# A GRID-BASED E-LEARNING MODEL FOR OPEN UNIVERSITIES

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## Abstract

E-learning has grown to become a widely accepted method of learning all over the world. As a result, many e-learning platforms which have been developed based on varying technologies were faced with some limitations ranging from storage capability, computing power, to availability or access to the learning support infrastructures. This has brought about the need to develop ways to effectively manage and share the limited resources available in the e-learning platform. Grid computing technology has the capability to enhance the quality of pedagogy on the e-learning platform.

In this paper we propose a Grid-based e-learning model for Open Universities. An attribute of such universities is the setting up of multiple remotely located campuses within a country.

The grid-based e-learning model presented in this work possesses the attributes of an elegant architectural framework that will facilitate efficient use of available e-learning resources and cost reduction, leading to general improvement of the overall quality of the operations of open universities.

## 1. Introduction

E-Learning is overtaking conventional classroom teaching methods. Via this approach, knowledge can be more flexibly propagated and absorbed irrespective of the teaching personnel and learners. Many universities in the world are adopting e-learning as their principal teaching method.

Distance Education is a vital link in the application of e-learning. The advantage of Distance education is that it can solve the problem of geographical location with Accessibility for those living far away from the educational center. Furthermore, it can conserve money, time and energy consumed in commuting between classes, improved flexibility to study in any convenient location with an Internet connection, Just-in-time learning; more opportunities to study the most current material available, flexibility for those with irregular work schedules, accessibility for those with restricted mobility (e.g., handicapped, injured, elderly), and accessibility for those with family responsibilities (e.g., parents with young children at home). This has been the focus of Open Universities.

Distance Education delivery mode for e-learning can roughly be classified into the four described below [8].

### 1.1 Voice

Instructional audio tools include the interactive technologies of telephone, audio conferencing, and short-wave radio. Passive (i.e., one-way) audio tools include tapes and radio.

### 1.2 Video

Instructional video tools include still images such as slides, pre-produced moving images (e.g., film, videotape), and real-time moving images combined with audio conferencing (one-way or two-way video with two-way audio).

### 1.3 Data

Computers send and receive information electronically. For this reason, the term "data" is used to describe this broad category of instructional tools. Computer applications for distance education are varied and include:

- Computer-assisted instruction (CAI) - uses the computer as a self-contained teaching machine to present individual lessons.
- Computer-managed instruction (CMI) - uses the computer to organize instruction and track student records and progress. The instruction itself need not be delivered via a computer, although CAI is often combined with CMI.
- Computer-mediated education (CME) - describes computer applications that facilitate the delivery of instruction. Examples include
- Electronic mail, fax, real-time computer conferencing, and World-Wide Web applications.

### 1.4 Print

Print is a foundational element of distance education programs and the basis from which all other delivery systems have evolved. Various print formats are available including: textbooks, study guides, workbooks, course syllabi, and case studies.

Although Distance Education has many advantages, its principal drawback is the costly and complex technology associated with using E-Learning platform. In order to help Open Universities apply Distance Education, this paper propose adopting Grid Computing technologies such as Access and Data Grid that features expandability, resource-sharing and virtual collaboration capability to enhance quality of pedagogy on the e-learning platform.

## 2. Related Work

There are a number of approaches to Grid-based E-learning that have been reported in literature.

In [7], Grid Computing and Parallel Virtual File Server (PVFS) Technologies for Construction of an e-Learning Environment was used to integrate the idle computer storage spaces in academies so as to save cost and make the best use of available resources.

In [6], an e-Learning Platform Based on Grid Architecture also employ Data Grid to integrate idle computer resources in enterprises into e-learning platforms, thus eliminating the need to purchase costly high-level servers and other equipment.

In [3], a grid enabled E-Learning framework for Nigeria Educational Institution was proposed. The solution proposed leverages an intergrid infrastructure that has the capability to enable virtual collaboration and resource sharing among remotely located partnering Universities.

In [12], a novel E-Learning architecture along with an implementation approach to build efficient E-Learning applications was proposed. In the architecture, E-Learning infrastructure used the Grid technology to choose the best available resources for E-Learning objects execution.

## 3. Grid Computing Infrastructure

The grid computing paradigm [5] essentially aggregates the view on existing hardware and software resources. The term “grid” alludes to an electric power grid and emphasizes the perception that access to computational resources should be easy as the common access to power grid. In addition, a grid user should not have to care where the computational power he or she is currently using comes from.

Grid computing is a form of distributed computing that involves coordinating and sharing computing capability, application, storage device, or network resources across dynamic and geographically dispersed institutions. When we turn on the PCs or facilities on the grid, other computers among the grid will search amongst themselves to begin processing and computing the relative work. This work not only uses the resources of the local computer, but also obtains the powerful virtual resources from other remote computers, including the computing and storage capabilities, application programs, database and I/O devices spread over the whole grid. This is then called “Grid Computing”. In other words, “Grid Computing” can be considered as a virtual super computer [4].

### 3.1. Access Grid and Grid Computing

Access Grid is the technology developed by U.S. Argonne National Laboratory. It enables many people to process interactions and opinion exchanges through video and audio. At present, it has been used in many sites that need video such as training, teaching, conference and seminar, etc. The application software of Access Grid is called Access Grid Toolkit. This is a freeware that can be freely downloaded from the Access Grid web site. The web site also provides complete technical archives that give the needed assistance to its users. The latest version of Access Grid Toolkit is Version 3.1. This release includes new functionality, including the latest VIC (video) and RAT (audio) tools from the Sumover project, support for hierarchical venue data storage, improved bridging support, and certificate-based Venue access controls [2].

After Version 2.0, Access Grid has already tightly combined with Grid technology, therefore the Grid Middleware Globus Toolkit needs to be installed before the installation of Access Grid Toolkit 2.0.

The middleware Globus will check thoroughly all the available resources in the Grid when making a computing task, such as which hosts are available, how much processing capability is left, what the available data is in the database. Then, the tasks required by the users will allocate its resources and control its action by the system.

As Access Grid 3.1 has already tightly combined with Grid so that all the functions of Grid technology such as authentication, resource allocation, and remote data access and fault detection are the standard function of Access Grid; at the same time, XML Web service is also the data transmitting method of Access Grid.

### 3. 2. Globus Toolkit

The Globus Toolkit (GT) has been developed since the late 1990s to support the development of service-oriented distributed computing applications and infrastructures.

The vital task in realizing a Grid is establishing a common open standard. Its core is based on an open set of standards and protocols - e.g., the Open Grid Services Architecture (OGSA) - that enable communication across heterogeneous, geographically dispersed environments. With Grid Computing, institutions can optimize computing and data resources, pool them for large-capacity workloads, share them across networks, and enable collaboration [9]. Some protocols and applications have been proposed and implemented in actual works, such as the GT [1].

The GT is an open-architecture, open-source suite of services and software libraries that support Grids and Grid applications. It provides software tools that enable coupling with computers, databases, and instruments. With Globus, jobs can be run on two or more high-performance machines at the same time, even though these machines might be located far apart and owned by different institutions. The toolkit includes software for security, information infrastructure, resource management, data management, communication, fault detection, and portability.

The GT components most relevant to OGSA are the Grid Resource Allocation and Management (GRAM) protocol, the Meta Directory Service (MDS-2), and the Grid Security Infrastructure (GSI). These components provide the following essential elements of a service-oriented architecture:

1. GRAM protocol: this component provides for secure, reliable, service creation and management of arbitrary computations.
2. MDS-2: this component provides a uniform framework for information discovery through soft-state registration, data modeling, and a local registry.
3. GSI protocol: this component supports single sign-on, authentication, communication protection, and certification mapping.

GT5.0 being the latest release contains an upgrade to the web services specifications used by the toolkit as well as new features in all services [11].

### 3.3. Data Grids

Scientific studies such as high energy physics and computational genomics require access to large amounts of data, that will require management services such as data file management, replicated files management and transfer, and distributed data access management. The data grid infrastructure integrates the data storage devices and data management service into the grid environment. Data Grid consists of scattered computing and storage resources, which, though located in different countries, remain accessible to users. [13]

The proposed Grid-based E-learning framework will adopt the GT as the Data Grid infrastructure. Many research projects, such as EU DataGrid [17] and Particle Physics Data Grid PPDG [15], are based on the GT. The Globus Data Grid comes in two layers. On the Low Level are Data Grid Core Services, and on the upper layer are High Level Components [18].

The storage system is a basic data grid component. It defines and covers all storage technologies capable of adding, deleting, reading, writing and operating file instances [10], such as HPSS, and DPSS (Distributed Parallel Storage System). Data access services are set up to access, manage, and transfer data in the storage system [14].

## 4. Architectural Framework

The Grid-based E-Learning Model Architecture for open Universities being proposed in this paper emulates the grid-cluster model that was implemented in [6]. With implementation for the front end that consist of the Grid Portal and the back end to contain the Data Grid contents. Here we introduced the Access Grid layer as shown in figure 1.

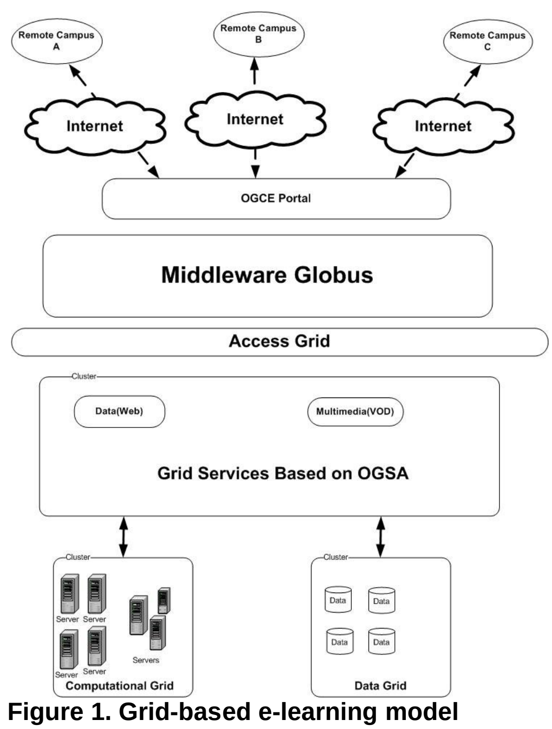


**Figure 1. Grid-based e-learning model**

### 4.1 The front end

At the front end, a portal web site is set up in the Grid system to provide services to Grid members and acts as a teaching platform for other remotely located campuses via the Internet. Campuses that have not joined the Grid will be restricted in their access to some resources.

The Education Grid set up will make use of the NMI's OGCE (Open Grid Computing Environment) Portal [16] as the network Grid Portal Site. The OGCE Portal includes the following functions:

1. Posting on the Discussions board and communicating with friends in Chat rooms, and providing users with the latest grid-related technological updates in the News section;
2. Monitoring Grid resources, such as node operating conditions;
3. Submitting tasks for Grid operations;
4. Transmitting data within the Grid via GridFTP; and
5. Managing the Grid CA via the Proxy Manager.

The OGCE Portal framework provides a general portal architecture that supports virtual organizations composed of scientists and project developers, which provides the API for the development of reusable, modular components that can be used to access the services being developed within the Grid organization.

The middleware Globus is responsible for checking systematically all the available resources in the Grid when making a computing task.

The Access grid enables virtual collaboration between lecturers, students, researchers, etc to process interactions and opinion exchanges through video and audio. It also enables the campuses integrate teaching courses and materials within the grid for enhanced teaching flexibility.

### 4.2 The back end

The back end comprises of the Data grid, Computational grid and any other grid infrastructure as depicted in figure 1 above.

The Data grid technology will comprise of idle teaching or administrative storage computer resources within the campus. This will be used as a substitute for the demand of a large storage server knowing that as the size of teaching material(multimedia, text etc) and the number of students who use this e-learning platform (for real-time courses or watch if absent) increase, there will also be a need for a high level storage server.
With the Data grid, it is possible that the storage space obtained will not be less than that of an expensive storage device, such as a Disk Array or NAS, in serving as an e-learning platform storage device.

The Computational grid will comprise of resources that will improve the processing capability of users on the Grid.

## 5. Conclusion and future work

The implementation of the grid-based e-learning model presented in this work will facilitate efficient use of available e-learning resources and cost cutback, virtual collaboration between remotely located campuses leading to general improvement of the overall quality of the operations of open universities.

As an immediate next step, we intend to implement the concepts presented in this paper using the National Open University of Nigeria (NOUN) and its study centers located in various states in the country.

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