

Towards an Efficient Privacy in Cloud Based E-Learning

A. A. Maher, H. M. A. Najwa, and I. Roesnita

Abstract—In recent years, the traditional classrooms ways are becoming unsuitable for the requirements of social progress and educational development. Education institutions are rapidly considering and adopting cloud based e-learning. The efficiency of using cloud computing in e-learning has been realized by many education institutions. Education institutions take the advantages of modern applications hosted on a cloud. Cloud computing provides to e-learning all necessities such as hardware and software resources to improve traditional e-learning. However, it is noted that privacy issues have been highlighted as a strong challenge in implementing cloud computing. Most studies of e-learning system have focused on course development and delivery, with a little consideration to the privacy aspects. This paper highlights some definitions of e-learning, and cloud computing, architectures and benefits of cloud computing. Also this paper raises the issue of cloud computing privacy and requirements of e-learning privacy. In addition, it proposes a variety of privacy recommendations to be considered in cloud based e-learning environment.

Keywords— Cloud Computing, E-learning, Privacy, Personal Information, Cloud Based E-Learning, , Benefits, Requirements.

I. INTRODUCTION

INFORMATION technology and communication evolve every single day and it brings many benefits to the people around the world. The current trend is cloud-computing adoption to provide services and storage through the internet. Besides, the implementation of e-learning is also one of contribution from information technology to the education field. E-learning provides many benefits to education such as flexibility, cost, diversity, measurement. On the other hand, increased using of information technology and communication requires privacy environment. Previous researches have highlighted some of the concerns related to privacy and cloud computing[1],[2]. However, this paper will discuss the privacy of e-learning in cloud computing environment, cloud computing architecture, service deployments models, service delivery models, benefits cloud in e-learning .

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In addition, this paper also addresses the concerns of cloud computing privacy and requirements of e-learning system privacy. A systematic search of this topic was performed. Researchers searched databases such as IEEE (Institute of Electrical and Electronics Engineer), and found relevant information from journals, government reports, web pages, and books. In addition, manual searched was also conducted using Google and Google Scholar. It is found data privacy protection in cloud computing faces many challenges such as access, storage, compliance, retention, destruction, audit and monitoring, breaches and controversy of various legal systems. These challenges are conflicting with e-learning privacy requirements.

II. CLOUD COMPUTING

Cloud computing is a concept that offers great advantages in many aspects. Cloud computing provides services and storage through the internet. Cloud computing is characterized by three entities (software, hardware and network)[3]. Cloud computing provides the ability to access and manipulate various information resources stored on remote servers.

There are many definitions and explanation of cloud computing. There is yet no single, commonly agreed definition of "cloud computing." The National Institute of Standards and Technology (NIST) has defined it as follows "Cloud computing is a model for enabling convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction." [4].



Fig. 1 NIST Visual Model of Cloud Computing Definition

III. CLOUD COMPUTING ARCHITECTURE

A. Service Delivery Models

Cloud computing services content three models, these delivery service models are not new to the IT world, the difference is only that cloud computing combines and integrate these models [4]. The models are Infrastructure as a Service (IaaS), Platform as a Service (PaaS), and Software as a Service (SaaS).

- i. **Infrastructure as a Service (IaaS)** is the lowest level of cloud computing which content hardware, as well as basic operating systems and virtualization of hardware resources. It is to ensure the stability and reliability of the infrastructure, management and maintain are the responsibility of the supplier [4]. However, the user just pays for the actual time usage of those resources and the supplier will resizes these resources based on user demand.
- ii. **Platform as a Service (PaaS)** is middle of clouds service; it could be as expansion of Software as a Service. PaaS provide platform for the users to create applications by using programming languages or tools that provide on the cloud infrastructure that made available to user over the Internet [5].
- iii. **Software as a Service (SaaS)** is a software distribution model in which software are hosted by a supplier or service provider such as Microsoft office. It made available to users over internet so they can access the software anywhere anytime, retrieve, and save their work [4].

B. Service Deployments Models

According to the various cloud computing service suppliers, cloud computing generally is divided in two types: Private Cloud and Public Cloud. However, they also can be extended to hybrid cloud or community clouds. This mixed from Private clouds and Public Clouds.

Private Cloud is cloud platform maintain for specific client. It could be managed internal by internet IT or external by third party. This main feature avoids many security issues but may be expensive for small organization.

Public cloud is the traditional platform of cloud computing by where IaaS, PaaS and SaaS are provided by third party provider. The client can access by internet connection shared services in term of low-cost.

Community cloud is when some clients with similar needs share an external private cloud. The platform of the cloud would be provided by a supplier but only the clients same community would be able to access the cloud.

Hybrid cloud or enterprise cloud consists of both in-house providers and third party providers. Where part of the cloud is private and only accessible internal and the other part is public and can be accessed externally.

IV. E-LEARNING

In recent years, Most of the traditional methods of learning are becoming not being adequate to the needs of social progress and not being able to catch up the rapid development

of learning in time. E-learning enhances productivity of education by providing access to educational resource at anytime, anywhere. E-learning will not displace traditional education methods. E-learning has many advantages such as flexibility, diversity, measurement, personalization. It becomes a primary way for learning in the new century [6]. In the literature, there are several definitions of the e-learning. The following are some definitions.

E-learning is the use of technology to enable people to learn anytime and anywhere. E-learning can include training, the delivery of just-in-time information and guidance from experts [7].

E-learning is the use of internet technologies to deliver a broad array of solutions that enhance knowledge and performance. It is networked, delivered to the end-user via a computer using standard internet technology and focuses on the broadest view of learning [8].

E-learning is learning utilizing electronic technologies to access educational curriculum outside of a traditional classroom. In most cases, it refers to a course, program or degree delivered completely online [9].

E-Learning covers a wide set of applications and processes, such as web-based learning, computer-based learning, virtual classrooms, and digital collaboration. It includes the delivery of content via internet, intranet/extranet (LAN/WAN), audio and videotape, satellite broadcast, interactive TV, and CD-ROM [10].

E-learning is a broad concept encompassing a wide set of applications and processes which use all available electronic media to deliver education and training more flexibly. The term "e-learning" is used to capture the general intent to support a broad range of electronic media (Internet, intranets, extranets, satellite broadcast, audio/video tape, interactive TV and CD-ROM) to make learning more flexible for clients [11].

V. CLOUD BASED E-LEARNING

Many education institutions have implemented e-learning in order to meet the needs of huge growth number of students and education contents. However, there are some issues faces e-learning. The recent e-learning applications need large investments in infrastructure systems and dealing with concurrent requests [12]. Consequently, various educational institutions are starting to take advantage of modern applications hosted on a cloud .Cloud based e-learning would be the perfect environment to reduce most of these issues.

Cloud based e-learning is one of cloud computing trends. It is the cloud computing on educational field for e-learning systems. Cloud computing is the next generation of many technologies and infrastructures. However, e-learning is not excluded. Cloud based e-learning provides to all e-learning necessities such as hardware and software resources to improve traditional e-learning technologies. The learning resources are hosted in cloud servers; these resources are available for education institutions by renting from Cloud Services Providers(CSP) [13]. Many education institutions recognized the significance of applying cloud computing. This

technology allows education institutions to focus on their learning rather than focusing on complex computer configuration [14].

VI. PRIVACY

Privacy is the ability to hide the information from becoming known to others [15]. Privacy rights or obligations are related to the collection, use, disclosure, storage, and destruction of personal data or personally identifiable information [16]. The right of privacy has evolved to protect the ability of individuals to determine what sort of information about themselves is collected. The concept of privacy is affected by many factors such as countries, cultures, and regulations. It is constituted by public expectations and legal interpretations. Thus, an accurate definition is extremely complicated even if it is impossible. However, the American Institute of Certified Public Accountants and the Canadian Institute of Chartered Accountants [16], has defined the privacy is “*The rights and obligations of individuals and organizations with respect to the collection, use, retention, and disclosure of personal information.*”

VII. TYPES OF PRIVACY INFORMATION NEED TO PROTECT IN E-LEARNING ENVIRONMENT/CONTEXT

E-learning system users are under no obligation to provide some information, but if they do not then, they may not be able to use certain services or personalise their experience. This information could be:

A. Personal identifiable information

Any information that could be used to identify or locate an individual such as student name, e-mail address, mobile phone number, birthday, birthplace, age, race, health, or facial photo [17].

B. Sensitive information

The learning system itself may automatically record the learner preferences, grades, assignments, learning history, and learning outcomes IP address, credit/payment card number and expiration date.

VIII. BENEFITS OF CLOUD COMPUTING IN LEARNING

Cloud computing allows educational institutions that do not have the sufficient technical capability to access all necessary resources and infrastructure on demand. Students can get many benefits by using cloud based e-learning. Students can run the applications from cloud through their PC, mobile phones, tablet PC to complete their tasks such as online courses, online exams, get feedback and submit their projects and assignments. Besides, teachers will be able to prepare online courses and tests and save their data with access anytime anywhere. The cloud computing has brought about many advantages for educational institutions and below is listed some:

A. Support

In the cloud computing, the hardware and software are in the service provider side, thus, the maintenance of hardware

and software is simplified, and there are lesser problems for the IT team [5].

B. Availability

Cloud computing provides high level of resources availability. Cloud computing system can automatically detect the node failure and exclude it without affect to the users system [18].

C. Cost

Cloud computing gives opportunity to reduce the amount of money they spend on IT. Cloud computing reduces the cost of hardware, software, networking, storage, electricity, cooling and the space to house the hardware. Education institutions do not have to invest in expensive new computing equipment and shift the cost to a more manageable operational expense. The cloud computing can also reduces the cost of database administration, OS upgrades, software license, frequent contracts, consulting company, It staff, testing and piloting new applications [13].

D. Performance

Since the most of the applications and processes in cloud, the user will not have any problem on performance when they perform their tasks.

E. On-Demand

Cloud computing users have an access to computing capabilities, 24 hours access to infrastructure and content and Software as needed without requiring human interaction with CSP [4].

F. Pay per use

Cloud computer users can access to potentially unlimited resources but they only pay for what they actually use. Users are charged using fee-for-service or advertising to promote optimization of resource use.

G. Wide Network Access

The resources are available over the network and can be for promote use by different users platforms. In addition, cloud computing environment educations institutions can enhance their communication by participation with each other.

H. Measured Service

Cloud computing has the potential to automatically monitor, control and report by handled through an integrated management platform by spreading application around thousands of different computers or servers and providing transparency to the users.

I. Rapid Elasticity

Services in cloud computing has the ability to scale resources both up and down on demand. To the users, the cloud appears to be infinite, and the consumer can get as much or as little computing power as they need and they can be appropriated in any quantity at any time [4].

J. Recovery

If any of cloud computer users crashed, there are almost no data lost because everything is stored in the cloud computing servers.

By including the Cloud computing services, education institutions achieve significant cost savings, good performance, and a higher level of availability. The use of cloud computing becomes a necessity and not an option for many institutes.

IX. CLOUD COMPUTING PRIVACY

There are two major issues with security and privacy aspects of cloud computing:

A. Loss of control over data.

B. Dependence on the cloud computing provider.

These issues are possible to lead to variety of legal and privacy considerations. These concerns related to access, compliance, storage, retention, destruction, audit, and monitoring, and privacy breaches [16] as illustrated in figure 2. The detail of each issue is as following:

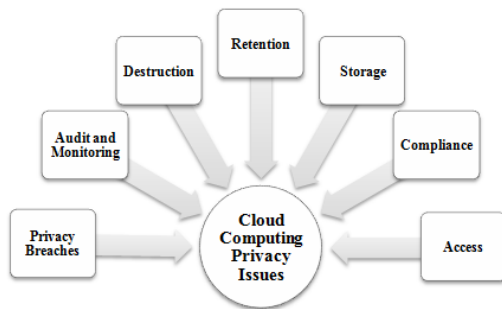


Fig. 2 Cloud Computing Privacy Issues [16].

A. Access

The main concern is whether the organization is able to provide their users with access to all personal information and to comply with users' requests. In addition, the provider must to overcome unauthorized attempts to access the data by others.

B. Compliance

Many compliance concerns on cloud computing that can challenge various compliance audit requirements currently in place. Thus, can the new cloud computing technology meet current and future regulatory requirements? , how are existing privacy compliance requirements impacted by moving to the cloud? [16].

C. Storage

Cloud computing users and organizations want to know where their data is stored, whether it is transferred to another data centre in another country, or it commingled with data from others, which use the same CSP [16]. Privacy laws in various countries place limitations on the ability of organizations to transfer some types of personal information to other countries. The transfer of personal information is limited by privacy legislation in many countries.

D. Retention

The retention concern may arise in the future. However, in the case of CSP stops services for any reason or the CSP may decide to mortgage the data if there is a contention.

E. Destruction

There is a concern of data destruction in the cloud. This concern is involved in the way of destroy the data at the end of the service. CSPs may just make the data inaccessible to the organization and they do not really destroy the data. CSP may keep the information longer than necessary so that it can mine the data for its own use.

F. Audit and Monitoring

How can organizations monitor their CSP and provide assurance to their users that privacy requirements are met. It seems unlikely there is any technical way can completely prevent cloud providers from the use of data in all cases [20]. Thus, there is a need for combination of technical and nontechnical procedures to achieve this.

G. Privacy Breaches

Many CSPs like Google have come under heavy breaches related to data collection and privacy. In case of these breaches happened, the cloud users need to know when and how the breach has occurred [16].

X. E-LEARNING PRIVACY

E-learning systems usually store some basic information in the user (learner) profile. Most of this information is very sensitive in the context of privacy. CAUSE highlights relevant requirements to provide a framework for privacy of users' information in an electronic learning environment [22] as illustrated in figure 3.

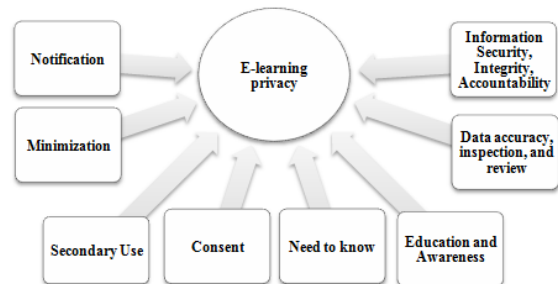


Fig. 3 E-Learning Privacy Requirements [22]

A. Notification

Learning system users must be notified if their information is being collected, who is collecting, whom it is being collected from, the reason of collecting, and the steps taken to protect the confidentiality, integrity, and quality of the information.

B. Minimization

Minimization refers to the nature and the quantity of information collected from users. Taking into account gathering the minimum amount of information, and deleting the information when they are done with it.

C. Secondary Use

For purposes of personalizing e-learning, the learning systems need to collect information about the users. The collected data must be used only for the purpose of which it was collected, even if at the same institution or for a use compatible with that purpose.

D. Consent

Consent principle involves consent strategies and data sensitivity. It relates to what user information can be released without user authorization. If any education institutions need additional information of users to be disclosed, the users must sign a release.

E. Need to know

The e-learning system can allow access to personal information only if there is need to know the information as part of an official and legitimate educational interest and in conformity with disclosure agreements.

F. Information Security, Integrity, Accountability

- 1) Information security is related to protection of information from loss, damage, inappropriate access, and unauthorized disclosure or use of sensitive.
- 2) The term of integrity is that only authorized users are allowed to access and modify personal data.
- 3) Accountability is the ability to clarify security events.

G. Data accuracy, inspection, and review

The collected data from the users must be accurate. The users have the right to check their information and to request modifies if they feel it should be change. In addition, they have the right of inspection and review of data captured through transactions and automatic logging.

H. Education and Awareness

The education institutions have a fundamental responsibility to educate their users about privacy rights and potential implications of use and misuse of personal information. This education is beyond a simple notification and approval which is knowledgeable.

XI. RECOMMENDATIONS

- a) The problems and risks that affect data protection must be considered and well defined in the contract between CSP, education institutions and end users.
- b) Develop systems in such way to work within minimum amount of personal information.
- c) Encrypt the most sensitive data to avoid secondary uses and government access.
- d) CSPs should provide sufficient auditing for strengthening the trust with the cloud users.
- e) Local backup must be performed of critical data by education institutions or users to ensure the availability avoid any retention problems.
- f) The education institutions must plan for how long their data will have retention in the cloud, what is the retention policy that governs the data, who will enforce the retention policy in the cloud, and how are exceptions to this policy managed.
- g) Educaion institutions and users must be aware of the privacy compliance requirements, applicable laws, regulations and standards that govern this information, and who is responsible for maintaining it.

- h) Cloud computing provider must guarantee not keeping additional copies and they will not be available to other cloud users.
- i) It is important to have a suitable technique to prevent cloud providers from using user's data without user's permission.
- j) The CSP must be responsible for managing the breach notification process (and costs associated with the process) and how the breach is determined

XII. CONCLUSION

Despite cloud computing has great advantages of support, availability, cost, performance, on-demand, pay per use, wide network access, measured service, rapid elasticity and recovery, concerns about the privacy are the biggest obstacles to cloud computing adoption in e-learning systems [1], [20], [23], [24]. Privacy is an essential issue in cloud computing environments, where the cloud computing model is different from the traditional computing model .Users' data may be dispersed in various data centre rather than store in the user side. Data privacy protection in cloud computing faces many challenges such as access, storage, compliance, retention, destruction, audit and monitoring, breaches and controversy of various legal systems. These challenges are conflicting with e-learning privacy requirements. With all these challenges, it is clear the cloud computing has a vital impact on the privacy. In addition, Privacy concerns should be seen not only as a technical issue but also as a legal problem. In Cloud computing exploring this issue is quite complex by the nature of clouds. There are still many uncertainties regarding privacy regulations and cloud computing. Thus, in order to adopt cloud based e-learning efficiently, it is important to clarify all possible issues of cloud based e-learning.

This paper highlights some definitions of e-learning, cloud computing architectures and benefits of cloud computing. Also this paper raises the issue of cloud computing privacy and requirements of e-learning privacy. In addition, it proposes a variety of privacy recommendations to be considered in cloud based e-learning environment.

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