Journal of
Teaching and
Education

GRID COMPUTING IN BOTSWANA: ENDEAVOR TO EDUCATIONAL TECHNOLOGY

Suresh Shanmugasundaram and Divyapreya Chidambaram

Botho College, Botswana

A distributed system consists of multiple computers that communicate through a computer network. The computers interact with each other in order to achieve a common goal. Distributed computing also refers to the use of distributed systems to solve computational problems. A distributed computing system can be categorized according to its specific characteristics as Grid Computing, Cloud Computing, Cluster Computing or Hive Computing. All these distributed systems in general have intricate connection to the distributed computing paradigm and all these systems require network to provide centralized facilities operated by third-party compute and storage utilities and hence they are used in a number of Organization to accomplish complex scientific problems. All these years, education has been influenced by a series of technologies that have been constantly emerging. With the advent of IT, curriculum design and development, assessments, assignments and other segments of academia have been considerably changed. This paper attempts to visualize the impact of the distributed computing environment in the field of education in Botswana. It will also explore the emerging distributed systems like the Grid/Cloud computing in bringing larger transformations in academia, by laying out an integrative vision of the pitfalls and the advantages of this platform for the future of teaching and learning in the Nation. It is believed that the challenges, opportunities identified and the recommendations to avoid the pitfalls will certainly help all the stakeholders involved as well as the academic community in other developing countries.

Keywords : Grid computing, Botswana education, Research sharing.

Introduction

Botswana is a small, dynamic country with visionary leadership particularly in the sector of ICTs in Education. In practice, Botswana arguably boasts among the highest PC penetration in Education institutions in Africa. The Government has committed financial resources to improve connectivity and to promote the educational use of ICTs. Botswana's educational system comprises seven years of primary education, three years of junior education and two years of senior secondary education. Education in Botswana is free but not compulsory. The educational mirrors the United Kingdom structure. The country has six colleges and one university. The second university is still being constructed and the classes for the first batch had already commenced from August 2012. The Nation has a very good ICT infrastructure which is not fully utilized. Thutonet promotes the critical component of the ICT Policy which is e-learning. The higher education sector which offer diplomas, certificates and degree programmes are all well-equipped with computers.

Grid Computing in Botswana

Despite the fact that the country has a good ICT infrastructure, it was noted that the awareness about Grid Computing in Botswana is yet to be enriched. A questionnaire and interview questions were prepared to establish the levels of awareness of Grid Computing in the Country. Personnel in all levels in IT firms, Educational institutions participated in this exercise and the contribution was quite helpful in assessing the knowledge levels of Grid Computing. About 70% of the participants were not aware of the term 'Grid Computing' and 50% of people thought that Grid Computing is related with complex scientific applications. The research finding established that more education is required in order to create the awareness about Grid Computing and also to make use of the grid approaches for education and learning. The research also confirmed that an elevated level of awareness could lead to behavioral changes [1], [4] and welcome the applications of grid computing.

Research Methodology

Questionnaire

A questionnaire was designed and issued to the participants from the Academia and IT industries. The questionnaire was designed using the approach used in a paper titled "A vocabulary test to assess information security awareness" [1]. The questionnaire aims to measure the awareness levels of computer users with regards to grid computing. The questionnaire consists of two parts-the first part to perform grid computing vocabulary test and the second part to evaluate the respondent's behaviour. The questionnaire questions are multiple choice questions with options to choose from. This is an exploratory study to test the awareness levels of respondents on grid computing hence it was decided to only ask ten elementary/general aspects of grid computing. It was anticipated that this analysis will help to initiate the readiness for the use of grid computing in Academia in Botswana. The text below is a sample of the first part of the questionnaire where the respondents were expected to choose all the relevant answers that they think are appropriate.

Section A

Grid computing is:

    a) combination of computer resources from multiple administrative domains to reach common goal
    b) a system where hardware resources are shared to work on projects also known as 'Computational Grid'
    c) is a service for sharing computer power and data storage capacity over the Internet
    d) all the above
    e) I don't know the definition for grid computing

For the above sample snippet, the respondents with good understanding of grid computing would select the first three options . Thus the idea to use these questions in section A is to establish the awareness of grid computing. It is assumed that a respondent with basic understanding of Grid computing will be able to attempt the questionnaire with little difficulty [1-4]. For the second part, the questionnaire aims to evaluate the respondents' behavior independently of their vocabulary knowledge about grid computing and hence scenario-type questions were used.

Please see the sample below;

Let's assume that you are a person who owns a personal computer or laptop. What will be your preference of action when you have finished using it for the day?

    a) Shut it down
    b) Hibernate it

c) Change it to sleep mode
d) Lock the machine
e) Keeping it active by performing system scan, virus scan, antivirus updates, etc

The questions will establish how the respondents will generally behave with regards to their personal computer usage. The questionnaire was distributed among personnel(from executive level to middle-management) in various IT firms, students doing computing courses in various colleges and universities in the Nation. A total of 220 participants were used for answering the questionnaire. Sampling approach was used, however, the point was made clear to distribute the questionnaire to a wide variety of participants across the Nation. The primary places which were considered were Gaborone, Francistown, Maun and other townships like Ghanzi, Kasane where there was minimal participation. Table 1 below shows a summary of the distribution of the questionnaire and its response.

Table 1. Summary of Questionnaire Distribution & Response.

No. of Questionnaires distributed in various places	No. of responses received
Gaborone	80
Francistown	60
Maun	50
Other places	30
Total	220

Interviews

Interview questions were prepared for the top management in Academia and IT firms across the Nation. The notion was for conducting the interviews was to establish the benefits of Grid Computing and also to understand their readiness to deploy it in their respective firms and institutions. The sample questions used in the interview are listed below.

- Have you taken or do you intend to take any initiatives in regard to sharing Computing Resources across the Nation or at least within the Organization?
- Do you have any established policy for computer usage, especially for the closing hours?
- Does your company/institution have the capability to monitor and measure the CPU usage during and after working hours?
- Have you ever conducted awareness in terms of sharing computing resources through internet across the Nation/Globe? If not, do you intend to do it in the future?

Outcome

Demographic Details

From the 220 responses, 104 were male and 116 were female. The pie charts in figures 1 and 2 below represent the percentage of respondents across the Nation, percentage of respondents from Academic and Non-Academic industries respectively.
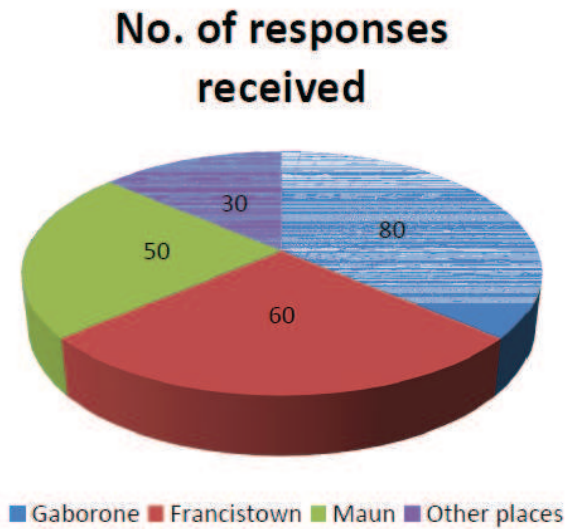
No. of responses received

Gaborone ■ Francistown ■ Maun ■ Other places

Figure 1. Pie Chart Depicting Responses across various places.

No. of responses received
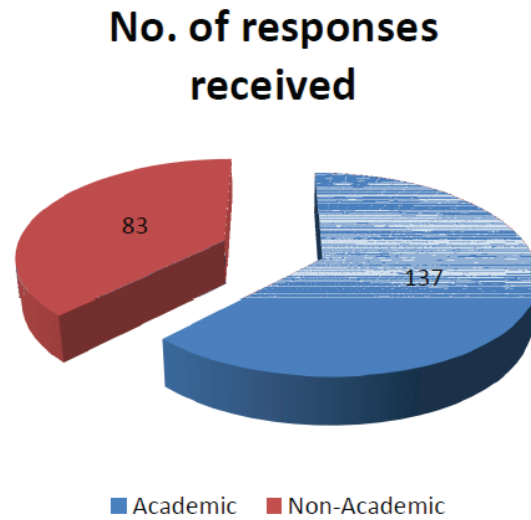

■ Academic   ■ Non-Academic

Figure 2. Pie Chart Depicting Responses between Academic & Non-Academic Organizations.

Interpretation of Questionnaire data

The following table shows how respondents answered each question.

Table 2. Summary of Cumulative Questionnaire Outcome.

Section	Q.No	Options	No. of part questions selected under each section	Positive Response	Responses that shows scope for improvement	No. of responses discarded
A	1	a	34	18	181	21
		b	66			
		c	12			
		d	20			
		e	88			
	2	a	54	125	51	44
		b	122			
		c	44			
		d	0			
		e	0			
B	1	a	20	104	96	20
		b	8			
		c	12			
		d	56			
		e	66			
	2	a	78	56	144	20
		b	94			
		c	10			
		d	60			
		e	52			
Average					118	27

The outcome shows that, in general the majority of participants have little or no knowledge on the concepts and the applications of grid computing. In question A.1, only 8% of the participants chose the correct option while remaining 92% of them had either stated that they haven't heard about that or selected a wrong option. It was affirmative that there are still lots of scope for improvement especially in making them understand the concept of grid computing. The inference that was obtained through these exercise is that majority of the population in the Nation, despite being a academician in Computing or an IT Personnel, lack in understanding the rudiments of Grid Computing. Also, it was observed that majority of the population had been assuming that only scientific and research organizations can be the resource providers for Grid projects, which in reality, is not so. In section B, about 72% of the respondents had shown positivity with regard to sharing computer resources with others. The responses show that the Nation is ready to welcome this scheme of distributing and sharing the resources that are idle during and after closing hours of work. The statistics clearly depicts that a lot of effort has to be put forth to sensitizing the nation on Grid Computing and its applications, especially in the areas of teaching and learning. The cumulative response for all questions reflect that even though the awareness on grid computing is not adequate in the Nation, the readiness, to be a service provider and/or consumer in the grid platform can be seen through behaviors like leaving the system idle or using it for full scan.

Interpretation of Interview data:

- The interviews which were conducted with the Top management of IT firms and Academic Institutions, gave the following inferences.
- Majority of Organizations (Academic and Non-Academic) have taken no initiatives in regard to sharing the resources.
- Most of the firms do not have an explicit policy for computer usage during and after closing hours, which had resulted in a tremendous wastage of computing resources from those idle machines which were left ON after closing hours.
- Most of the companies have the capability to monitor and measure the computer usage. However, this was not put on practice as the benefits were not known.
- Awareness program were never conducted on sharing computing resources through internet because of lack of knowledge in this. However, almost all the firms were ready to take up this initiative quite seriously, should they take up an intense training program.

Recommendation

As it was inferred from this study, a common misconception that prevails in the Nation is that Grid Computing is used only by the scientists for their research. The primary objective of this study is to create the awareness of grid computing so that all industries (both small scale and large scale) that use computers and hence they can be benefitted through resource distribution and sharing. The recommendations that follow are adopted from this study that was carried out across Botswana.

From the study, it was understood that the primary objective to make the Nation 'Gridfy'[2-4] is to create awareness and to educate the concepts to the relevant population in the Country.

- Experts in this domain can take up the initiative to educate and train the target audience and also can support in deploying grid computing ambience in various organizations.
- Workshops could be organized across the Nation to disseminate and educate the IT personnel and staff in Computing academia about Grid Computing, Resource sharing & utilization and the benefits that they might acquire from this ambience.
- Campaigns to elucidate that Grid Computing Model could offer wide variety of solutions which can address the issues that might arise due to shortage in computing power, processing cycles and storage space[Gridcafe].

- Academia may identify effective short-term incentives and long term behavioral modification strategies in sharing resources that would be of particular benefit for mobile learning, where learners use portable devices with limited memory and processing power.[Grid café]
- Introducing Grid computing module in Schools of Computing will be a good initiative towards creating the awareness in the Country. Also, Distance Education and Higher Education are the fields more directly touched by grid application in education. Network grid makes[7] it possible for data-intensive streaming applications to be executed on non-specialized communication networks. This allows for audio and video applications to take place, such as remote learning sessions, and even collaborative sessions in which a large number of parties can participate.[Grid Comp in r and E].

Conclusion

This paper was motivated by the perception of Botswana about Grid Technologies and to measure the awareness levels across this developing Nation. Majority of Nation's population had been presuming that grid technologies are used to support advanced scientific projects. This research will be the initial step taken to change this mindset that had been prevailing across the country with the aforementioned recommendations. Through this research paper, the benefits of deploying grid technologies in Education and other non-academic industries were put forward. This endeavor has certainly brought out the readiness of the Nation in deploying grid technologies in all relevant sectors which is quite encouraging. Grid technologies are appealing due to the fact that the requirements for building such framework match very closely [8] what a grid can offer in terms of computational resources. Additionally, a grid offers a much more cost-effective solution, [9]as it employs existing low-cost and non-specialized computing resources to do the job. It is certain that the technological revolution thanks to grid technologies is about to bring will definitely change the way that people deal with information and, ultimately, knowledge. In this sense, grid computing and IT infrastructure form a perfect match in a developing country like Botswana.

References

1. De Haes, S, Van Grembergen, W, 'An Exploratory study into IT Governance Implementations and its Impact on Business/IT Alignment', *Information Systems Management*, vol. **26**, no. 2, pp. 123–137, October 2009.
2. C Burne. (May 2008). Five big ideas and grid powered projects. GridCafé Version 2. [Online]. Available: http://www.gridcafe.org/virtual-organizations.html
3. Abbas, "Grid Computing: A Practical Guide to Technology and Applications", Charels Media, 2004, Ch 3, pp. 34–46.
4. IBM Redbook, "Grid Computing in Research and Education" [online], 2005, ch 8, pp 79-91. Available: http://www.redbooks.ibm.com/redbooks/pdfs/sg246649.pdf
5. Xenos M., Avouris N., Komis V., Stavrinoudis D. and Margaritis M., "Synchronous collaboration in distance education: a case study in a Computer Science Course", Proceedings of the 4th IEEE International Conference on Advance Learning Technologies, Joensuu, Finland, pp. 500–504, August 2004.
6. S. Pandey, W. Voorsluys, M.Rahman, R. Buyya, J. Dobson, and K. Chiu, Brain Image Registration Analysis Workflow for fMRI Studies on Global Grids, Proceedings of the 23rd IEEE International Conference on Advanced Information Networking and Applications (AINA 2009), Bradford, UK, May 26-29, 2009.
7. R. N. Calheiros, E. Alexandre, A. B. do Carmo, C. A. F. De Rose, R. Buyya, Towards Self-Managed Adaptive Emulation of Grid Environments, Proceedings of the 14th IEEE Symposium on Computers and Communications (ISCC 2009, IEEE Press, New Jersey, USA), Sousse, Tunisia, Jul 5-8, 2009.
8. R. Buyya and K.Bubendorfer , "Market Oriented Grid and Utility Computing", ch 5, pp 45-67, Wiley Press, New York, USA, 2009.
9. R. Buyya and S. Venugopal, "Market Oriented Computing and Global Grids: An Introduction", Market Oriented Grid and Utility Computing, pp 98-107, Wiley Press, Hoboken, New Jersey, USA, Oct. 2009.