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# An E-Learning System Architecture based on Cloud Computing

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**Abstract:** The widespread adoption of information and communication technology (ICT) to revolutionize education is a result of the widespread availability of reasonably priced computers, Internet broadband connectivity, and rich educational content. In order to better satisfy the needs, the educational system must be redesigned. The development of sophisticated software on computers has sped up and reduced the cost of solving many complex problems. In this work, the aspects of contemporary e-learning are introduced, followed by an analysis of the cloud computing idea and an architectural description of the cloud computing platform that combines e-learning elements.The authors have made an effort to establish an e-learning cloud, introduce cloud computing to e-learning, and actively research and explore it from the following angles: architecture, construction technique, and external interface with the model.

**Keywords:** Architecture, Cloud Computing, E-learning, Information Technology

## 1. Introduction

Computer networks have created chances for education as the majority of traditional educational methods are currently becoming unsuitable for the demands of social growth and educational development and are unable to keep up with changes in learning demands in a timely manner. However, in the case of traditional web-based e-learning, system development and maintenance take place inside educational institutions or businesses. This leads to a number of issues, including the need for significant investment but in the absence of capital gains, development potential, and longevity. Because of its efficient resource utilization and dynamic scalability, cloud computing is gaining popularity as a technology that may be applied in situations when resources are scarce.

The applications of cloud computing are receiving increased attention from researchers since it has emerged as a hotspot for contemporary technology study. Many issues, including the technology for future cloud-based distance education, teaching information systems, the integration of instructional resources, and the development of teaching systems, have been researched in relation to cloud computing's application in the educational sphere.

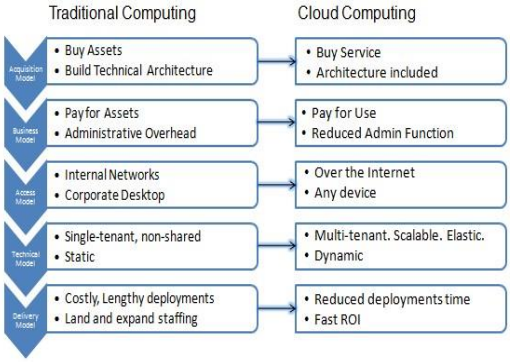
## 2. History of Cloud Computing

Cloud computing was developed by JohnMcCarthy in 1960s."The use of computers, as a subject of research may be arranged as a public utility eventually. “As stated by Parkhill in The Challenges of Computer Utility. The term "Cloud" computing originated from a virtual private network used in the telecommunications industry.Throughthe use of point-to-point data links, bandwidth was wasted.A virtual private network was used to balance network usage.Network infrastructure and servers are now provided. The usage of cloud computing is common among industry players. Amazon's business has greatly benefited from the introduction of Amazon Web Services. Furthermore, research on cloud computing has been started by IBM and Google. The first open-source platform for deploying private clouds was called Eucalyptus.

**Cloud Computing**

Cloud computing, a new breed of cutting-edge technology, has accelerated innovation in the computer industry in recent years. The goal of cloud computing, a computer architecture built on networks, particularly the Internet, is to let users pay for the resources they use only when they need them, using a metering system much to that used for electricity and water. Consequently, it introduces a new economic model in which the services it offers are transformed into computer resources. Cloud computing generates virtualized resources that may be made available to consumers and is very scalable. Connecting their computers to the server where apps are installed and using them doesn't require users to have any particular understanding of the idea of cloud computing. Users can speak with distant servers via the Internet. These servers are able to swap out their own computer slots.One of the newest technological developments that is probably going to have a big influence on the classroom is cloud computing.

Resources in cloud computing might be privately held (private Cloud) or externally owned (public Cloud, as offered by Google and Amazon).Access to public clouds is provided to outside users, who are usually charged on a pay-per-use basis. The private cloud is designed for internal access within the company, where users can use the resources at no cost. The strategies for addressing issues including user interface, task distribution, and coordination are discussed and assessed. We have discussed how cloud computing is being used in universities, evaluated the condition of enterprise information management, and discussed how cloud computing could transform it into a more dependable, efficient, and worldwide infrastructure. They have talked about applications as well as architecture. The following comparison helps to visualize the characteristics of cloud computing.




## 3. From Traditional E-Learning Network to Cloud E-Learning

While e-learning will not completely replace traditional teaching techniques, it will significantly increase their effectiveness. E-learning is an Internet-based learning process that uses Internet technology to develop, implement, select, manage, support, and extend learning. With so many benefits, including assessment, diversity, opening, flexibility, and so forth, e-learning is set to become the predominant mode of instruction in the twenty-first century, as illustrated in Fig. 1.

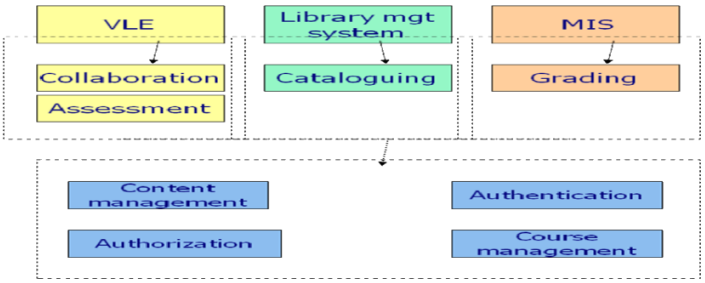



Fig. 1: Architecture of a simplified Learning System

We demonstrate how, in the case of traditional web-based learning, system development and maintenance are carried out within educational institutions or businesses. This has resulted in a number of issues, including the need for large investments that do not yield financial returns, which limits the potential for growth. The building of the e-learning system is left to cloud computing providers in the cloud-based e-learning model, on the other hand, which can result in a win-win scenario for both providers and users. This is known as the scale efficiency mechanism. The development of new e-learning systems that can operate on a variety

of hardware platforms and store data in the cloud is made possible by the cloud-based environment.

We have showcased a cutting-edge e-learning environment built on Web 2.0 and cloud computing. The article highlights the benefits of implementing E-Learning 2.0 applications for public cloud computing environments like Google App Engine, Amazon Elastic Compute Cloud (EC2), or Windows Azure, and analyses the most significant cloud-based services offered by these environments. The authors also highlighted the improvements in terms of cost and risk management and listed the advantages of cloud-based E-Learning 2.0 applications (scalability, feasibility, or availability).

This article introduces cloud computing as a way to improve the scalability, flexibility, and availability of e-learning systems, highlighting a new paradigm in the educational field. The writers have assessed the advantages and disadvantages of the conventional e-learning networking architecture as well as the potential for moving the e-learning system into a cloud computing infrastructure and away from educational institutions or businesses. Cost effectiveness and the division of entity roles are two significant benefits. While the vendor handles system development, construction, maintenance, and management, the institutions will be in charge of instruction, content management, and distribution.The e-learning system can be scaled, both horizontally and vertically, and the educational organization is charged according to the number of used servers that depends on the number of students as in Fig. 2.

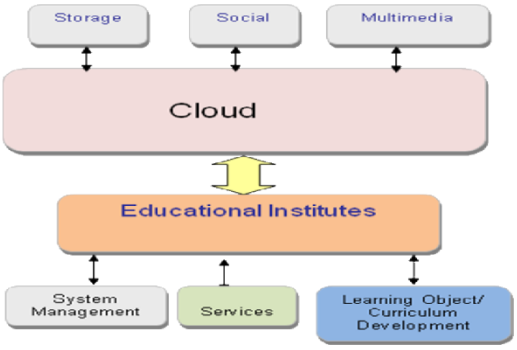



Fig. 2: Modified E-learning System Architecture.

## 4. Cloud Based E-Learning Architecture

Since e-learning simply updates technology, concepts, and tools while providing fresh information, teaching techniques, and concepts, it cannot fully replace teachers in their duties. Teachers will continue to take the lead in creating and utilizing the e-learning cloud. The educational act ought to be enhanced by the blended learning approach. Additionally, the virtual cooperation and interactive content provide a high retention rate.

Conversely, E-learning cloud refers to the integration of cloud computing technology into the e-learning space. It is a future-oriented infrastructure for e-learning that includes all the hardware and software resources required for e-learning. Following virtualization, these computer resources can be rented out by corporations, educational institutions, and students at a reasonable price. Fig. 3 depicts the architecture of the e-learning cloud.

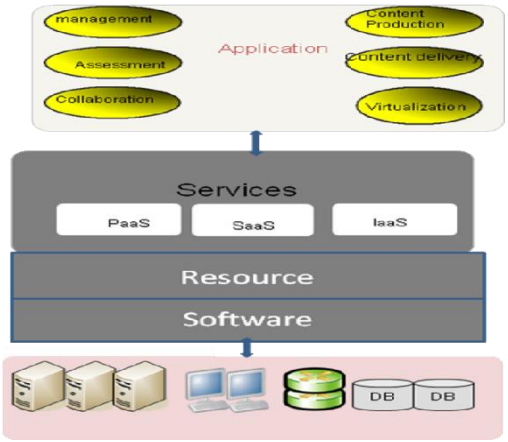



Fig. 3: E-learning Cloud Architecture.

The following layers comprise the suggested e-learning cloud architecture: The physical host pool that serves as the infrastructure layer is dynamic and scalable. The software resource layer provides a unified interface for e-learning developers. The resource management layer allows for the loose coupling of software and hardware resources. The service layer comprises three tiers of services: software, platform, and infrastructure. The application layer offers features such as content production, delivery, virtual laboratories, collaborative learning, assessment, and management.

Teaching resources and informationinfrastructure make up the infrastructure layer. The information infrastructure comprises of several components such as the Internet/intranet, system software, information management system, and common hardware. On the other hand, the teaching resources are mostly gathered using the traditional teaching paradigm and dispersed across various departments and domains. This layer, which is the lowest level of cloud service middleware, provides the fundamental processing capability, including RAM, CPU, and physical memory. The physical server, storage, and network form a virtualization group through the application of virtualization technology, which is called by an upper software platform. In order to increase the physical processing capacity for cloud middleware services, additional physical hosts can be added to the dynamic and scalable physical host pool. This is seen in greater detail in the accompanying Fig. 4.

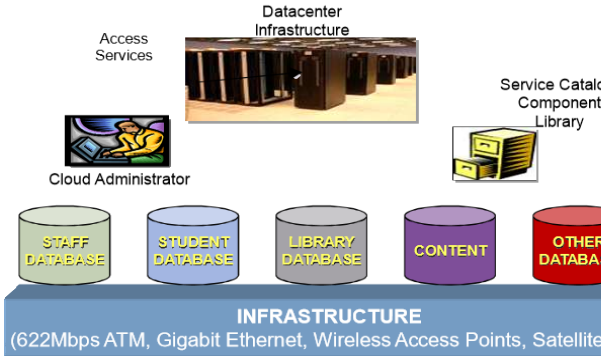



Fig. 4: Proposed Infrastructure Layer in an expandable view

- Middleware and the operating system make up the majority of the software resource layer. A uniform interface for software developers to easily construct numerous apps based on software resources and embed them in the cloud, making them accessible for cloud computing users, is made possible by middleware technology, which integrates a range of software resources.
- The secret to achieving loose coupling between hardware and software resources is the resource management layer. Software distribution over several hardware resources and on-demand free flow can be accomplished by integrating virtualization with cloud computing scheduling technique.
- The service layer consists of three service levels: infrastructure as a service (IaaS), platform as a service (PaaS), and software as a service (SaaS). Customers can access cloud computing services using SaaS. Unlike traditional software, which requires a one-time purchase of hardware and software as well as maintenance and upgrades, Internet-based software is used by customers for a monthly charge.
- The application layer refers to the particular uses of the cloud computing model's integration of educational materials, such as sharing and interactive courses. The interactive programs are primarily intended for teachers, who can tailor them to the needs of their students and make full use of the underlying information resources once they've finished. The course material and progress can also be adjusted at any time in response to feedback, making them more effective than traditional teaching methods. The complete sharing of human resources is included in the sharing of teaching resources, together with the sharing of teaching information resources (such information centers and digital libraries). The primary components of this layer are the management component, educational objectives, content delivery technology, evaluation, and content production.

## 5. Expected Benefit from the Architecture

The intended advantages derived from the proposed architecture are as follows:

- Strong computing and storage capacity: The sea of clouds, which consists of tens of thousands of computers, is where the computing and data are located in a cloud-based e-learning architecture. This allows for massive computing power and enormous data storage space to be made available to students through the Internet.

- High availability: This system can offer a greater level of service by integrating high-performance processing capability with mass storage. The cloud computing system is capable of automatically identifying and excluding node failures, which have no impact on the system's regular functionality.

- High security: Data is heavily stored in the cloud computing model. The managers ensure the highest level of data protection for consumers by utilizing one or more data centers to handle unified data, assign resources, balance load, deploy software, control security, and perform dependable real-time monitoring.

- Virtualization: The key feature of this kind of design is virtualization. The physical platform and each application deployment environment are unrelated. It is utilized as a virtualized platform for management, expenditure, migration, and backup. In order to create a shared, distributed on-demand resource pool, it completely virtualized the underlying hardware, which included servers, storage, and networking equipment.

- The proposal's main benefit is that it intends to give rural students at universities with limited resources simple access to pricey software operating on high-performance CPUs. This architecture would take a significant financial outlay to install, but the advantages would more than offset the expense. The benefit is demonstrated in Fig. 5, which shows the connection tier of the suggested architecture.

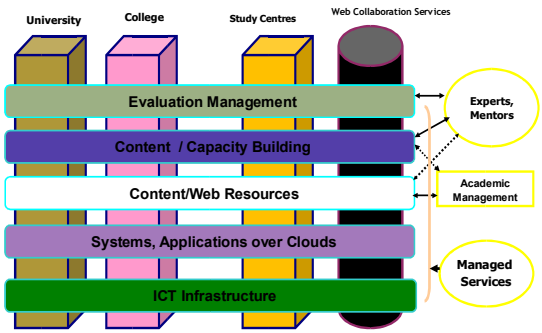



Fig 5: Connectivity Scenario of the Institutions in the proposed architecture

The traditional e-learning strategy involves teachers giving students assignments, holding frequent lectures, or providing skill training. The students complete their teachers' tasks or participate in the online cooperative learning and independent learning activities. However, in the suggested architecture, instructors also respond to inquiries from students and provide crucial instruction on important and challenging topics. Multimedia can also be used by educators to improve the curriculum. Students design their own curricula and choose their own teaching strategies. They study each unit independently online, complete the online test, then apply statistics to the test findings. This is known as online autonomous learning. Instructors also push their students to collaborate in order to complete challenging group projects or easy learning assignments.

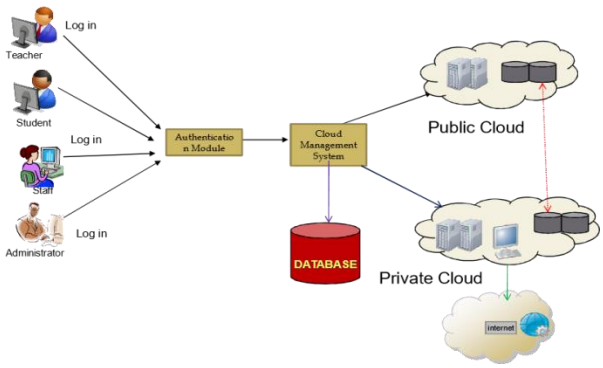



Fig 6: Interactive mode of the proposed architecture

## 6. Conclusion and Future Work

Lately, cloud computing has become a very attractive paradigm for online service delivery and management. The emergence of cloud computing is drastically altering the information technology landscape and eventually bringing utility computing's long-held promise to fruition. Cloud computing has the potential to improve education and benefit entire countries. Thanks to cloud-based services, educators and students can now access a vast amount of information from any location at any time on any device. Cloud computing helps students all around the world obtain the 21st-century skills and training they need to compete and prosper in the global information society by assisting nations worldwide, cutting costs, and simplifying the delivery of educational services.

The current state of the economy will compel several enterprises, including educational institutions, to think about implementing a cloud solution. Universities have started to follow through on this commitment, and there is evidence that the use of cloud technologies has resulted in a notable reduction in costs. Finding an architecture that will use cloud computing in higher education was the goal of our study. Our main focus has been on the advantages of cloud architecture. Future studies will look into the mindset and approach for implementing the suggested cloud-based architecture.

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