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Application of Grid Computing for on line Learning Resources

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There is a big difference in education sector between first world and developing world. This difference is based on digital learning resources and computing power. Unfortunately all of these resources are geographically distributed all over the world. There is no doubt that ICT is playing a big role for introducing E-learning around the world. But if we really want to overcome these differences we need a revolutionary approach that support mutual use of geographically distributed computing and learning resources as an aggregated environment that will create new ways of flexibility, interoperability and extensibility. According to IBM there are millions of distributed computers on the web and most of the computing powers of those PCs are under utilized. Fortunately Grid is the technologies that can integrate all of these resources of knowledge’s and produce super-computing power from those geographically distributed computers to access those knowledge’s without sacrificing local autonomy. In this paper we will describe the ICT infrastructure for on line collaborative learning and then we will design service oriented Grid technology that will be able to support ICT infrastructure by generating supper computing power from distributed resources for sharing learning resources. We will also analyze the challenges related with technology, standard, security and performance of grid Technology for resource share and management based on literature review and cutting edge technologies of available industry standard software and toolkits. Finally we will propose recommendations for successful implementation of Grid technology with ICT for collaborative leaning revolution in the world. Methodology of this paper is based on study, analysis and literature review as well as empirical as we will do few experiments using grid tools to taste feasibility of this technology.

1. Introduction

E-learning is the key stream of Information Technology Revolution around the world as with the help of it learning materials can be delivered to the users even in remote place without having any physical presence of the teacher. Due to this revolutionary approach many techniques of E-learning have been developed and implemented by various organizations of the world like client-server, peer to peer or modern web service architecture [Vossen G., Westerkamp, 2003]. But the main disadvantages of E-learning is related with scalability, availability, distributed computing power and memory allocation. As a result E-learning is using in areas that do not highly require these requirements. Thus the power of E-learning cannot be explored properly for the welfare of man kind. But with the passage of time E-learning desperately requires sharing and further uses of knowledge resources, interoperability and different types of interactions among them and this is the place where the concept of grid technology is required. By recommending the use of grid computing as scalable, flexible, coordinated and secure
resource sharing among geographically distributed individuals and organizations [Foster, I and Kesselman, C.and Tuecke, S. 2001] based on E-learning, we will be able to define these matters. The middleware based on Grid Technology and recent developed web service [Newcomer, E. 2002] is capable to support developers an integrated architecture facilitating E-learning system development. Moreover to reuse the functionalities of grid services we have to implement the middleware as well as grid services. In this way, many organizations based on E-learning service and content providers will be able to take part for generating a very large scale integrated e-learning system.

**ICT Infrastructure for supporting GRID**

Grid Technology is completely based on Web services and web services completely depends on Internet. As a result Internet Backbone is the main source of Grid. As Grid technology will generate super computing power from distributed resources the internet line must be able to support those activities with maximum data rate. The Information and Communication Technology (ICT) of the world is divided in three parts. First the submarine cable that is the main backbone of the world which is the supper high way of information and faster enough to support Grid as for example SEA ME WE-4 is the submarine cable that connects all most all countries of Asia, Middle East and Europe. This submarine cable provides at least 10 G.B Bandwidth to each of the countries which is sufficient enough to support Grid Technology. Second is the Fiber Optic Communication Backbone of respective countries. Every country has its own optical fiber backbone network. This should be sufficient enough to carry this 10 G.B bandwidth and should be capable enough to distribute 8 to 10 mbps to individual nodes by using wired or wireless broadband. This requirement is also necessary to access online application software’s or online video streaming for E-Learning. Fortunately by January next Wimax will make a revolution for wireless broadband internet for rural area. As Grid with E-learning infrastructure can make an educational revolution for rural parts of the world all those countries must ensure internet availability with this ICT infrastructure to get maximum output.

**Role of Grid Technology for Future E-learning System**

E-learning is a revolutionary approach for spreading education around the world. The key elements of this technique are learner, author and administrator. Authors who may also be teachers are responsible for preparing content which is stored under the control of learning management system (LMS) and basically in a database [Vossen, G., P.Jaeschke, 2002]. Contents of E-Learning resources should be regularly updated and there should be facility to exchange contents among different resources or systems. Basically the Learning management system is maintained by an administrator. User or Learner can interface with this LMS any time from any place. These three key elements should be distributed in different systems. Different learners require different things. They have different ability, different target and different speed of learning. In this way
the learning groups are heterogeneous. For example a student of computing may want to run simulation software of robotics and another student may want to see the simulation result of chemical reactions. From this point of view to meet all the requirements of all learners E-learning environment must support integration of several resources and materials, the potential deviation from predetermined sequence of action [Casati, F., U.Dayal, Eds, 2002], personalization and adaptation and verifiability of work and accomplishment [Vossen, G., P.Oberweis, 2002]. Unfortunately most of the E-learning Systems are only trying to concentrate to reuse the resources for all rather than extending the size of the storage or computation power that can support simulation based learning technique. For example E-learning system [IMSContentPackagingSpecifications, 2005] is a traditional system that only concentrates on reusability rather than Web services let alone Grid technology. Very few E-learning systems are now trying to use the web service to enhance the integration of various applications that are very useful for E-learning. For example most of the Universities of USA and UK are offering Web service based architecture for E-learning to extend there quality of education all over the world using online. Now the fact is if we want to integrate the E-learning services of various universities of UK and USA definitely we have to require an intermediate platform that will search and select all of these E-learning services and will produce a giant product of knowledge that is the composition of all of these resources. The successful use of Web services for E-learning demands various types of application software’s that will create user friendly environment between learners and E-learning resources to produce various types of services to learn quickly. For example information retrieval is an important feature of web based E-learning system because various types of learners may want to search for various information’s from the millions of information’s as a result search engine software has to be distributed to all learners or it has to be built on the E-learning Website that should be the ultimate choice for successful E-learning system [FU, 2004, FUY, Mostafa.J, 2004]. Moreover with the help of web service various types of simulation software can be installed with E-Learning systems specially for practical based education system. With the help of this simulation software learners will be able to do their lab based experiments residing in home and this may vanishes the criticism that E-learning may not effective for lab based education. Fortunately many organizations and universities have high quality learning resources with different simulation software’s for different arenas. Unfortunately all of these valuable learning resources are distributed around the world. Next generation E-learning system must integrate all of these geographically distributed resources. But for this large volume of information and related application or simulation software’s there is a necessity of large storage. On the other hand millions of learners can access or run these information’s or simulation of application softwares. To manage these millions of activities definitely we need largest supper computing power which is not possible to build by the scientists at present or near future. From this point of view Grid is the technology that can combine storages as well as computing power of the processors from various computers, servers
of learning resources that are geographically distributed around the world and connected with web services. If it is possible with the help of Grid technology then it can be ensured that there will be no difference between on campus education and distance or E-learning rather than E-learning system based on Grid will dominate the class room or lab based education.

**Grid Technology**

The concept of Grid has been taken from power grid of electricity where grid is the backbone to carry the main power that is generated from various sources and all users who have access to the power grid can share electricity without knowing from where they are getting the electricity. Like this in computing geographically distributed various types of resources like, CPU of computers, various types of servers or storages can be connected through internet with the help of web services to produce a super highway of information’s, storages and computing power that can be shared by any user from any parts of the world. According to the IBM that most of the computers on the web are idle in most of the time. Grid technology can aggregate all of the powers from the CPUs to generate a super computing power that will help millions of users to access various types of services simultaneously. Grid computing unifies geographically distributed resources in such a way that it seems to be a large powerful computer. Grid computing extends this view to a large scale flexible, secure, coordinated resource sharing among dynamic collection of individuals, institutions and resources [Foster, I., C.Kesselman, S.Tuecke, 2001]. The next generation of scientific experiments and studies, popularly called as e-Science will be carried out by communities of researchers from different organizations that span national and international boundaries. However data grid service has to face two challenges of large datasets and multiple data repositories at distributed locations in data-intensive computing environments [Chervenak.A, Foster.I, Kesselman.C, Salisbury.C, and Tuecke.S 2000]

**Web Services**

Internet is the amazing invention for communication around the world but web service is the tool that makes internet as a service oriented technology for human beings. A web service is a stand alone software component that has a Unique Resource Identifier that works based on various types of standard protocols. Basically there are four types of protocols which are used by web services. Web service description language (WSDL) is used to specify the operations that are supported by web services [Christensen, E., F.Curbera, G.Meredith, S.Weerawarana, 2001]. The simple object access protocol (SOAP) is used to exchange structured data through web. Hyper text transfer protocol (HTTP) is used to help the function of (SOAP) protocol. Universal description discovery and Integration protocol (UDDI) is used to discover new service on the web [Bellwood, T., L. Clement, D. Ehnebuske, et al, 2002]
Integration of Grid Middleware for E-learning

Figure 1: Layered Grid Architecture

Basically grid technology is based on middleware that is used to provide all services of grid technology. Actually middleware acts as a protocol which is used for communication from source to destination and vice versa. This middleware is a combination of programs where communication technique has been defined. This middleware is divided in five individual layers which are responsible for individual tasks. The lowest layer is called fabric layer which will be responsible to provide uniform access to all E-learning resources like servers, storages that contain learning materials or softwares. It also ensures interoperability. This layer has to be installed locally in all learning resources to connect with Grid. Connectivity layer contains communication and security protocols to protect learning resources of grid. Cryptography algorithm is installed in this layer as a result authentication will be required for learner, teacher or for administrator. After authentication they will be able to access any resources. This grid security will also cooperate with local security technique of each resource. Resource layer is responsible to provide access to single learning resource and also look after the status of that resource. Collective layers coordinate global access for collection of resources. Calculation or information’s are distributed in this layer. Finally application layer contains all Grid applications. The function of grid middleware has been already tested in various projects with Globus or Condor-G. Specially Globus toolkit with its Open Grid Service Architecture [Foster, I., C.Kesselman, J. Nick, S. Tuecke, 2002] has already been proved as a best and it should be the best for Grid on E-learning. To use the grid technology user just need Java enable internet browser.
4. Standard software and toolkits of Grid

A software toolkit is used for addressing key technical problems in the development of Grid enabled tools, services, and applications that actually contain a “bag of technologies”. This toolkit is also used for incremental development of Grid application and to implement standard Grid protocols and APIs that support open source license. This Globus Toolkit is responsible for authentication, scheduling, file transfer and resource description. Condor-G is also software that drives Globus toolkit to execute jobs of Grid or to solve any kind of computing related problem. Condor-G is the most successful software for Grid services and has been already implemented in various Grid related projects in Europe as it combines the strength of both Condor (Runs jobs within a single administrative domain) and Globus Toolkit (Runs jobs through many administrative domains).

4.1 Challenges of Grid Service

1. Poor ICT infrastructure to support Grid Technology especially in 3rd world countries who need it most.
2. Lack of awareness about the advantages of Grid
3. Lack of expert ICT professionals who may be capable of installing and maintaining Globus toolkit or Condor.
4. Grid Technology is not yet included as a major course in undergraduate and post graduate levels.
5. World class IT training providers like Microsoft, Cisco, Comptia have not yet started any professional certification course on Grid Technology.
6. Security may be a big challenge for Grid because attacks on Grid services allow attacker to get into any resources of the Grid.

4.2 Recommendations for Grid Service

1. Governments of the 3rd world countries have to implement a master plan of ICT that will support high speed internet access to support Grid Technology.
2. The main beneficiary of Grid technology based E-learning will be the developed countries as well as rural people. So First initiative has to be taken by them.
3. Ministry of education should come forward so that all schools, colleges and Universities can be registered under the same Grid platform for E-Learning.
4. Grid should be included as a major course in both under graduate and post graduate courses of computing or ICT.
5. Different ICT based organizations should send their ICT professionals for training to Europe or North America where Grid technology has been implemented.
6. It may be difficult to bring all E-learning resources of the world under same Grid platform but it is quite possible to bring the entire E-learning resources or Universities of SAARC region under same Grid Platform so that a cooperative learning and knowledge sharing environment can be established.
7. Finally as security may be a major threat for Grid, organizations should take necessary initiatives to monitor the online security all the time.

5. Conclusion
Quality education is the first priority for sustainable socio-economic development and with the help of ICT E-learning is playing a great role for spreading online education around the world even in rural areas. Although ICT is reducing the difference between on campus education and distance education still there are few limitations of E-learning for Lab based education due to computation power. Fortunately Grid is the technology which can generate knowledge Grid with super computation power to access that knowledge by sharing distributed E-learning resources. It is the responsibility of scientists to concentrate on further research on Grid so that they can spread this light of the knowledge for the deprived people of rural areas of Asia and Africa rather than keeping it inside a small machine.

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