

A Generic Agent Based Cloud Computing Architecture for E-Learning

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Abstract. E-learning can be referred to as “education through electronic media”. It is one of the most emerging concepts in the field of technology. E-learning systems can be either synchronous or asynchronous. Agent based e-learning is helpful in managing the information overload, it can serve as academic expert and manages creation of programming environment for learners. There are many characteristics that an E-learning environment has to support; they are Interaction, Data Security, User Personalization, Adaptability, Intelligence, Interoperability, Accessibility and User Authentication. E-learning must also support a few other features like cost effectiveness, reusability, storage capacity, powerful computing and virtualization which can be provided by Cloud computing. Cloud computing is everywhere these days, pick any blogs, journals, papers. The Cloud computing Architecture is built using three models, Software as a Service (SaaS), Platform as a Service (PaaS) and Infrastructure as a Service (IaaS), which provides a variety of services. This proposed architecture integrates the features of Agents and Cloud Computing to produce an Agent based Cloud Computing Architecture to enhance e-learning.

1 Introduction

Electronic learning (E-Learning) has been widely adopted in universities and educational institutions in the last few decades. It offers a virtual online learning environment that facilitates the learning process. Cloud computing has also created a much hype in the IT industry in the past few years. It has the potential to play a vital role in the educational transformations. Software agents are also used widely to reduce system complexity. The following sub-sections give a detailed description about E-learning, Cloud computing and Software agents, which would help in the further understanding of our proposed architecture.

1.1 E-Learning

In recent years, E-learning has emerged to be the most effective and time saving way of learning. It is the most suited for distance learning and flexible learning.

It's providing education through the use of electronic media and information and communication technologies. E-learning can be either synchronous or asynchronous. Synchronous learning occurs in real time, with everyone interacting at the same time, while asynchronous learning is self-paced and allows participants to engage in exchange of ideas and information without depending on the involvement of others at the same time [1]. E-learning includes numerous types of media support that delivers text, audio, images, animation and streaming videos for interaction purpose. It also includes technology applications and processes such as audio or video tape, satellite TV and computer based learning. There are various technologies that facilitate e-learning; blogs, wikis, white boards, web casting and more. E-learning provides a better environment for learning. It also provides different learning courses based on the students' interest at any location and anytime away from classroom, which in turn maximizes the effectiveness of learning.

1.2 Cloud Computing

Cloud computing is a computing archetype where large number of systems are connected in a network to dynamically provide scalable infrastructure for applications, data and file storage. Cloud computing follows a practical approach of pay-per-use technique, where the consumers have to pay depending on what they use and how much they use. The basic idea of using cloud computing is a principle of reusing the IT capabilities. Cloud computing provides computation, software, data access, and storage services that do not require end-user knowledge of the physical location and configuration of the system that delivers the services. It helps in improving the ability of handling and computing large scale data [1]. It is growing rapidly, with applications in almost every area, including education.

Cloud Computing Service Models. Cloud computing mainly provides three levels of services within the system, referred to as delivery models, they are, Software as a Service (SaaS), Platform as a Service (PaaS) and Infrastructure as a Service (IaaS) [1].

Software as a Service. This is a model in which an application is hosted and delivered as a service to customers who can access it via the internet. When the software is hosted off-site, the customer doesn't have to maintain it or support it. This delivers software applications like, email, social networking, ERP, etc., through cloud infrastructure.

Platform as a Service. This model is the most recent development and it refers to the availability of the application development platform services through cloud infrastructure. This helps the developers to build and deploy applications without having to invest on the infrastructure.

Infrastructure as a Service. Infrastructure as a Service is the delivery of computing services (hardware, storage, and networking) through cloud infrastructure. It is described as utility computing datacenters that make use of cluster technology to provide powerful and flexible computing resources.

1.3 Software Agents

Software agents are computational autonomous entities capable of acquiring information and producing and sending information in an environment to accomplish set of designated goals. These agents possess certain characteristics [2]:

Autonomy: The Agent acts without the direct intervention by humans or other agents; it has control over its own actions and internal state.

Adaptivity: The Agents react flexibly to the changes in its environment. They take goal directed initiatives.

Sociability: The Agent is capable of interacting in peer-to-peer manner with humans or other agents.

Competency: The capability to effectively manipulate the problem domain environment to accomplish the prerequisite tasks. Competency includes specialized communication proficiency.

Amenability: The ability to adapt behavior to optimize performance in an often non-stationary environment in responsive pursuit of the goals of the client.

We have designed this architecture using certain powerful characteristics of agents, where different agents are assigned different functions which are integrated into a single system. The agents deliver services to the client by acquiring the services from the cloud. These agents can be configured through an agent configuration interface to perform its job on behalf of the clients for a certain set of features of an E-learning system. It can retrieve information such as that about students' learning progress and study their behavior; aggregate the information, etc. One of the advantages of the agent-based approach is that many times a complex processing function can be broken into several smaller, simpler ones. Since each individual agent can be crafted to be an expert in solving a specific problem or performing a particular task, you can build systems that exhibit complex behaviors by using a collection of relatively simple agents. Incorporating Agents with the cloud make the cloud services smarter and an efficient application.

In this paper, section 2 presents the Related works which discusses about the previous architectures and their disadvantages, section 3, we propose our architecture and explain its functioning, section 4 we analyze our architecture and describe it's advantages, section 5 presents the conclusions and future enhancement.

2 Related Works

In this section we present a few earlier proposed architectures depicting various cases of using cloud computing but not agents and those using agents but not cloud computing.

- (1) Zhang Guoli and Liu Wanjum [3] developed an architecture based on cloud computing platform for E-learning. It is composed of three layers: Infrastructure layer of E-learning Platform, Layer of platform integration and Application layer. The Infrastructure layer provides system software, information management systems, scheduling combination and utilization of teaching resources. The layer

of platform integration integrates variety of resources belonging to different organization and various platforms in Infrastructure layer. The Application layer has the application of integrating the teaching resources in the cloud computing model including interactive courses and sharing teaching resources. This architecture mentioned the advantages of using cloud computing in E-learning and concluded that cloud computing platforms can be widely used in distance education and online learning.

- (2) K. Sakthiyavathi and K. Palanivel [4], proposed a generic Layered architecture which supported all the agents in one single system. The architecture is provided with a user interface layer, which provides adaptive interface for online learners, a middle layer which consists of all the agents needed by the system and a lower

Table 1. Drawbacks of different architectures

Architecture	Draw backs
A Novel Approach for Adopting Cloud based E-Learning system [6]	Fails to provide dynamism in E-Learning.
A Sharable E-Learning Platform based on Cloud Computing [7].	Since this architecture is modeled on the basis of cloud, it only concentrates in providing sharing, reusability and interoperability and fails to incorporate any other feature necessary for an E-Learning System.
Framework of an E-learning environment in continuing education institutions [8].	The services here are not hosted on the cloud so it fails to provide reusability, easy access, interoperability, scalability, versatile compatibility and serving automatic updates.
Research on E-learning system based on SOA [9].	This architecture does not provide a client interface and provides connection only through network service interface.
A New framework Semantic Web Technologies based E-learning [10].	It is platform dependent.
Towards an Effective Integrated E-learning System: Implementation, Quality assurance and Competency Models [11].	Does not provide reusability, sharing of information, adaptable framework.
The Applied Research of Cloud Computing Platform Architecture In the E-Learning Area [3].	Does not provide interoperability with the external content and social network.
A Generic Architecture for Agent based E-Learning System [4]	Does not provide Authentication facilities. Since it is not hosted in cloud, it does not provide any of the cloud features.

layer which contained a user repository. This paper provided a Generic Agent based architecture for E-learning that provides features like Intelligence, Distributed, Adaptive, Interactive, Extensible and Collaborative in a single system architecture using the web services.

- (3) Sh. Umar Khalid, Amna Basharat, Arshad Shabid and Syed Hassan [5] developed a conceptual architecture which focused on the core features required for an emerging E-Learning system; 1) Domain Specific Learning Services 2) Student Capability Analysis 3) Adaptive Lecture Authoring Tool 4) Intelligent Assessment Engine 5) User friendly E-Learning Portal. This framework is designed to make learning process class independent and to abate the distance between the teacher and the student. The highlight of this system is to judge the students' capability and adaptive management of learning process.
- (4) In Table 1. We have compared different architectures which were proposed earlier and listed out the drawbacks with those architectures.

On the basis of the study about different architectures given above, we infer that they fail to provide Dynamism in the system, Accessibility, Authentication, Interoperability, Data security and an Adaptive user interface. We also infer that hosting and delivering services through a cloud is in itself a major benefit.

3 Our Approach

The main actors in the education process are students, teachers and the course coordinator. Most of the time, these actors are geographically and temporarily remote from each other, and they use the course website as the online environment for course delivery, assignment management and communication. Therefore, the course web server contains a lot of data about students' learning process and their study behavior [12].

The figure 1 represents a use case diagram for E-learning system. The student can login, browse through the course material, which facilitates download access, submit assignments and write tests, view his grades, and can have interactive sessions with the teachers through the discussion board. The teacher creates the course, evaluates the students based on their performance, finalize grades to the students. The administrator manages the system by uploading and upgrading the course materials, and also the user profiles.

As seen above, Agent based E-learning can manage the information overload, serve as academic experts, and create programming environment for the learners [4], which provides certain specific characteristics of E-learning system such as Interaction, Personalization, Adaptability, Intelligence, Interoperability, Accessibility and Security.

The applications that run on cloud have many advantages. Those in accordance with educational institutions will be that it is cost effective, that is, it reduces capital costs as it is pay-per-use. It minimizes licensing new software, has measured services, can also globalize the workforce in cheap. Any application in cloud will have unlimited storage, ubiquitous network, quick deployment, easy to access information,

efficient monitoring, scalability and speed, versatile compatibility, multi tenacity, on demand self-service, access to automatic updates, convenient, and also innovative [13]. This architecture is efficient, system-wise also, because the processes are streamlined, optimal resource utilization, high collaboration efficiency, flexible work practices, broad network access, rapid elasticity, and provides backup and recovery. The user can use the application anytime on any device, Personal Computers (PCs), mobile devices like smart phones and Personal Digital Assistants (PDA), having just the internet access as these applications are location independent. This also makes the application mobile.

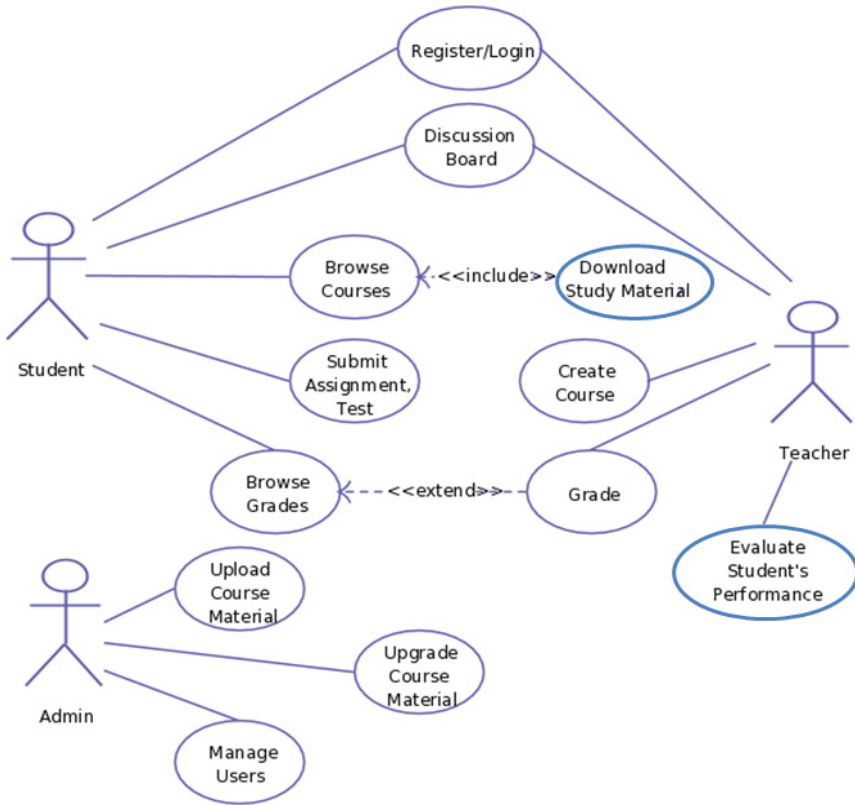


Fig. 1. Use Case diagram for E-learning.

Having mentioned the advantages of generic agent based architecture for E-learning system and cloud computing applications, we combine these to get “A Generic Agent-Based Cloud Computing architecture for E-learning”. In this approach, the software agents are integrated with the cloud computing architecture. In this architecture, each functionality required by the E-learning system is provided by an agent. These agents interact directly with the cloud and provide the various services to the clients via internet.

In this architecture we are trying to overcome the drawbacks of previously mentioned architectures, namely; Dynamism, Accessibility to wide range of data, Data Security, Authentication, Interoperability with the external content and social networking and provide an effective user interface. Hence this generic architecture supports all the features to make the E-learning system efficient.

3.1 A Generic Agent-Based Cloud Computing Architecture for E-Learning

We introduce, E-Learning Software as a Service, ELSaaS. This is a cloud service which is basically for the students to interact with the cloud services, via agents. This will provision the students with their learning process. This architecture is as shown in figure 2.

The various layers described in the figure are:

User Interface Layer: This is the upper layer which provides adaptive interface for various users. The clients like students and teachers can avail the benefits of the system. The online learners can avail the E-courses that are offered, listen or watch

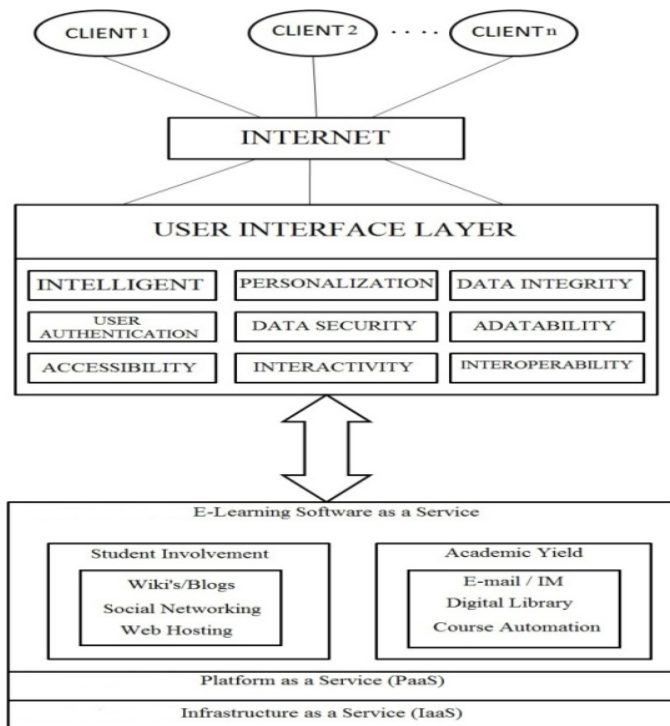


Fig. 2. A generic agent based cloud computing architecture for an E-learning System

lectures, write tests, etc. The study material, like notes, audios and videos of lectures, tests and certification exams, and the extra facilities are offered to the learners. The user interaction with their devices is facilitated by this layer. Any device with a browser and internet connection is enough to use this application.

Agent Layer: This is the middle layer, which contains software agents that support various functionalities. This is an important layer where the features of an E-learning system come into the picture. The agents here carry out those functionalities in a very efficient manner. It reduces the information overload in the network. The various agents here are as follows [4]:

Intelligent Agent. This agent uses Artificial Intelligence (AI) in the pursuit of providing dynamism in E-learning. It performs few specific tasks on behalf of the students and the teachers.

Personalization Agent. This agent provides a set of personalization functionalities to the user so that the learners have a better learning experience. This agent enables the dynamic insertion, customization or suggestion of content and adaptive instant interaction that is relevant to the individual user, based on the user's preferences and requirements. This enables personalized learning plans, learning materials, etc.

Data Integrity Agent. This agent provides maintenance and assurance of accuracy and consistency of data over its entire life cycle. Data integrity is identically maintained during any operation. When functions operate on the data, this agent ensures integrity.

User Authentication Agent. This agent provides user authentication, that is, it confirms the identity of the user as to what they claim to be.

Data Security Agent. This agent applies security framework and data privacy standards in the E-learning system. Security is a major issue for applications in the cloud and hence this agent ensures maximum security along with other agents like data integrity agent and user authentication agent.

Adaptability Agent. This agent provides adaptability functionalities in the E-learning system. This is an important factor for the efficiency and economic success. Adaptability increases the capability of monitoring the user activities, interpreting these on domain-specific model basis, infers user requirements and preferences, representing them in certain models, and finally, acting upon the users with the available knowledge, to dynamically facilitate the learning process.

Accessibility Agent. This agent makes the geographically dispersed content of the E-learning system easily accessible for its authenticated users. The main intention is to make the service available to as many people as possible.

Interactive Agent. This agent makes the system interactive to the users to provide a better learning environment. The users are allowed to modify certain objects in the learning environment according to their preference.

Interoperability Agent. This Agent helps to interoperate with the external content and the social network. This is brought up by using an open structure, and with external

content and social service, it can interoperate or inter-communicate with enterprise applications, like Groupware and consumer applications, like Gmail, Twitter, YouTube at data level by mapping mechanism [14]. The main motivation for this is by the increased importance of reusing and combining various learning elements in different ways. This also helps adding on to the economic benefits of the education system in the developed and developing nations.

Cloud Services Layer. This layer provides the cloud services for the agents, to provide the various functionalities to the users. The main service used here is the ELSaaS, as mentioned above, which enables the students to interact with the cloud services in educational institutes. The agents assist it by providing functionalities like interoperability and interactivity. This is definitely for the entrusted users as security is of major importance.

Digital Library has a wide variety of applications and content, multimedia and text files, on different topics available to the users, which can be downloaded. This has Online Storage to maintain and manage individual user data. This layer also helps the users to collaborate and generate contents like wikis, blogs, etc. Personalization tools are also available here which will be provided by the particular agent to control user profiles, access technical support, etc. Agents are used for authorization of applications and content which enables better security.

Next layer is the PaaS, which provides directory services, developer tools and database access. Then is the IaaS, which provides storage, virtual machine facilities, web services and service hosting functionalities.

This architecture provides Dynamism, Accessibility, Data security, Authentication, Interoperability, User interface, Adaptability, Interactivity, and overcomes all the drawbacks faced by the previous architectures, through the software agents using cloud services.

4 Analysis

Agent based E-learning can manage the information overload, serve as academic experts, and create programming environment for the learners [4]. As seen before there are a few specific characteristics in an efficient E-learning system such as Interaction, Personalization, Adaptability, Intelligence, Interoperability, Accessibility, User Authentication, Data Integrity and Data Security. Our architecture provides all these features in a single system. As this architecture hosts and delivers applications through cloud, it incorporates all the advantages of cloud computing. The major advantages like cost effectiveness, unlimited storage, reusability, ease of access, ubiquitous network, scalability and speed, versatile compatibility and convenience. E-learning has speeded up the knowledge transfer without restrictions on time and space in recent years. In order to achieve the goal of knowledge sharing and reusing interactively, many E-learning architectures have been proposed. But the main drawbacks of these architectures are that they are not efficient in many ways, like dynamism, interoperability, speed, personalization, intelligence, installation costs, and security as a whole.

Hence, we have come up with this architecture combining all the major features required by an efficient E-learning system. This architecture combines the agents providing the functionalities, in cloud, which accesses the cloud services like the ELSaaS, PaaS and IaaS and delivers them to the online learners. This architecture is better in every perspective that is, it is beneficial to the educational institute, the clients and cloud service providers.

5 Conclusion and Future Work

Cloud Computing has become one of the hottest buzzwords in the IT area over the past few years. It plays a vital role in education transformations which reaches a wide variety of users. This advantage can be used to educate people in developed and developing countries and eventually eradicate illiteracy in the world. This generic agent based cloud architecture for an E-learning system provides the most basic and primitive features that must be present in an E-learning system for a better learning experience. This architecture uses software agents to provide all the important functionalities to the online learners using the cloud services. This definitely contains the advantages of using software agents and cloud computing as well.

Our proposed architecture is just a conceptual idea for an E-learning system. This must be implemented in a real time E-learning application to validate our architecture, which will be the future work. The only concern is regarding the security issues that arise in cloud applications which have to be taken care of in the future.

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