Research Article

Cloud Computing Paradigm in Academics

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Cloud computing is experiencing a surge in popularity due to its convenience and accessibility. The global lockdown and widespread adoption of the Work from Home (WFH) approach have further propelled the demand for cloud computing. In this scenario, the integration of cloud computing and education can offer a unique and high-quality experience for all stakeholders, including educators, administrative staff, parents, guardians, and most importantly, students. To leverage the vast array of cloud services, educational institutions are encouraged to embrace a cloud computing paradigm, as suggested by extensive research in the field of ed-tech cloud-based concepts. However, the proposed paradigm involves certain intricacies. The initial stages of the study address the pivotal question of choosing cloud computing, which significantly impacts institutions and organizations. Additionally, the study endeavors to compare the three leading cloud computing platforms, aiming to identify the most suitable and optimal choice for the suggested model.

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I. Introduction

Many procedures, concepts, and goals in modern society have been streamlined by computers. No one could have predicted that the capability provided by a straightforward wooden contraption in Babylonia in 2400 BC would set the groundwork for the finest 'innovation' known to humankind, namely computers. However, at this time, the available processing power is starting to become insufficient for the reasons for which it is being used. As a result, John McCarthy's 1961 concept of "publicized computing" has never been clearer [1]. The development of "Big Data" and the issues it raises is a legitimate explanation for the surge in demand for computer capacity. The fact that educational institutions are likewise embracing technology has further strengthened them. However, all of these problems can be solved by cloud computing. This phrase's underlying concept is similar to paying your

power bills. The national grids' personnel or information systems (if automated) manage all maintenance while we receive our bills based on the meters installed in our homes. Most significantly, customers do not have to worry about any hard lifting.

The cloud provider takes fantastic care of all the heavy work when it comes to cloud computing, including growing both horizontally and vertically, maintaining the underlying hardware and architecture, and maintaining security. Many cloud service providers offer publicly accessible cloud-based services, making them accessible to anybody with a subscription and a support plan. However, trust is something to consider when selecting a cloud service. It is crucial to be aware of their TOCs (Terms of Conditions), FUPs (Fair Use Policy), and Privacy Policies before providing your company or organization with any personal or corporate information. Any of the possible cloud-based installations can be chosen. This paper tries to thoroughly discuss all necessary features of cloud computing in the context of educational technology.

II. Literature Review

Despite [2] noting that application service providers have been disseminating their services over the internet ever since the internet came into existence, many people still have the misconception that cloud computing is a novel idea. All that has changed is the form. While earlier systems relied solely on XML, SOAP, or comparable forms, there are now a wide variety of data formats from which providers can pick. By virtue of the services and experience it offers, cloud computing can ease the standard of the standard operating procedures in educational institutions. Virtualization, which can split physical capabilities into comparatively small pieces and then distribute these pieces to meet demand, is the heart and soul of cloud computing [3]. It is also clear that a lot of educational institutions play a significant part in other economic operations. For instance, the University Sains Malaysia's business section offers consulting, consultation, and testing services. [4] It is also evident that such a luxury needs a robust computer network. As previously noted, virtual computers can satisfy this demand. However, we must remember that running numerous virtual machines (VMs) on the same host might cause performance problems, as investigated by authors of [5][6][7]. It is also clear that a lot of educational institutions play a significant part in other economic operations. For instance, the University Sains Malaysia's business section offers consulting, consultation, and testing services. [4] It is also evident that such a luxury needs a robust computer network. As previously noted, virtual computers can satisfy this demand. However, we must remember that running numerous virtual machines (VMs) on the same host might cause performance

problems, as investigated by authors of [5][6][7]. As shown by [8], a study that raised worries about numerous prominent websites secretly gathering substantial amounts of personal information led to fear and panic among many users. Privacy has always been a major worry for many users.

For this strategy to be successful, more cloud-based apps are required. Fortunately, according to Amazon, the biggest cloud service provider worldwide. Building applications for the cloud is no longer a tedious task to do. Either brand-new apps or cloud versions of currently existing applications may be developed and deployed with ease. One issue drives the logical next important thing: Would the faculty and students be able to use those applications? Yes, it is the solution. [3] Clients do not have to worry as much about technological details using the cloud. Furthermore, the cloud may make the technological staff nimbler. More than that, the institutions may take advantage of Google Cloud services as a starting point. According to [9], the G Suite enterprise provides all the capabilities needed by both instructors and pupils. Several of its traits are listed below:

- **Enable Collaboration:** Collaboration is made possible by the G Suite's features, which allow students and teachers to work together on the same papers and projects both inside and outside of the classroom, increasing student productivity.
- **Simple scaling:** Whether you have 10 students or 10,000, there are many different APIs accessible to meet your needs. You can even add third-party software apps to your ed-tech ecosystem.
- **Getting started with G Suite is simple**: A unified platform is provided for students, teachers, and IT personnel to manage and arrange their roles and responsibilities appropriately. Through the Google Cloud Platform, Google furthermore provides a trial version of the vast majority of its services. Where can one try these services out? If the experience is in line with what the firm is looking for, one can subscribe.

Blended learning refers to the concept of combining conventional learning with online learning. [10] With the introduction of e-learning, the issue of time can be readily resolved, and it also better utilizes technology. The use of mobile devices for educational purposes is known as "mobile learning," and it has become increasingly common among students seeking higher education. The concept of remote or dispersed learning has gained some traction with web-based learning environments, and we must also take students' preferences into account when thinking about educational technology [11].

III. Related Work

The underlying institution may secure the intricate infrastructure by using the cloud to enable disaster recovery and business continuity in case of unforeseen disasters. Additionally, the ed-tech industry benefited greatly from cloud solutions. One such situation is described below. Clever [12], a digital learning platform for schools, has made it easier for students to use information systems by offering functionality like single sign-on and federated identity along with the following features:

- All information is simply available since the innovative platform, which offers free services to all the schools in a district, has a single sign-on function for the whole institution that uses it.
- The digital classrooms are the center of every educational technology hub. The entire school community may maintain contact with the children's and their families' lives through smart classrooms.
- With Clever, you may access an extensive network of 600 partners that are trying to give safe access. More importantly, Clever makes sure that it never sells or rents the private or public data of its customers and does not allow advertising on its platforms.

IV. Important Cloud Services

This section examines the cloud services relevant in the context of education technology and forms the basis of the proposed work discussed in a later section. The bigger the cloud provider, the bigger the range of services offered. As mentioned earlier the world's top three cloud providers are Amazon, Microsoft, and Google. We examine in detail a few of the services that can help institutions to build a cloud-based environment.

Cloud Storage: Whether a platform is on-premises or in the cloud, storage is the most crucial component. We require more storage as technology advances and our reliance on electronic gadgets grows. One such instance is Google Drive [13] Its free tier (or trial version) provides around 15 gigabytes of storage per user, however for business use, there are four price options to consider:

- **The Business Standard package,** which costs Rs 672 per user per month in India, offers personalized email addresses, 150-person virtual meetings with recording capabilities, 2 Terabytes of storage per user, as well as support services.

- **The Business Plus Plan,** which has all the features of the starting plan and costs Rs 1260 per user per month in India, also has a participant capacity increase to 250 people with recording and attendance monitoring. The 2 TB cap has been raised to 5 TB.
- **Enterprise plan** for big institutions. Google recommends contacting the sales representative for details on this plan as it can be customized as per the business needs.

Apart from Google Cloud, Amazon web services also offer its storage services like Amazon Simple Storage Service (S3) which allows users to store data objects of all sizes suitable for all purposes. The high performance, high availability and security features are the most opportune for settling the requirements of education technology. Below are some of the benefits of the service as described by Amazon [14]:

- **Scalability:** When it comes to big academic institutions, the need for their IT resources varies greatly. When utilization reaches its peak, in such a case, extra resources would be needed on-demand. In order to prevent further charges, we would also like the excess resources to be released when consumption returns to normal. In the context of Amazon Web Services, this capability is referred to as elasticity.
- **Various Storage Classes:** The S3 service offers distinct types of storage classes to fit your business needs for instance:
- **Standard Storage:** This storage class is the most popular class for your data objects as a business. It offers high durability and availability and is the best option to store frequently accessed data.
- **Intelligent Tiering:** This is the most advanced storage class that uses machine learning methods to shift your data between other storage classes depending upon the frequency of accessing it. By doing so, it is able to save a lot of expenses.
- **S3 Standard Infrequent Access (IA):** The mentioned storage class is the optimal choice for long-term storage, thus the term infrequent access. It offers high availability and durability and also has a low billing price as compared to its counter-part standard storage.
- **S3 One Zone Infrequent Access:** This storage class is similar to the S3 IA storage class but has a major difference in the fact that it does not replicate your data objects to provide redundancy which comes in handy when a problem occurs. Thus, the term One Zone is used as it only stores your data in one availability zone.
- **S3 Glacier:** It provides inexpensive storage for archiving data. The S3 Glacier features three retrieval modes that allow the retrieval time to vary from a few minutes to a few hours depending on your company's needs. Aside from this, your company has the choice of either explicitly uploading data

items to the S3 Glacier service or having them uploaded to the service automatically when specific criteria are satisfied. The S3 lifespan is utilized in this strategy.

- **S3 Glacier Deep Archive:** Despite being a different version of the S3 Glacier service, this storage class provides storage at the lowest prices. But there is a cost involved. If your company wants inexpensive storage, your retrieval times will be longer. For regulatory purposes that need enterprises to retain data from the last n years, where the number of n depends on the company and regulatory requirements, the S3 Glacier Deep Archive service is the best option. It is also a suggested service for your disaster recovery plans, although it might start at 12 hours to fulfill a data retrieval request.
- **Security, compliance, and audit capabilities:** Simple Storage Service offers better security practices than its competitors as it happens to be the only storage service that allows a business to block public access to the data objects as a whole on either on a bucket level or on the account level. S3 is also follows various compliances like:

Health Insurance Portability and Accountability Act: In 1996, the federal government passed HIPAA, requiring the countries that adopted it to uphold strict requirements for securing and safeguarding patients' sensitive Personal Health Information (PHI). To put into practice the stated act's proposal, the US Department of Health and Human Services published the HIPAA privacy regulation [2].

Payment Card Industry Data Security Standard: American Express, MasterCard Worldwide, JCB International, Discover Financial Services, and Visa Inc. created the PCI-DSS, a well-known security standard. All organizations that oversee or process cardholder and sensitive authentication data must adhere to this specific standard (CHD & SAD). All merchants, processors, acquirers, issuers, and service providers are included under the word "entities" in this context. The highest known certification to date for PCI-DSS compliance is level-1, which is held by Amazon Web Services [15].

European Union Data Protection Directive: The aforementioned directive, which took effect in May 2018, protects personal data, and establishes rules for the transfer of such sensitive data for commercial reasons. Protecting user privacy, which is no less than a fundamental right, is essential as the expanding connectivity converges into a unified digital market.

Data access and management controls: With the help of the straightforward storage service, your company can simply regulate prices, data security and protection, and access control, which enables you to specify who has access to and who does not have access to your underlying data objects. Since the S3 service operates on the principle of serverless computing, activities like activity tracking, alert

management, and workflow automation have become simple. The replication function of the service provides high availability and durability. Additionally, you may make your data objects versionable.

Data Analytics with S3: With the business data objects stored within S3 buckets (storage unit for the service) one can utilize the query in place service set for running analytics. This maneuver works best when combined with the following other services:

- Amazon Athena: The S3 service works best with Athena. In other words, Amazon Athena is especially optimized for working with S3. It allows you to query your data objects using SQL standard.

V. Proposed Model

This section outlines a suggested high-level cloud-based architecture that makes use of the vast majority of services offered by Amazon Web Services due to its acceptance and popularity in the community.

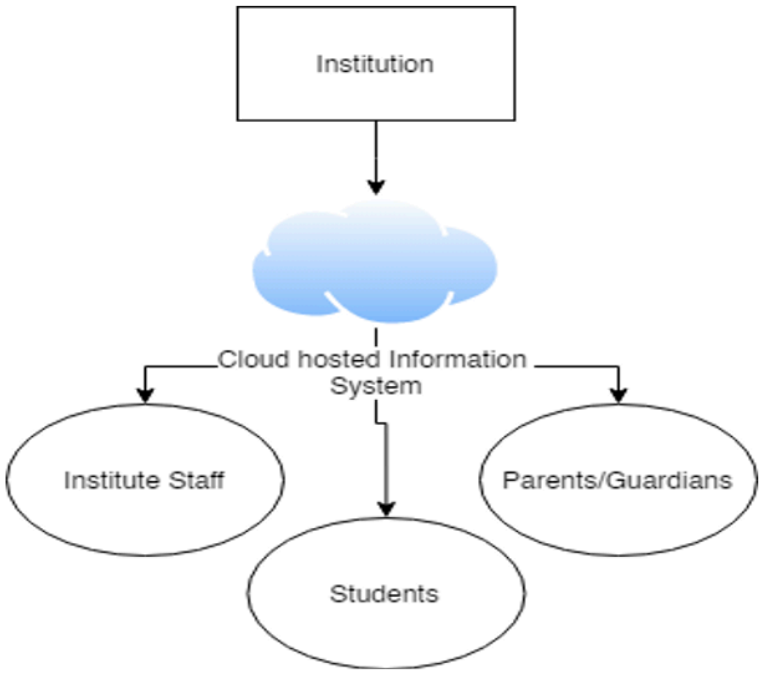

Fig. 1. Users/Actors of the cloud based platform

The actors who will engage with the cloud-based application or platform are described in figure 1. Deep specifics are not considered because the goal of this study is to give a high-level overview of a cloud-based model for the education sector (or education technology). The three main characters are the

institute staff members who will use the program every day to check or update student data. The student information is understood to include all of the student's grades for all semesters, including both internal and external evaluation. The accomplishments of the student should also be mentioned (if appropriate). They will be able to see their Performa, which would be developed by committed data analysts and workable futuristic insights produced by virtue of machine learning algorithms, so students may use this programme as well, but with restricted access.

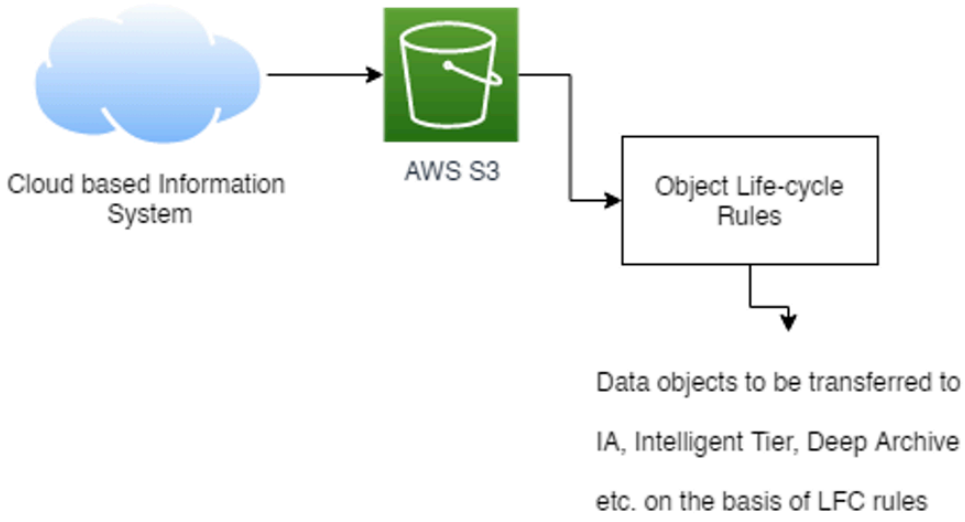

Fig. 2. Amazon Web Services S3 Usage

To maintain data security while it is at rest, the majority of the data will be kept on Amazon S3 buckets as specified in Figure 2, with the appropriate encryption rules. Because of its broad support from the community and inherent ease, Amazon S3 has been chosen. The AWS S3 may be set with Life Cycle rules that would regulate the activities to be made with the data, even though the data wouldn't be in the same location forever. It can be moved between any of the classifications previously described in this paper.

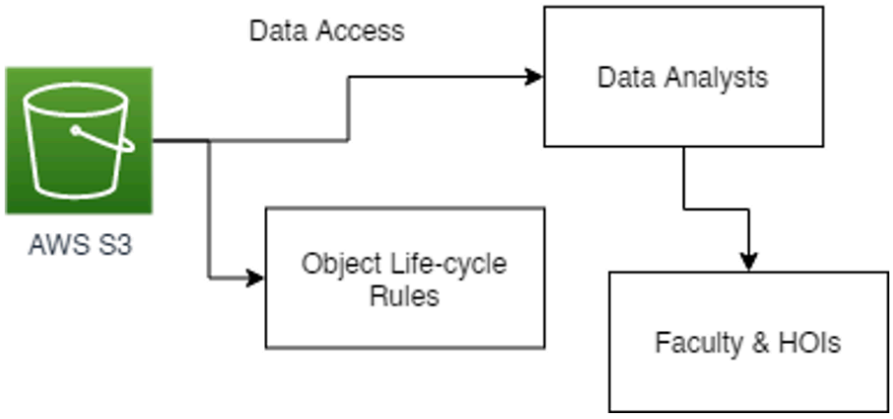

Fig. 3. S3 Data Usage scenario

Figure 3 shows how three different entities might utilize and consume the student data stored in the Amazon Simple Storage Service. Data analysts would conduct exploratory data analytics on the underlying student test score data to finally produce reports that were simple to grasp and read and included graphs and other visual elements. The faculty members and institution heads would then be informed of all this information. The student will also be given a portion of the pertinent report so that they may examine the performa and get an understanding of their own strengths and opportunities for development. If necessary, the faculty and institution's head may also share all of this information with the parents or guardians.

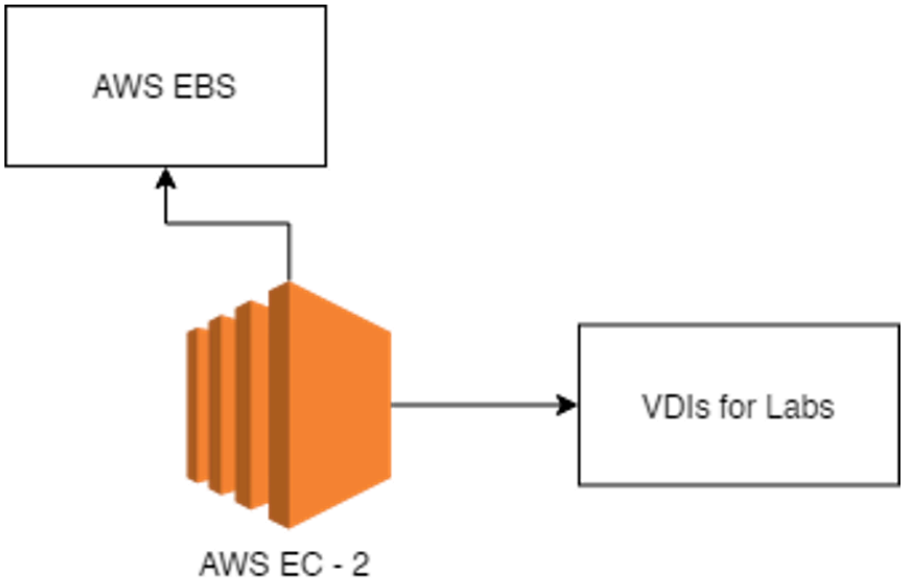

Fig. 4. Amazon EC-2 Scenario

The usage of Amazon Elastic Compute 2 instance(s) to give students and staff virtual desktop interfaces is explained in figure 4. Many courses need that computer laboratories be set up and equipped with all the required equipment. It also necessitates a significant amount of additional time and financial effort. The institutions can build up virtual computers using EC-2 according to their needs, because they are so customizable. Additionally, one may find the necessary VMs on the AWS market at reasonable prices.

VI. Conclusion

The goal of this study was to provide a framework for the work-from-home paradigm, which has become popular in these trying times of a global pandemic. The diagram above shows the relationship between users and the threats and vulnerabilities they expose themselves to, as well as some well-known threats and vulnerabilities. The compact structure being presented aims to sever this connection. The next focus of this research is to provide a more detailed architecture of the suggested model, covering issues such as cloud security, scalability, and performance, among others.

Other References

- Ahmed, Engr Ali, and Huma Ali Ahmed. "A proposed model for education system using cloud computing." 2018 3rd International Conference on Emerging Trends in Engineering, Sciences and

Technology (ICEEST). IEEE, 2018.

References

1. ^*Shi, Yinghui, et al. "Trends of cloud computing in education." International Conference on Hybrid Learnin g and Continuing Education. Springer, Cham, 2014.*
2. a, b*Waga, Duncan, Esther Makori, and Kefa Rabah. "Utilization of Cloud Computing in Education and Rese arch to the Attainment of Millennium Development Goals and Vision 2030 in Kenya." Universal Journal of Educational Research 2.2 (2014): 193-199.*
3. a, b*Ding, Wei Min, Benjamin Ghansah, and Yan Yan Wu. "Research on the virtualization technology in cloud computing environment." International Journal of Engineering Research in Africa. Vol. 21. Trans Tech Publi cations Ltd, 2016.*
4. a, b*Al-Rousan, Thamer, and Hasan A Al Ese. "Impact of cloud computing on educational institutions: A case study." Recent Patents on Computer Science 8.2 (2015): 106-111.*
5. a, b*Corradi, Antonio, Mario Fanelli, and Luca Foschini. "VM consolidation: A real case based on OpenStack C loud." Future Generation Computer Systems 32 (2014): 118-127.*
6. a, b*Steinmetz, Dylan, et al. "Cloud computing performance benchmarking and virtual machine launch tim e." Proceedings of the 13th annual conference on Information technology education. 2012.*
7. a, b*Von Laszewski, Gregor, et al. "Comparison of multiple cloud frameworks." 2012 IEEE Fifth International Conference on Cloud Computing. IEEE, 2012.*
8. ^*Aldeen, Yousra Abdul Alsahib S., Mazleena Salleh, and Mohammad Abdur Razzaque. "A survey paper on p rivacy issue in cloud computing." Research Journal of Applied Sciences, Engineering and Technology 10.3 (2 015): 328-337.*
9. ^*Kakoulli-Constantinou, Elis. "Teaching in clouds: using the G Suite for Education for the delivery of two E AP courses." Journal of Teaching English for Specific and Academic Purposes (2018).*
10. ^*Oliver, Erna. "Digital game-based learning and technology-enhanced learning for theological education." Verbum et Ecclesia 39.1 (2018): 1-8.*
11. ^*Nam, Chang S., and Tonya L. Smith-Jackson. "Web-based learning environment: A theory-based design pr ocess for development and evaluation." Journal of Information Technology Education: Research 6.1 (2007): 23-43.*
12. ^*Clever – The new way of doing schools https://clever.com/schools (3/5/2021 – 1530 hrs.)*

13. ^ *Jeber, N. "Jalal. (2019)." The Future of Cloud Computing Google Drive 10.*

14. ^ *Mishra, Abhishek. "Amazon Rekognition-Machine Learning in the AWS Cloud." (2019): 421-444.*

15. ^ *Amazon Web Services PCI-DSS Compliance: https://aws.amazon.com/compliance/pci-dss-level-1-faqs/*

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