World Academy of Science, Engineering and Technology
International Journal of Computer and Information Engineering
Vol:3, No:1, 2009

Grid Learning; Computer Grid Joins to e-Learning

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***Abstract*—**According to development of communications and web-based technologies in recent years, e-Learning has became very important for everyone and is seen as one of most dynamic teaching methods.

Grid computing is a pattern for increasing of computing power and storage capacity of a system and is based on hardware and software resources in a network with common purpose. In this article we study grid architecture and describe its different layers. In this way, we will analyze grid layered architecture. Then we will introduce a new suitable architecture for e-Learning which is based on grid network, and for this reason we call it *Grid Learning Architecture*. Various sections and layers of suggested architecture will be analyzed; especially grid middleware layer that has key role. This layer is heart of grid learning architecture and, in fact, regardless of this layer, e-Learning based on grid architecture will not be feasible.

***Keywords*—**Distributed learning, Grid Learning, Grid network, SCORM standard.

I. Introduction

WEB-BASED learning, tries to ease the process of teaching and learning; So all electronic tools and equipments are used to relate learner with environment. This model has benefits that we can rarely find in classic learning environments; such as interaction between learner and resources, independency from time and place, supervisory capability and continuous validation [1].

At the other hand, according to increasing band-width and usage of multimedia, e-Learning is used widely in on-line classes [2].

Although there are many benefits for e-Learning, but we can name some of its disadvantages as below:

1) Difference between LMS (Learning Management System) and LCMS (Learning Content Management System).
2) Difference between standards and formats of creating electronic contents.
3) Difference between learner's and teacher's skill.
4) More attention to content and less attention to interaction and co-operation.

Considering that most of current e-Learning systems are based on client-server or peer- to - peer model, they have some limitations; such as scalability, shareabilty [3], accessibility [4], availability, distributed computing and storage.

In this paper we introduce a new suitable architecture for e-Learning which is based on grid computing and we call it *Grid Learning Architecture.*

Grid computing opens a new horizon to e-Learning. In other terms, e-Learning shall:

1) Use power of distributed computers in grid network to create virtual labs.
2) Use distributed contents to create a completely customised class for learners.
3) Make possible collaboration between education resources, contents and services within grid network [5].

II. e-Learning Systems

Most e-Learning systems consist of 4 parts as below:

1) Role management.
2) Authoring system.
3) Learning Management System (LMS).
4) Run-Time Environment.

We can show such a system in Fig. 1. In this figure, relations are seen in addition to system parts.

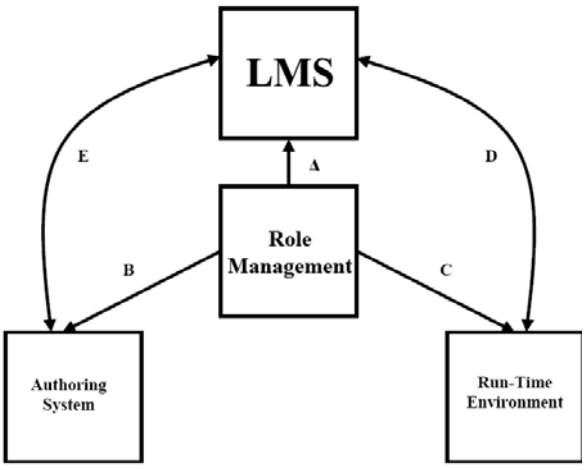

Fig. 1 Convention model for e-Learning architecture

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III. Grid Computing

Grid computing is a pattern for increasing the computing power and storage capacity of a system and according to hardware and software resources in a network.

The name *Grid* is based on electric power distribution grids. In those networks, consumer does not know that his/her power is supplied from which specific power plant. The connection, itself, is more important [6], [7].

IV. Grid Architecture

Grid architecture has a 5-layer basis. We can see this architecture in Fig. 2. The layers are:

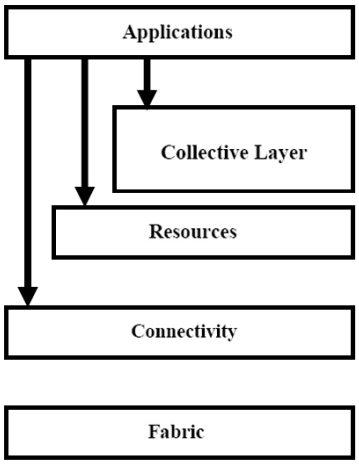

Fig. 2 Grid protocol architecture

1) Fabric Layer: The lowest layer in grid architecture. All shareable resources are placed in this layer; such as processors, memories, sensors and actuators. It is clear that in grid network, grid protocols are responsible for resource control.

2) Connectivity Layer: In this layer those protocols are placed which are related to communication and authentication.

3) Resource Layer: All common actions related to network parts are guided in this layer; like negotiation, initiation, monitoring, control, accounting and payment.

4) Resource Layer: All common actions related to network parts are guided in this layer; like negotiation, initiation, monitoring, control, accounting and payment.

5) Collective Layer: Any Collaborative operations in the shareable resources are placed in this layer.

V. Web Services

Web services are methods for required softwares which we want to access in WWW easily; In fact, they prepare a platform for relation between installed softwares and different hardwares.

Web services standards are known as W3C. These standards are supported by softwares based on XML, SOAP, WSDL and UDDI; therefore, good approaches for heterogeneous resources problem are implemented. Forming XML-based metadata is a useful solution for interacting with different data; because not only make management of those data possible, but also ease interchange of such information and data.

Web services are described by XML and some details are considered for interaction between various services; such as message format, transport protocol and position of every required resource.

You can see web services architecture in Fig. 3. This architecture has 3 layers which are built on XML and DTD. Three other layers are considered as purposes; such as management, security and communication via different services.

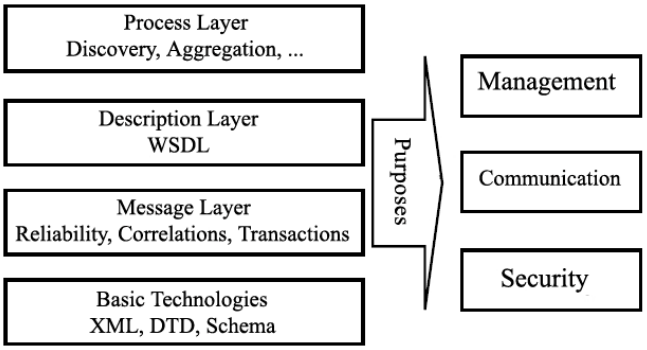

Fig. 3 Web services architecture and its purposes

1) SOAP (Simple Object Access Protocol): This protocol is lowest layer in web services architecture and is responsible for relation between consumer and provider of services. SOAP has a mechanism for sending and receiving messages and is compatible with STMP, FTP and HTTP protocol. SOAP is not necessarily used in grid networks and we can use other protocols according to our requirements.
2) WSDL (Web Services Description Language): This language is middle layer in architecture and describes web services; therefore, WSDL creates a framework for describing web services based on service protocols.
3) UDDI (Universal Description, Discovery and Integration): The highest layer in web services architecture. This layer has stored a standard description for services in itself. In other words, UDDI is a discovery service in WSDL layer to search a service properly.

VI. Suggested Architecture for E-learning Grid

According to grid network architecture, our suggested layered structure is shown in Fig. 4. This architecture has 5 layers as below:

1) Infrastructure layer: This layer constructs network communication infrastructure and consists of computer equipments and network protocols.

2) Basic service oriented architecture: This layer contains all services related to protocols such as WSDL, SOAP, UDDI and XML; so flexible and reliable interaction with upper layers will occur.

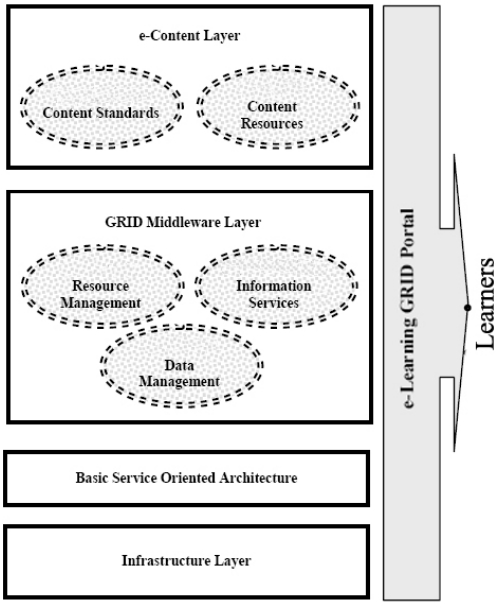

Fig. 4 Suggested Architecture for e-Learning Grid

3) Grid middleware layer: This layer is heart of suggested architecture. E-Learning based on grid architecture will be feasible with this layer.

4) Content layer: This layer consists of all educational resources, which are placed in separated systems.

5) E-Learning grid protocol: This layer is an interface between learners and grid network.

We will describe middleware and content layers more precisely.

A. Grid Middleware Layer

You can see details of this layer in Fig. 5. This layer consists of 3 service sub layers, called GRAM (Grid Resource Allocation and Management Services), MDS (Monitoring and Discovery Services) and GRLS (Grid FTP and Replica Location Protocol). The first point that should be considered in implementation of this layer is using Globus Toolkit 4 or shortly GT4. This toolkit provides us with all software tools which are necessary for grid computing among grid network [8].

1) GRAM: The activities which are performed in this sub layer are resource registry, resource execution, exploration of required resources and secure access to specific resources. The GRAM tool (Grid Resource Allocation and Management) is used for this purpose.
2) MDS: These services cooperate in process of using educational resources. We will be able to communicate in a full heterogeneous environment and have access to static and dynamic information flexibly.
3) GRLS: This part of layer contains all services which help us to manage grid computing environment. Grid FTP is a version of FTP that clarifies necessities of grid computing.

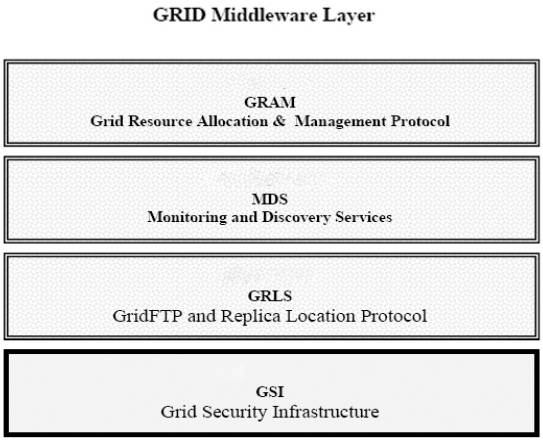

Fig. 5 Grid middleware layer in detail

B. e-Content Layer

This is the last layer in our suggested model and all learning contents are placed there. As we know, for containing and management of e-Contents we need a LCMS or Learning Content Management System. SCORM reference model [9] indicates factors for validating e-Contents. This standard is concerned to 2 subjects: packaging contents and interchanging information with run-time environment.

According to SCORM standard, a content package is consisted of 3 parts that we can see in Fig. 6.

Fig. 6 Packaging e-Content, according to SCORM standard

a) Manifest: Part of e-Content that gives necessary information for that package.
    a. Meta data: Identification information for introduction of e-Content; such as subject, author, multimedia type, etc.
    b. Organization: Information that show structure of e-Content.
    c. Resources: Part of manifest that indicates

resources in a tree structure.

b) Physical Files: All files which are used in creation of an electronic lesson.
c) Content Package Interchange File: Prepares a common infrastructure for interchange between packaging content and run-time environment.

C. e-Learning Grid Portal

In this architecture, grid portal is an interface between all learners and resources all over of learning grid; so all users after authentication (entering their user name and password) can access to related resource.

VII. Learning Process Design in e-Learning

One of the most important problems facing e-Learning designers is role of pedagogical requirements. Therefore, we should consider learner's activities in process [10].

An Important achievement in recent years is a framework called IMS-LD. This framework introduces a language for description of learning process which is known as *learning Scenario.* We can define various activities in learning process as series of rules [11].

In short terms, we have to consider a suitable scenario for learning in grid. In this case, 2 factors are notable: IMS-LD and technologic approaches for implementation of scenario [12].

VIII. Service Oriented Distributed e-Learning

Every Learning Management System (LMS) or Learning Content Management System (LCMS) has different capabilities and tools for users. Also, it may only use a text chat environment, not a video conference tool.

A *Service* is an entity in grid which has specific capability to do a job. As we mentioned before, service oriented architecture combines grid network with web services to reach a distributed frame work for learners [13].

So it is very important to consider standards for resources. These standards shall cover exploration, dedication, accounting and co-ordinations related to resources.

Some of the topics around Service Oriented Distributed e-Learning for future researches are:

1) User identification and authentication.
2) Learning policy management.
3) Learning services discovery.
4) Service level agreement.
5) Service level monitoring.
6) Virtual education organization creation.
7) Membership and inner communication management of services.
8) Orchestration of services.

IX. Grid Capabilities for Mobile Learning

The increase in computing power and development of equipment has created a new approach in e-Learning called *Mobile Learning* or *m-Learning.* Service oriented grid is a reliable and suitable platform for e-Learning and it is clear that its achievements are very important for m-Learning [14].

One of the notable benefits of service oriented grid is sharing services. In m-Learning, part of a giant software is loaded whenever is required. So, in our suggested architecture learner's machine does not need too many memories.

Another considerable point in grid e-Learning is using processors all over grid. Thus, according to little process power in mobile devices, it is possible to use other processors. This capability can be used in virtual labs and simulation systems.

X. Conclusion

Grid learning presents a new approach for e-Learning services. It is necessary to consider new technologies and architectures for grid networks. Consideration of standards and policy is notable too. According to geographical separation of grid networks, we should pay attention to user's behaviour and pedagogical requirements. Finally, a suitable process for learning must be designed.

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