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Implementing E-learning System Through Grid-network

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Abstract: Education is always improved by new technologies, especially with the emerging of computer related information communication technology. In recent years, e-learning has gained the great popularity as a convenient way of providing teaching methods and sharing knowledge all over the world. With the evolving development of network technologies the amount of information and services available on the Internet continues to rise. But currently, e-learning systems are reaching their limits due to the limitations in resource sharing, management, scalability and integration in the dynamic environment.

Key words: Education, technology, e-learning, grid computing, resource sharing

INTRODUCTION

Network education (including distance education and distance learning), or e-learning, which came out several years ago resulted from the development of the computer network. Wireless and mobile computing has enabled the mobile education or m-learning. With wireless and mobile convenience, it is very likely to realize anytime, anywhere, anyway, any device learning and instructing. In short, any new technology will enhance education and new function will provide better education service, but it will result in too much work to modify and update the old system.

Though many organizations have adopted e-learning, the software and hardware facilities they use vary greatly. This causes major difficulties in sharing teaching resources. Web service techniques enable the integration of different information systems within grids and solve this problem (Foster *et al*., 2001).

While, the Grid is often thought of in terms of providing a distributed system of high-performance compute resources, this is only one aspect of successful use of Grid computing. We can consider distributed computing resources as services, delivered by different organizations, which are used for enriching and improving e-learning environment. Grid technologies can satisfy the needs of effective e-learning system, dynamic resource and user management, resource sharing, integration and discovery, security among different, multi-institutional administrative domains.

With the Globus Toolkit version 4 (GT4) move to the Open Grid Standards Infrastructure (OGSI) and finally to Web Services Resource Framework (WSRF), Grid has matured to its latest development stage, adopting a service-oriented approach. WSRF defines conventions for managing state so that applications can reliably share changing information. In combination with WS-Notification and other WS standards, the result is to make grid resources accessible within web service architecture. GT4 for grid computing emerged as a middleware that addresses the common issues of web service based distributed systems, providing the building blocks for constructing the secure distributed systems for virtual organizations (Foster *et al*., 2001).

THE TECHNOLOGIES

The internet: The Internet is a global network enabled by a common set of simple protocols that allow theinter-operability among networks with different technologies, physical network interconnections and varying peering arrangements (Huston, 1999). Even though, the Internet has a complex topology, it has a structure that can grow quickly because there is no need of agreements and negotiations involving multiple organizations, a host in the Internet does not need to be directly connected to a large number of networks in order to have access to hosts in other networks. A self-healing structure is available, in which the failure of part of the network does not compromise the whole Internet. Although, ISPs (Internet

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Service Providers) compete with one another, peering allows peered ISPs to provide global connectivity (Metz, 2001), reduce the amount of traffic across an expensive boundary and improve the efficiency for their customers. In addition, its business model benefits end-users and compensates service providers (Huston, 1999). Routing protocols allow traffic to be diverted when it is not allowed or viable to cross a specific network but these protocols allow autonomous systems to deploy a range of routing policies based on internal interests (Feigenbaum *et al*., 2004). Networks are linked through routers in the Internet, therefore forming a large network of networks.

The world wide web and content delivery networks: The World Wide Web (WWW) is one of the major network applications that contributed towards the rapid growth of the Internet. Currently, the Web is a merge of network, protocols and hypertext, which has led to the emergence of a plethora of scientific and commercial applications and several business models. Although, the WWW provides a global system on top of the Internet that allows the sharing of several kinds of media, there have been concerns about the performance and quality of the content delivered to Web users. Content Delivery Networks (CDNs) address some of these issues. A CDN is an infrastructure that replicates Web content from origin servers to replica servers (surrogates) placed in strategic locations. The main aim is to minimize internet traffic and response time by making clients retrieve files from nearby servers. Each CDN is set up and operated by providers such as Akamai and Mirror Image. In addition, several content providers have set up their own CDNs. A CDN can generally grow to a certain extent due to economical and technical reasons that prevent it from covering specific regions such as the high cost of over provisioning. Content Delivery Internetworking (CDI) through the peering between CDNs has been proposed as a solution to this problem, allowing CDN providers to cover broader areas and minimize costs with infrastructures. However, CDI poses challenges like the definition of protocols and policies for internetworking of accounting systems, content distribution and request routing. The challenges imposed by CDI have some similarities with those of the internetworking of Grids.

The replication and delivery of Web through CDNs is crucial in today's WWW. Many Web sites rely on CDNs to deliver increasing variety of content, such as hypertext files, images, videos, among others. The outsourcing and placement of services in strategic locations is also a reality in current WWW. It is important to note that CDNs have incentives for cooperating with one another, to alleviate flash crowd events, provide a better QoS to their customers and minimize the costs of expensive infrastructures.

Ontology: Ontology is an explicit specification of a conceptualization. The term is borrowed from philosophy, where ontology is a systematic account of existence. For Artificial Intelligent (AI) systems, what exists is what can be represented. When the knowledge of a domain is represented in a declarative format, the set of objects that can be represented is called the universe of discourse. This set of objects and the describable relationships among them, are reflected by the representative vocabulary with, which a knowledge-based program represents knowledge. Thus, in the context of AI, the ontology of a program can be described by defining a set of representative terms. In such ontology, definitions associate the names of entities in the universe of discourse (e.g., classes, relations, functions, or other objects) with human-readable text describing what the names mean and formal axioms that constrain the interpretation and well-formed use of these terms. Formally, ontology is the statement of a logical theory.

In implementing e-learning through grid technology, ontology is used to describe the concepts of networked education platform and their relations. The ontology mainly includes two kinds of ontology: content ontology and activity ontology. Educational ontology is the core module to control other components.

Semantic web: The vision of the semantic web aims to have distributed data and services defined and linked in such a way that they can be used by machines not just for display purposes, but for automation, integration and reuse of data and services across various applications. Some functions of semantic web are described as follows.

Automatic web service discovery: Automatically finds the location of Web services that provide a particular function.

Automatic web service invocation: Involves the automatic execution of an identified Web service.

Automatic web service monitoring: Helps users or administrators know the status of a web service once it is invoked.

Automatic web service composition: Involves the automatic composition and interoperation of Web services to perform some tasks. With this function, some new activities can be composed automatically without programming.

Grid computing: From an application perspective, there are 2 types of grids: compute grids and data grids.

A compute grid is essentially a collection of distributed computing resources, within or across locations, which are aggregated to act as a unified processing resource o r virtual supercomputer (Rajan *et al.*, 2005). These compute resources can be either within or between administrative domains. Collecting these resources into a unified pool involves coordinated usage policies, job scheduling and queuing characteristics, grid-wide security and user authentication (Foster *et al.*, 2001). The benefit is faster, more efficient processing of compute-intensive jobs, while, utilizing existing resources. Compute grids also eliminate the drawback of tightly binding specific machines to specific jobs, by allowing the aggregated pool to most parallel jobs with fine-grained user.

A data grid provides wide area, secure access to current data. Data grids enable users and applications to manage and efficiently use database information from distributed locations. Much like compute grids, data grids also rely on software for secure access and usage policies. Data grids can be deployed within one administrative domain or across multiple domains. It is these cases where the grid software and policy management become critical. Data grids eliminate the need to unnecessarily move, replicate, or centralize data, translating into cost savings. Initial data grids are being constructed today, primarily serving collaborative research communities. Software vendors and large enterprises are currently investigating data grid solutions and services for business applications. Down the road, data grids will be a key element in the rollout of Web services.

The evolution from compute grids to data grids is an important factor in repositioning grid applications from education and research development to the large enterprise. This transition is an indicator that the market, in addition to the technology, is maturing. From a networking view. Grid computing is a service-oriented architectural approach that uses open standards to enable distributed computing over the Internet, a private network or both. This approach can help academic organizations and universities aggregate disparate IT elements such as computational resources, data storage, devices, instrumentations and sensors and filing systems to create a single, unified system and address fluctuating workload requirements.

At its core, grid computing enables devices-regardless of their operating characteristics to be virtually shared, managed and accessed across an enterprise, consortium or workgroup. Although, the physical resources that compose a grid may reside in multiple locations, users have seamless and uninterrupted access to these resources. This resource virtualization provides the necessary access, data and processing power to rapidly solve complex business problems on demand for research. Grid computing helps to promote the efficient utilization of technology resources and foster the creation of cost-effective, resilient IT infrastructures that are adaptable to change.

ARCHITECTURE DESIGN

Based on ontology, semantic web technology, grid technology, we propose a flexible network education platform architecture, as shown in Fig. 1. As indicated in Fig. 1, five components are included; user adaptation, auto composition, education ontology, service module and content module.

User adaptation: User Adaptation receives parameters from user and does some adaptation transformation. Threefunctions are involved: to get the user requests and context/preference, to complete device adaptation and take preference adaptation. The user requests mainly include the parameters input from keyboard, mouse and other input/output devices. User context is comprised of 3 major components of the client: hardware platform, software platform and individual applications, such as a browser. The user context and preference can be transferred to the server by Composite Capability/ Preference Profiles protocol. Device Adaptation module is an interface betweens human and Auto Composition module. One of the functions of device adaptor is to get

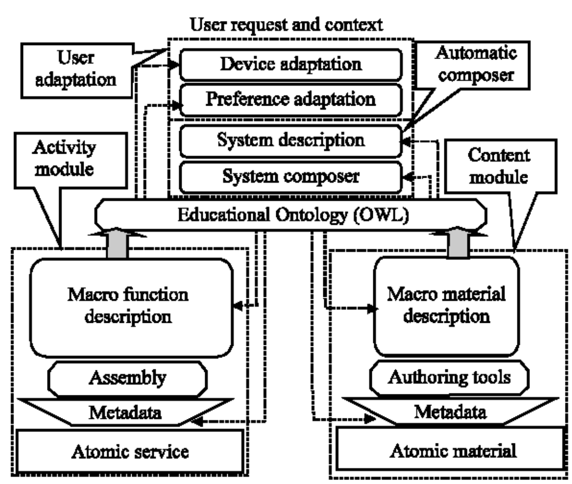

Fig. 1: Semantic web technology and gride technology

inputs from human, which are called physical inputs and then translate them into logic inputs, which can be understood by program module (machine understandable). Another, function of device adaptor is translating the logic outputs (pure data without presentation format) into physical outputs (its format is matched with the client device). Preference adaptation means the interface adaptability is in line with the user's preference.

Auto composition: Auto Composition is responsible for the creation of tasks according to the user request. This part includes 2 components: System Description and System Composer. System Description creates function description according to user's requests. The function is described with Ontology Web Language for Services. System Composer translates the function description into an implementation format with the published web services in grid system.

Education ontology: The education ontology includes 2 big parts: Activity Ontology (AO) and Material Ontology (MO). AO describes all the activities and operations of education and relations (including necessary parameters) among them. There are 3 levels in AO: conception level, metadata level and implementation level. The conception level gives a detailed description of education activities and its relations. The metadata level gives a detailed description of every activity, including function and parameters. We implement this level by OWL-S model, which can be processed by machine automatically. The implementation level refers to the execution code of education activity described in higher level. This level is implemented by web service, which may be distributed in any network location. The latter 2 levels are also called service model. MO describes the educational content organization that is also divided into 3 levels: conception level, metadata level and atomic material level. The conception level gives a detailed description of macro material concepts and its relations. The metadata level gives a detailed description of every atomic material, which is specified according to related standards. The atomic material level includes many atomic material entities of application domain. The metadata level gives a detailed description of all atomic material. The concept in the first level includes composition resource made of atomic or other composition resource. In practice, MO is implemented with Web Service resource model.

Service module: In order to raise, the traditional Web-based distributed learning to a new high level achieving a true dynamic model, the following requirements must be given special considerations.

Open architecture and interfaces: The framework should have an open architecture and open application interfaces to enable interaction and integration seamlessly between educational institutions, learning service providers and other entities that enable distributed learning.

High interoperability for information exchange: The framework should have the ability to take learning components or applications developed in one location with one set of tools or platform and use them in another location with a different set of tools or platform. In other words, these components can be retrieved from anywhere, anytime with any device (wired or wireless).

Flexibility: All the sharable learning objects in this model are loosely coupled, which means the system should offer a dynamic mechanism that allows developers to easily add or remove components anytime.

Accessibility: The learning objects can be published with well-defined description in a universal repository for search, discovery and retrieval by other remote applications that need them.

Durability and reusability: The system based on this framework should be designed in an object-oriented model, in which the learning materials or applications are treated as encapsulated components with well defined interfaces. As long as the interfaces remain consistent, these components can withstand technology changes without redesign, reconfiguration or recoding and can be reused in multiple applications and contexts.

Compatibility with other systems: The system based on this framework should provide an open standard interface to communicate with the third party learning applications.

As shown in Fig. 1, all educational services are organized in this hierarchy: the bottom services are atomic services, which are self-described and can not be divided into smaller operations, the higher level services are composed with the lower level services. All the learning objects, contents and applications are built as services with Extensible Markup Language (XML) front end and described with some generally available terms such as metadata so that service requesters are able to search and map these services to their needs.

Content module: This module is the same as the service module except for replacing service with content.

CHALLENGES

When considering a large-scale system such as the InterGrid, a number of challenges arise. This study discusses, some challenges that need to be addressed in order to realize the InterGrid vision.

Peering arrangements: In the internet, although there are standard protocols, ISPs have policies that define how the peering with other ISPs is performed. ISPs have agreements and implement the peering policies by defining what routes are preferable by considering the economic impact and incentives of peering with other ISPs. Work in Grid has focused on interoperability, but not on the peering between Grids and its economic implications.

Standards: A broad and well-attended standardization process has been going-on in the Grid community under the auspices of the Open Grid Forum (OGF) and based on the Open Grid Services Architecture (OGSA). The adoption of these standards is important for applications to be able to execute seamlessly over different Grids.

Different policies and mechanisms for resource allocation: Besides the interoperability between Grids at the middleware level, interlinking Grids requires advanced and automated mechanisms for inter-Grid resource allocation, reservation, accounting and scheduling (Dumtrescu *et al*., 2005). However, this is complicated by the different policies and mechanisms for resource allocation, followed within Grids, that may be incompatible with one another due to different levels of importance given to various resource usage criteria. This may create potential problems in reconciling different allocation policies or to create mechanisms to map policies from a Grid to another. An agreement on the standard criteria for resource usage and standard levels of Quality of Service (QoS) between federated infrastructures is therefore, required for inter-Grid resource allocation (Yu-Kwong *et al*., 2005).

In Differentiated Services (DiffServ), Differentiated Service (DS) domains can define Per Domain Behaviours (PDBs) that have associated Per Hop Forwarding Behaviours (PHBs), traffic classifiers and conditioners that specify how a given traffic flow is treated within a DS domain.

Particularly, a PDB aims to provide means to measure how a traffic flow is handled within the domain and is a building block for inter-domain QoS. A PDB specification intends to define under what conditions the output of a domain can be joined to another under the same traffic conditioning and expectations. PDBs can enable business agreements between ISPs regarding how one another's traffic flows are treated within their networks. The Grid community has been working towards enabling the recruitment of resources from multiple sites to process high-priority jobs. However, we envision that lessons can be drawn from other fields, such as DiffServ, to enable Per Grid Behaviours and QoS guarantees across Grids.

Incentives for collaboration and attracting service providers: In the internet, ISPs have incentives for cooperating and establishing peering agreements with one another. Consumers and enterprises have benefits in establishing their presence in the WWW. The InterGrid needs to provide incentives for equivalent participation of individual Grids and resource providers. A number of approaches have been proposed using economic models to address resource usage and incentives in a Grid. Particularly, a well designed market-based resource allocation mechanism provides incentives for participation by ensuring that all the actors in the system maximize their utility and do not have incentives to deviate from the designed protocol.

Connectivity and interaction patterns: The integration of Grids can enable a large number of interaction patterns, which would be difficult to design in terms of middleware, scheduling and resource allocation. It is advocated that overlay networks will be important in a large-scale Grid to tackle this heterogeneity and guarantee several interaction patterns. Overlay networks, are virtual networks that cover physical infrastructures such as the Internet and add value to them with some features and semantics. They can enable various interaction models through, Application Programming Interfaces (APIs) to abstract the middleware from the complexity of the underlying network.

Coordination mechanisms: As demonstrated by Ranjan *et al*. (2005), the most of current approaches to resource allocation are non-coordinated. Such approaches can lead to inefficient schedules and sub-optimal resource utilization. Coordination mechanisms that allow brokers and resource management systems to exchange information need to be put in place. However, the main challenge is that the InterGrid has Grids with different connectivity patterns.

CONCLUSION

In this research, we present a case model for implementation of e-learning systems through grid network as an evolvable and sustainable system. We start with the analysis of analogous global systems, how they have evolved and what principles can be applied to Grid computing in order to enable our vision. We then present the architecture with the aim of realizing it. A discussion on current issues that arise when linking islands of Grids as well as a gap analysis of current Grid technologies was provided to motivate the need for new technologies to enable the implementation of e-learning system through grid technology. The research contains a discussion on existing projects aiming at creating national and continental Grids. However, many applications currently require amounts of resources that are only achievable by creating Grids of Grids. Existing projects have tried to federate Grids and have provided means to enable virtual organizations to solve several problems. However, the Cyber infrastructure to cope with these and next generation challenges will not be realized given that today's Grids follow organizational models and mechanisms that prevent them from internetworking.

Current technologies do not allow the InterGrid vision due to conceptual and technological drawbacks such as the lack of coordination mechanisms. As argued in this research, there is a need for an architecture that allows Grids structures to evolve from the local to the InterGrid level and enables the easy development of Grid applications for e-Science and e-Business. In addition, many issues related to cultural, social and political divergences have to be considered or even solved. Like the Internet, the InterGrid will comprise of numerous self-interested stakeholders and the design of its architecture has to consider these aspects.

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