iJRASET
International Journal For Research in Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 2 **Issue:** IV **Month of publication:** April 2014

DOI:

www.ijraset.com

Call: 08813907089 | E-mail ID: ijraset@gmail.com

ISSN: 2321-9653

INTERNATIONAL JOURNAL FOR RESEARCH IN APPLIED SCIENCE AND ENGINEERING TECHNOLOGY (IJRASET)

Privacy Protection of User's Data in Cloud Storage Against External Auditors Attacks

[1]B Kumara Swamy, [2]Errolla Venkataiah, [3]A. V. S. M AdiSeshu
Assistant professor[1 2 3]
CSE Department, Sree Dattha Institute of Engineering & Science

Abstract*—Cloud computing is the delivery of computing services over the Internet. It supports remote accessing of resources. The physical existence of users using data in cloud is very less. The data integrity is a challenging issue of data in cloud. The user's data privacy and preserving in cloud can be introduced by third party auditing system. Extensive security and performance analysis gives good security and highly efficient. Using Cloud Storage, users can remotely store their data and enjoy the on-demand high quality applications and services from a shared pool of configurable computing resources, without the burden of local data storage and maintenance. Thus, enabling public auditability for cloud storage is of critical importance so that users can resort to a third party auditor to check the integrity of outsourced data and be worry-free.

Key Words: Cloud computing, privacy-preserving, auditing protocol, data integrity.

1. INTRODUCTION

The importance of Cloud Computing is increasing and it is receiving a growing attention in the scientific and industrial communities. The cloud enhances collaboration, agility, scalability, availability, ability to adapt to fluctuations according to demand, accelerate development work, and provides potential for cost reduction through optimized and efficient computing. From users' perspective, including both individuals and IT enterprises, storing data remotely to the cloud in a flexible on-demand manner brings appealing benefits, relief of the burden for storage management, universal data access with independent geographical locations, and avoidance of capital expenditure on hardware, software, and personnel maintenances. While Cloud Computing makes these advantages more appealing than ever, it also brings new and challenging security threats towards users' outsourced data.

Cloud computing is an umbrella term used to refer to Internet based development and services. The cloud is a metaphor for the Internet. A number of characteristics define cloud data, applications services and infrastructure:

- Remotely hosted: Services or data are hosted on someone else's infrastructure.
- Ubiquitous: Services or data are available from anywhere.
- Commodified: The result is a utility computing model similar to traditional that of traditional utilities, like gas and electricity. You pay for what you would like.

The typical characteristic of this technology, cloud computing customers do not generally own the physical infrastructure serving as host to the software platform in question. Instead, they avoid capital expenditure by renting usage from a third-party provider. The entire onus lies on the service provider who owns the huge scalable and variable host of infrastructure, software and bundle of other services. Cloud computing consumers consume resources as a service and pay only for resources that they use. Many cloud-computing offerings employ the utility computing model, which is analogous to how traditional utility services (such as electricity) are consumed, while others bill on a subscription basis. Sharing "perishable and intangible" computing power among multiple tenants can improve utilization rates, as servers are not unnecessarily left idle (which can reduce costs significantly while increasing the speed of application development).

Since cloud service providers (CSP) are separate administrative entities, data outsourcing is actually relinquishing user's ultimate control over the fate of their data. As a result, the correctness of the data in the cloud is being put at risk due to the following reasons.

Therefore, how to enable a privacy-preserving third-party auditing protocol, independent to data encryption, is the problem we are going to tackle in this paper. Our work is among the first few ones to support privacy-preserving public auditing in Cloud Computing, with a focus on data storage. Besides, with the prevalence of Cloud Computing, a foreseeable increase of auditing tasks from different users may be delegated to TPA. As the individual auditing of these growing tasks can be tedious and cumbersome, a natural demand is then how to enable the TPA to efficiently perform multiple auditing tasks in a batch manner, i.e., simultaneously.

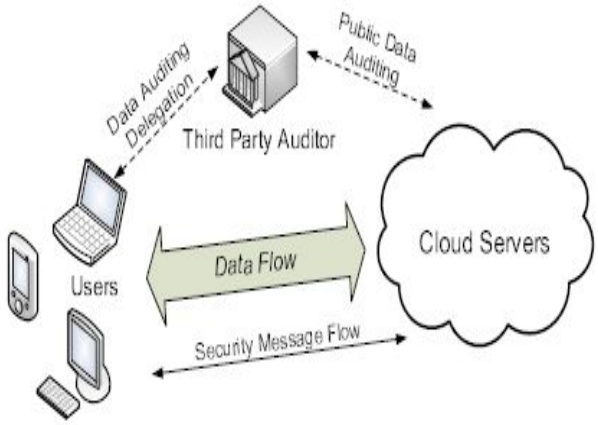
2. RELATED WORK

This section presents our public auditing scheme which provides a *complete outsourcing* solution of data – not only the data itself, but also its integrity checking. We start from an overview of our public auditing system and discuss two straightforward schemes and their demerits. Then we present our main scheme and show how to extent our main scheme to support batch auditing for the TPA upon delegations from multiple users. Finally, we discuss how to generalize our privacy-preserving public auditing scheme and its support of data dynamics.

To address these problems, our work utilizes the technique of public key based homomorphic linear authenticator which enables TPA to perform the auditing without demanding the local copy of data and thus drastically reduces the communication and computation overhead as compared to the straightforward data auditing approaches. By integrating the HLA with random masking, our protocol guarantees that the TPA could not learn any knowledge about the data content stored in the cloud server during the efficient auditing process. The aggregation and algebraic properties of the authenticator further benefit our design for the batch auditing. Specifically, our contribution can be summarized as the following three aspects:

1) We motivate the public auditing system of data storage security in Cloud Computing and provide a privacy-preserving auditing protocol, i.e., our scheme enables an external auditor to audit user's outsourced data in the cloud without learning the data content.
2) To the best of our knowledge, our scheme is the first to support scalable and efficient public auditing in the Cloud Computing. Specifically, our scheme achieves batch auditing where multiple delegated auditing tasks from different users can be performed simultaneously by the TPA.
3) We prove the security and justify the performance of our proposed schemes through concrete experiments and comparisons with the state-of-the-art.

Without a properly designed auditing protocol, encryption itself cannot prevent data from "flowing away" towards external parties during the auditing process. Thus, it does not completely solve the problem of protecting data privacy but just reduces it to the key management. Unauthorized data leakage still remains a problem due to the potential exposure of decryption keys.



Cloud Data Storage Service

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the individual auditing of these growing tasks can be tedious and cumbersome, a natural demand is then how to enable the TPA to efficiently perform multiple auditing tasks in a batch manner, i.e., simultaneously.

To enable privacy-preserving public auditing for cloud data storage under the aforementioned model, our protocol design should achieve the following security and performance guarantees.

1) Public auditability: to allow TPA to verify the correctness of the cloud data on demand without retrieving a copy of the whole data or introducing additional online burden to the cloud users.

2) Storage correctness: to ensure that there exists no cheating cloud server that can pass the TPA's audit without indeed storing users' data intact.

3) Privacy-preserving: to ensure that the TPA cannot derive users' data content from the information collected during the auditing process.

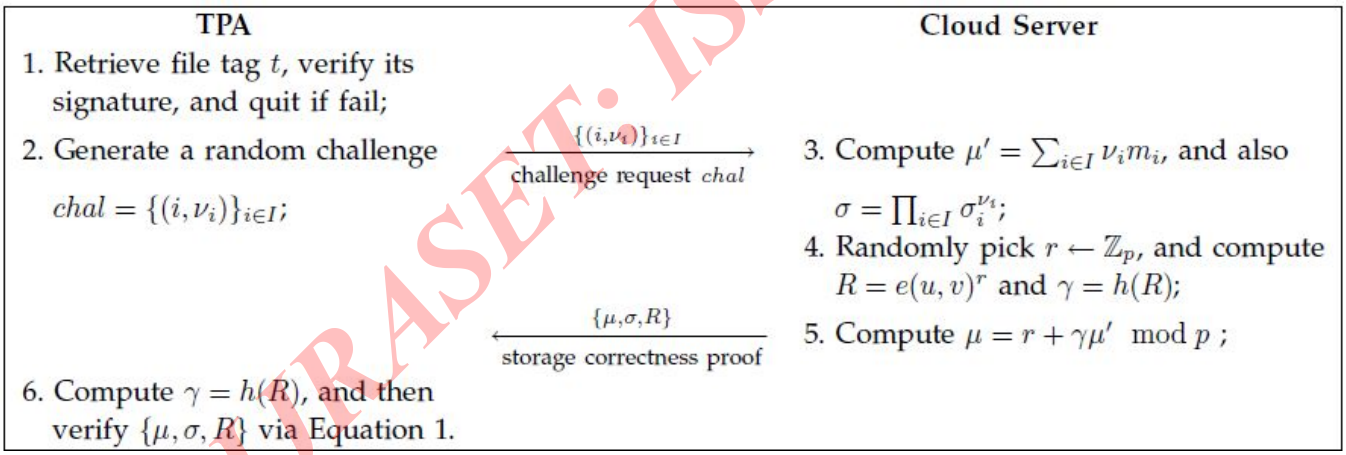
4) Batch auditing: to enable TPA with secure and efficient auditing capability to cope with multiple auditing delegations from possibly large number of different users simultaneously.

5) Lightweight: to allow TPA to perform auditing with minimum communication and computation overhead.

3. THIRD PART AUDITING

To achieve privacy-preserving public auditing, we propose to uniquely integrate the homomorphic linear authenticator with random masking technique. In our protocol, the linear combination of sampled blocks in the server's response is masked with randomness generated the server. With random masking, the TPA no longer has all the necessary information to build up a correct group of linear equations and therefore cannot derive the user's data content, no matter how many linear combinations of the same set of file blocks can be collected. On the other hand, the correctness validation of the block authenticator pairs can still be carried out in a new way which will be shown shortly, even with the presence of the randomness. Our design makes use of a public key based HLA, to equip the auditing protocol with public auditability. Specifically, we use the HLA proposed in, which is based on the short signature scheme proposed by Boneh, Lynn and Shacham.

The privacy-preserving public auditing protocol



We follow a similar definition of previously proposed schemes in the context of remote data integrity checking and adapt the framework for our privacy-preserving public auditing system. A public auditing scheme consists of four algorithms (KeyGen, SigGen, GenProof, VerifyProof). KeyGen is a key generation algorithm that is run by the user to setup the scheme. SigGen is used by the user to generate verification metadata, which may consist of MAC, signatures, or other related information that will be used for auditing. GenProof is run by the cloud server to generate a proof of data storage correctness, while VerifyProof is run by the TPA to audit the proof from the cloud server.

Running a public auditing system consists of two phases, Setup and Audit:

• Setup: The user initializes the public and secret parameters of the system by executing KeyGen, and pre-processes the data file F by using SigGen to generate the verification metadata. The user then stores the data file F

and the verification metadata at the cloud server, and deletes its local copy. As part of
pre-processing, the user may alter the data file F by expanding it or including additional metadata to be stored at server.

• Audit: The TPA issues an audit message or challenge to the cloud server to make sure that the cloud server has retained the data file F properly at the time of the audit. The cloud server will derive a response message from a function of the stored data file F and its verification metadata by executing GenProof. The TPA then verifies the response via VerifyProof. Our framework assumes the TPA is stateless, which is a desirable property achieved by our proposed solution. It is easy to extend the framework above to capture a stateful auditing system, essentially by splitting the verification metadata into two parts which are stored by the TPA and the cloud server respectively. Our design does not assume any additional property on the data file. If the user wants to have more error-resiliency, he/she can always first redundantly encodes the data file and then uses our system with the data file that has error-correcting codes integrated.

4. CONCLUSION

Data storage security in Cloud Computing is a challenging issue which can disturb the regular system. It can be managed by using third party auditing system which can be provided privacy-preserving public auditing system for data storage security in Cloud Computing. The homomorphic linear authenticator and random masking to guarantee that the TPA would not learn any knowledge about the data content stored on the cloud server during the efficient auditing process but also alleviates the users 'fear of their outsourced data leakage. TPA may concurrently handle multiple audit sessions from different users for their outsourced data files and finally extensive analysis shows that it is secure and highly efficient.

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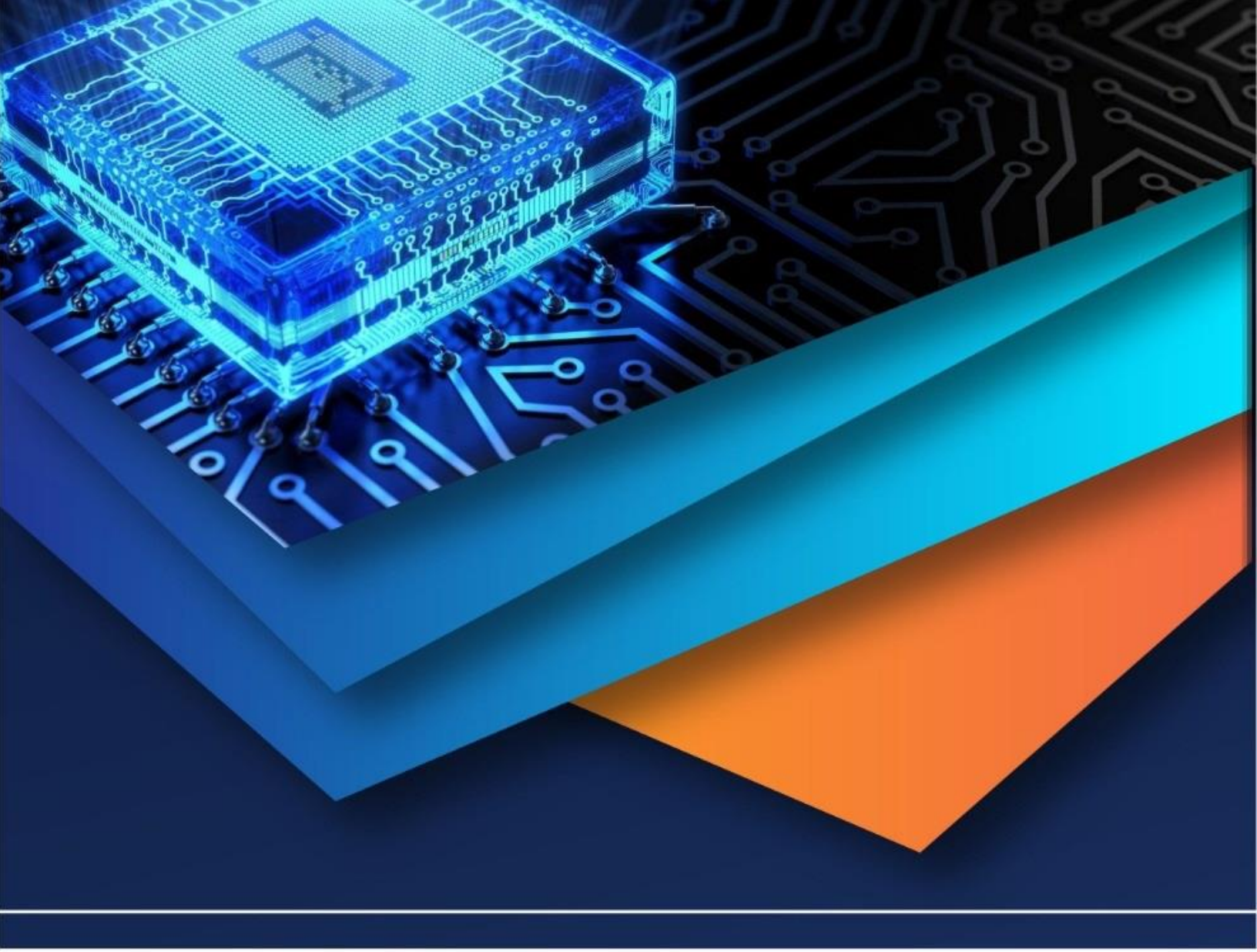
Mr. B Kumara Swamy received his M.Tech (CSE). Present he is working as an Assistant Professor in the CSE Dept at Sree Dattha Institute of Engineering & Science. Hyderabad.

Mr.E Venkataiah received M.Tech(CSE) from HCU. Present he is working as an Assistant Professor in the CSE Dept at Sree Dattha Institute of Engineering & Science, Hyderabad.. His research includes Automata & Compiler Design.

Mr. A. V. S. M AdiSeshu received his M.Tech (CSE). Present he is working as an Assistant Professor in the CSE Dept at Sree Dattha Institute of Engineering & Science, Hyderabad.



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