

# Fully Homomorphic Encrypted Auditing System for Data Security and Integrity in Multicloud

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**Abstract:** Now a days, cloud computing is one of the dominant methods used for providing computing infrastructure for Internet services. A major hurdle to the adoption of cloud-based services is security. We are having a technique called pdp (provable data possession) for ensuring the integrity of data in storage outsourcing. In this paper, we address the construction of an efficient PDP scheme for distributed cloud storage to support the data security and integrity, in which we consider the existence of multiple cloud service providers to cooperatively store and maintain the clients' data. We present a Cooperative Provable Data Possession (CPDP) scheme based on Homomorphic verifiable response and hash index hierarchy. Our proposed system provides security for data and integrity by using fully homomorphic encryption in a multi cloud environment by using Depsky model. Depsky model which is virtual storage cloud system that consists combination of different clouds to build a cloud of cloud. We are providing a scheme which could audit data integrity without decrypting it.

**Keywords:** Fully Homomorphic Encryption, Cooperative Provable Data Possession, Depskymodel, Virtual storage.

## Introduction:

Cloud is an emerging trend and envisioned as a next generation of IT. It defines a framework to deliver IT as a service in most efficient and the fastest way possible, without a need to actually own the resource. It provides level of transparency and monitoring which was not possible in earlier computing paradigms. According to the definition provided by the NIST, "Cloud computing is a model for enabling ubiquitous, 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 and service

provider interaction". The services of Cloud Computing are broadly divided into three categories: Infrastructure-as-a-Service (IaaS) provides infrastructure services to the end user on a subscription basis), Platform-as-a-Service (PaaS) provides platform services to the end user on a subscription basis and Software-as-a-Service (SaaS) provides services to the end user on a subscription basis). Cloud computing is thus being used significantly in IT industry. However, data security is a major concern in adaption of cloud. Client customer does not have full access to outsourced data; it have major concern of ensuring that provider has taken security measures to protect and store data safely. Auditing is thus, employed as a verification tool. It is a process where tracing and logging of data is significant and is used for analyzing and validating security measures to achieve security in all area. Even after applying auditing process there are some loopholes like, data can still be revealed to outsider via auditor for their own benefits. Many schemes have been introduced to address this problem. We are providing a scheme which could audit data integrity without decrypting it.

## 1. Cloud System Model

Whole system of cloud architecture can be divided into three significant components:

1) Client: An entity, which contains large data and data files that are to be stored in the cloud for the computation and monitoring purpose. Client totally relies on the cloud provider for security of their data and they can be either individual consumers or organization.

2) Cloud Services Provider (CSP): It is an entity, which stores and manages all the data stored by the client. The Cloud storage service provider makes all the computation resources available to manage the data files.

3) Third Party Auditor (TPA): It is an entity, which has power and capabilities that a client does not have and a trusted entity that has the access to

other than cloud to check on the exposed risk of cloud storage data on behalf of the client. In the following section we present the details of TPA and other related preliminaries and background.

## 2. Third Party Auditor

As Cloud Service Provider belongs to separate entity, the stored data are at stake. The data outsourcing takes away client's full control over data. As a result the data integrity is hard to check. First, the correctness of the data is being put at a risk since cloud has internal and external threats. Second, there may be some motivations or personal benefits which can make CSP to behave unfaithful e.g. Byzantine failure where CSP can hide errors from the client for own benefits. Another and more serious issues can be deliberately deleting or neglecting data which are rarely accessed by clients, just to save money and storage. Thus, TPA was introduced to cloud system architecture. TPA reduces the burden of Client for managing their data and ensures that the data in cloud is intact and data integrity is maintained. TPA not only helps clients for securing their data, but is also beneficial for the cloud service provider to maintain and increase standards of their platforms and to gain trust over the cloud by consumers.

In other words, providing public auditing services plays a substantial role for this aborning cloud economy to become fully established; users will be needing ways to assess risk and gain trust in the cloud.

Tpa provides integrity and security, if the data still revealed by tpa the fully homomorphic encryption provides security by providing security by its algorithm

## 3. Fully Homomorphic Encryption

we propose highly privacy-preserving public auditing it uses concept of fully homomorphic encryption. This scheme, not only check the data integrity but also keep the data secure even from the third auditor.

Following are some important terminology used in the scheme:

**Homomorphic Authenticator:** It consists of probabilistic-polynomial time algorithms given by Gentry Cargis in his paper[10]. Following functions are integral part of Homomorphic authenticator

**KeyGen(1n) → (evk, sk) :** Takes input string and initializing secret key "sk" for it and an evaluation key "evk".

**Authsk(b, τ) → σ:** It creates a tag σ that authenticates the bit b {0, 1} of sk under the label τ {0, 1}\*.

**Evalevk(f, σ) → ψ:** The deterministic evaluation procedure takes a vector of tags σ = (σ<sub>1</sub>, ..., σ<sub>k</sub>) and a circuit f: {0, 1}<sup>k</sup> → {0, 1}. It outputs a tag ψ. If each σ<sub>i</sub> authenticates a bit b<sub>i</sub> as the output of some labelled-program P<sub>i</sub> (possibly the identity program), then should authenticate b\* = f(b<sub>1</sub>, ..., b<sub>k</sub>) as the output of the composed program P\* = f(P<sub>1</sub>, ..., P<sub>k</sub>).

**Versk(e, P, ψ) → {accept; reject}:** The deterministic verification procedure uses the tag to check that e {0, 1} is the output of the program P on previously authenticated labeled data.

**Fully homomorphic Encryption:** A Fully Homomorphic (public-key) Encryption (FHE) scheme is also consist of probabilistic-polynomial time algorithms given by Gentry [9]. HE = (HE.KeyGen; HE.Enc; HE.Dec; HE.Eval) defined as follows

**HE.KeyGen (1n) → (pk, evk, sk):** Outputs a public encryption key pk, a public evaluation key evk and a secret decryption key sk.

**HE.Encpk (b) → c:** Encrypts a bit b {0, 1} under public key pk. Outputs cipher text c.

**HE.Decsk (c) → b:** Decrypts ciphertext c using sk to a plaintext bit b {0, 1}.

**HE.Evalevk (g; c<sub>1</sub>, ..., c<sub>t</sub>) → c\*:** The deterministic evaluation algorithm takes the evaluation key evk, a boolean circuit g : {0, 1}<sup>t</sup> → {0, 1}, and a set of t ciphertexts c<sub>1</sub>, ..., c<sub>t</sub>. It outputs the result cipher text c\*.

## 4. Existing System

Before going to proposed schemes we study one class of algorithm that is being used in Third Party Auditing. This system based on RSA algorithm, which covers many recent proofs of storage systems

### 4.1 RSA ALGORITHM:

RSA is a Partial homomorphic encryption, with multiplicative encryption technique.

In this algorithm, TPA selects two prime no's p<sub>1</sub> and q<sub>1</sub> thus values are computed

$$n_1 = p_1 * q_1$$

$$fn_1 = (p_1 - 1) * (q_1 - 1)$$

Then, the public key α<sub>1</sub> is selected. So, the Private Key of the TPA is:

$$\beta_1 = (1/\alpha_1) \% fn_1$$

Similarly, the client selects prime numbers p<sub>2</sub> and q<sub>2</sub> with these the private key and the public key of the client is calculated as:

$$n_2 = p_2 * q_2$$

$$fn_2 = (p_2 - 1) * (q_2 - 1)$$

The public key of the client is declared as  $\alpha_2$ . So, the Private Key of the client:  $\beta_2 = (1/\alpha_2) \% fn_2$   
Now, Key set of TPA is:  $\{\alpha_1, n_1\}, \{\beta_1, n_1\}$   
Key set of client is:  $\{\alpha_2, n_2\}, \{\beta_2, n_2\}$

Thus, with the help of keys, data is being encrypted. But this algorithm still has some security problems; if attackers could interrupt two ciphers which are encrypted by same private key, it is then become easy for hacker to decrypt all messages exchanged between the server and its client and it is only because the fully homomorphic encryption is multiplicative, i.e. the product of the ciphers equal the ciphers of the product.

## 5. Existing Work:

Privacy-Preserving Public Auditing for Secure Cloud Storage:

It motivates the correctness of the cloud data can be verified by the TPA without retrieving the copy of the data. To achieve this, homomorphic linear authenticator with random masking technique is used. This technique, does not allow the TPA to have all the necessary information to build upon correct group of linear equation and therefore TPA cannot derive the user's data.

The linear combination of sampled blocks in the server's response is masked with randomness generated by server known as challenges. The user can ask the server to compute challenge for various inputs, and the server uses secret key to derive a short and efficiently verifiable proof that certifies correctness of the computation.

In this model, the client first needs to send some challenges  $c = \text{chall}(x)$  to the server and proof  $\psi$  is computed in response to  $c$ .

Consider outsourcing  $t$  CD(.) that has the data  $D$ , gets input a program  $P$ , and outputs  $CD(P) = P(D)$ . Then, we can think of the pre-processing of CD as creating an authentication tag  $\sigma$  for the data  $D$ .

Later, the user can take a program  $P$ , create a challenge  $c = \text{chall}(P)$ , and get back a short tag  $\psi$  that authenticates  $y = CD(P) = P(D)$ .

## 6. Problem Statement

Some identified problems in existing auditing systems are discussed below.

Existing systems require round of interaction; User first has to create challenge and only then server can authenticate output with respect to challenge [6]. The above delegation allow anyone to evaluate chosen encrypted data and non-interactively authenticate the output user needs to outsource all of data in one shot and stores some small secret state associated with the data to verify computation. Thus data can be easily predicted if decrypted by other than TPA

The schemes require a prior bounded computation by some fixed polynomial chosen during authentication. Furthermore, the complexity of authentication is proportional to the polynomial used. Thus, it increases complexity of algorithm.

Here we propose new concept of integration of fully homomorphic encryption with TPA, which resolves the above mentioned problem.

## 7. Proposed System:

Our Proposed System Fully Homomorphic encryption provides security even from the Tpa. If the tpa will leak the outsourced data it provides security and integrity of data without decrypting it.

### 7.1 Advantages

The advantages of the proposed system are

- Ability to provide auditing technique which not only preserves privacy but also provide authenticator that allows an unbounded number of verification.
- Fully homomorphic encryption scheme solve the security problem while still being compatible with a cloud deployment scenario.
- It reduces complex key management domain.
- It audit data integrity without decrypting it.
- Provides more security when compared to existing system because of four algorithms.
- As the secret key generated it will be difficult for the hacker to estimate the original text.

## 8. Detailed Analysis

User first chooses a public/secret key for an FHE and a pseudo-random function. To authenticate a bit 'b' under a Labelled Program  $\tau$  creates ciphertexts. User chooses ciphertexts and encrypt as random encryptions of bit  $b$  being authenticated. Given some program  $P$  with  $t$  inputs and authentication tags, we can homomorphically derive an authentication tag for output.

We derive each cipher text by homomorphically evaluating the program  $P$  over  $t$  cipher texts that lie in position within the tags. In particular, we set Eval. We assume that evaluation procedure for the FHE scheme is deterministic so that results are reproducible.

User can verify to certify, that  $y$  is the output of the labelled program  $P$ . For indices, user can re-compute the pseudo-random input cipher texts using the PRF, without knowing actual input bits. User then computes Eval and checks that the ciphertexts in

tag were computed correctly. If this is the case, and all of other ciphertexts decrypt to claimed bit y, then user accepts. In proposed scheme fully homomorphic authenticator is being included in TPA.

## 9. Testing

**Test Case1:** if username and password are not same login will be unsuccessful



**Test Case2:** user need to decrypt before he download



**Test Case3:** if the file key didn't match it shows file key is incorrect



**Test Case4:** if the username and password of server didn't match it shows not a valid user



## 9. Conclusion

We concluded that proposed fully homomorphic encryption auditing system for the data security and integrity in the multi cloud provide much security. We have integrated the fully homomorphic encryption in TPA auditing system. Proposed scheme of fully homomorphic provides auditing technique which not only preserves privacy but also provide authenticator that allow an unbounded number of verification. In future we intend to verify its approach more practically and to add experimental analysis to derive some conclusion from it.

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