected. This is in consonance with Nucci and Bannerman, (2007), which states that "network security software products on the market today offer only limited defence". Figure 2 shows the status of anti-virus program on the clients systems used in the study. Viruses and worms usually render computers on a network unstable, and in many cases unusable by harming the network (consuming bandwidth) or have CPU load increased unnecessarily by starting or running irrelevant and unnecessary codes on the system. Unfortunately, 70% of these systems used windows operating system (97, 98, 2000, XP etc.), which is more vulnerable to virus/worm attack. More so, most of the systems in the study are sub-standard as revealed by the ranking procedure used. 60% of the systems were rated poor, 26% rated average while 14% were rated good.

3. Most of the e-commerce sites used in the study had no structured way of presenting information (product categories) to users and beside, they offered little assistance in helping customers find appropriate products. More importantly, the information retrieval model of these e-commerce sites expressed queries as a set of limited keywords which often give rise to unsatisfactory results flooding user's desktop with information resulting to an unpalatable user's experience. Especially for those having limited computing facilities.
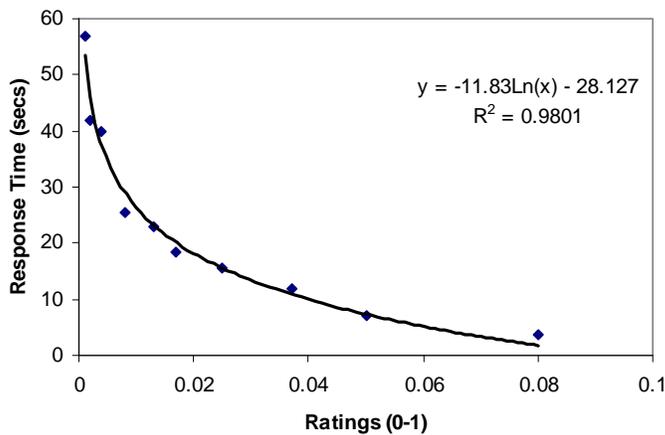

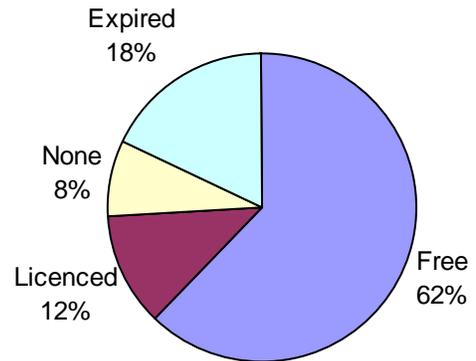Figure 1: Relationship between Response time experienced and system's ratings

Figure 2: Status of Anti-Virus program

CONCLUSION

Over the years, researchers in the industry and academy had proposed a wide set of solutions aiming at improving the user perceived QoS especially as it relates to e-commerce (Menasce et.al, (2000); Nahum et.al, (2002); Zhou et.al.,(2004)), but none was targeted to the needs and situations of a typical developing economy.

Most e-commerce QoS frameworks do not take into consideration the limited bandwidth between end user and its Internet Service Provider (ISP). Additionally, the capabilities and characteristics of the user's device (device type, processor load, processor speed, screen resolution, colour depth, available memory, display size etc.) were often ignored in ensuring that customers have a fruitful and eventful session while conducting business online.

Many challenges and obstacles must be overcome before developing countries can benefit from e-commerce potentials. Few of these are: the necessary technological infrastructure is either inadequate or non-existent. To upgrade or develop the infrastructure would be extremely expensive and require the support of the government, which may never happen. Additionally, most income earners in Africa, for instance, used sub-standard Personal Computers (PCs) to costlier branded PCs and to upgrade or develop network infrastructure is extremely expensive.

In summary, for the developing countries to fully benefit from the prospects of e-commerce, the following needs should be addressed:
Firstly, governments in the developing countries should be Internet friendly in some way by setting the Internet access and use as a priority. They should also be business friendly so as to encourage foreign investments in domestic businesses. Without outside investments, telecommunications may not reach the level necessary to participate in the Internet global economy. Partnerships should be allowed to enhance the development of the technology infrastructure necessary for Internet penetration.

Secondly, researchers and software architects should strive to create secure systems that would eliminate the need for antivirus products in the computers meant for use in the developing countries. The platform should be designed in a way to drastically raise the bar for would-be hackers and render many kinds of attacks useless. More so, the need to introduce advanced semantic web principles to help users organize, explore, analyze and share information better with appropriate compression algorithms implemented at the servers to reduce the size of multimedia data (images and videos) to a value commensurate to the client's system capacity. It is however important that the compression algorithm is performed in advance of transmitting multimedia data so as to reduce computing delay since the device processing capability can affect the information processing speed. Finally, the providers of web services should endeavour to formulate QoS framework that will effectively optimize the limited resources available in the developing countries so as to improve the perceived response time experienced by online buyers.

REFERENCES

Bhatti N, Bouch A, Kuchinsky A. (2000). Integrating User-Perceived Quality into Web Server Design. Proc. of the 9th international WWW conference on Computer networks: the international journal of computer and telecommunications networking, pp. 1-16.

Bamodu G (2005). The Legal Landscape for E-Commerce in Nigeria. The Nigerian

Village Square. Available online:
http://www.nigeriavillagesquare1.com/Articles/Guest/2005/04/legal-landscape-for-e-commerce-in.html.

Molla A and Licker P.S (2005). eCommerce adoption in developing countries: a model and instrument. Information Management 42(6),877-899

Nucci, A and Bannerman, S. (2007). Controlled Chaos. IEEE SPECTRUM. 44(12);36-42.

Frankfort-Nachmias C and Nachmias D, (1996). *Research Methods in the Social Sciences*, 5th Edition, Hodder HeadlineGroup, London

Humphrey J, Mansell R, Pare D and Schmitz H.(2003). The reality of E-commerce with developing countries, Available: www.gapreseach.org/production/publications.html

ITU-T Recommendation E.800 (0894): Terms and definitions related to quality of service and performance including dependability.

Kraemer K., Gibbs J, and Derick, J. (2002), Impacts of globalization on E-commerce adoption and firm performance: A cross country investigation. Center for research on information technology and organization, University of California, Irvine.

Menasce D. A., Fonseca R, Almeida V. A. F., and Mendes M. A. (2000). Resource management policies for E-commerce servers. ACM SIGMETRICS Performance Evaluation Review, 27(4), 27-35.

Nahum, E. M., Barzilai, T., and Kandlur, D.D. (2002). Performance issues in WWW servers. *IEEE/ACM Trans. Networking 10*, 2 (Feb.), 2–11.

NCC (2006): "Industry Statistics", available at: http://www.ncc.gov.ng/index5.htm

Nielsen, J (1999). Designing Web Usability. New Riders publishing. Indianapolis, USA. p 42.

Olshefski D, Nieh J (2006). Understanding the Management of Client Perceived Response Time. In Proc. ACM Conference on Measurements and Modelling of computer systems, Saint Malo, France, pp 240-251.

Ortiz S (2008). Internet Researchers Look to Wipe the Slate Clean. IEEE Computer. 41(1),12-16.

Rhee, Y-J, Hyun E-I, Kim, T-Y.(2002) Connection management for QoS service on the Web. Journal of Network and Computer Applications; 25(1),57-68.

Thuraisingham,B.(2002).XML Databases and the Semantic Web. CRC Press, Florida. Pp. 3-93

UNCTAD (2004), *E-Commerce and Development Report, 2004*. Geneva: UNCTAD.

Zhou X, Wei J, and Xu C-Z. (2004). Modelling and Analysis of 2D Service Differentiation on E-commerce Servers. In Proc. Of the 24th Int. conference on distributed computing system, IEEE Computer Society, pp 740-747.