INTERNATIONAL JOURNAL OF COMPUTATIONAL MATHEMATICAL IDEAS
ISSN: 0974-8652 / www.sijcmi.weebly.com / VOL 6-NO3-PP 6300-6304 (2014)

Sheltered Multi-Owner Data distribution For vibrant Groups in the Cloud

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Abstract—With the personality of low preservation, cloud computing provides an reasonable and efficient solution for distribution group resource among cloud users. Unfortunately, sharing data in a multi-owner manner while preserving data and identity privacy from an untrusted cloud is still a challenging issue, due to the frequent change of the association. In this paper, we propose a sheltered multi owner data distribution scheme, for vibrant groups in the cloud. By leveraging group signature and vibrant broadcast encryption techniques, any cloud user can anonymously share data with others. Meanwhile, the storage transparency and encryption computation cost of our scheme are independent with the number of revoked users. In addition, we analyze the defense of our scheme with rigorous proofs, and demonstrate the efficiency of our scheme in experiments.

Index Terms— Cloud computing, data distribution, privacy-preserving, access control, vibrant groups

1 INTRODUCTION

Cloud computing is recognized as an alternative to traditional information technology [1] due to its intrinsic resource-sharing and low-maintenance characteristics. In cloud computing, the cloud service providers (CSPs), such as Amazon, are able to deliver various services to cloud users with the help of powerful datacenters. By migrating the local data management systems into cloud servers, users can enjoy high-quality services and save significant investments on their local infrastructures.

To preserve data isolation, a basic solution is to encrypt data files, and then upload the encrypted data into the cloud . Unfortunately, designing an efficient and secure data sharing scheme for groups in the cloud is not an easy task due to the following challenging issues.

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Manuscript received 29 Feb. 2012; revised 1 Oct. 2012; accepted 22 Nov.
2012; published online 4 Dec. 2012.
Recommended for acceptance by V.B. Misic, R. Buyya, D. Milojicic, and Y. Cui.For information on obtaining reprints of this article, please send e-mail to: tpds@computer.org, and reference IEEECS Log Number TPDSSI-2012-02-0167.

First, identity privacy is one of the most momentous obstacles for the wide deployment of cloud computing. Without the guarantee of identity privacy, users may be unwilling to join in cloud computing systems because their real identities could be easily disclosed to cloud providers and attackers.

Second, it is highly recommended that any member in a group should be able to fully enjoy the data storing and sharing services provided by the cloud, which is defined as the multiple-owner manner. Compared with the single-owner manner [3], where only the group manager can store and modify data in the cloud, the multiple-owner manner is more flexible in practical applications.

Last but not least, groups are normally vibrant in practice, e.g., new staff participation and current worker revocation in a company. The changes of membership make secure data sharing extremely complicated. On one hand, the unspecified system challenges new granted users to learn the content of data files stored before their participation, because it is impossible for new granted users to contact with anonymous data owners, and obtain the corresponding decryption keys.

By setting a group with a single attribute based on the cipher text-policy attribute-based encryption technique, which allows any member in a group to share data with others. However, the issue of user revocation is not addressed in their scheme, scalable and fine-grained data access control scheme in cloud computing based on the key policy attribute-based encryption (KP-ABE) technique. Unfortunately, the singleowner manner hinders the adoption of their scheme into the case, where any user is granted to store and share data.

Our contributions. To solve the challenges presented above, we propose a secure multi-owner data sharing scheme for dynamic groups in the cloud. The main contributions of this paper include:

1. We propose a secure multi-owner data sharing scheme. It implies that any user in the group can securely share data with others by the untrusted cloud.
2. Our proposed scheme is able to support dynamic groups efficiently. Specifically, new granted users can directly decrypt data files uploaded before their participation without contacting with data owners. User revocation can be easily achieved through a novel revocation list without updating the secret keys of the remaining users. The size and computation overhead of encryption are constant and independent with the number of revoked users.
3. We provide secure and privacy-preserving access control to users, which guarantees any member in a group to anonymously utilize the cloud resource. Moreover, the real identities of data owners can be revealed by the group manager when disputes occur.
4. We provide rigorous security analysis, and perform extensive simulations to demonstrate the efficiency of our scheme in terms of storage and computation overhead.

2 RELATED WORK

cryptographic storage system that enables secure file sharing on untrusted servers, named Plutus. By dividing files into file groups and encrypting each file group with a unique file-block key, the data owner can share the file groups with others through delivering the corresponding lockbox key, where the lockbox key is used to encrypt the file-block keys. However, it brings about a heavy key distribution overhead for large-scale file sharing. Additionally, the file-block key needs to be updated and distributed again for a user revocation Specifically, the data owner encrypts blocks of content with unique and symmetric content keys, which are further encrypted under a master public key. For access control, the server uses proxy cryptography to directly re encrypt the appropriate content key(s) from the master public key to a granted user's public key.

The user revocation in the scheme is an intractable issue especially for large-scale sharing, since the file metadata needs to be updated. In their extension version, the NNL construction [10] is used for efficient key revocation.

However, when a new user joins the group, the private key of each user in an NNL system needs to be recomputed, which may limit the application for dynamic groups. Another concern is that the computation overhead of encryption linearly increases with the sharing scale.

The data owner uses a random key to encrypt a file, where the random key is further encrypted with a set of attributes using KP-ABE. Then, the group manager assigns an access structure and the corresponding secret key to authorized users, such that a user can only decrypt a cipher text if and only

if the data file attributes satisfy the access structure. To achieve user revocation, the manager delegates tasks of data file reencryption and user secret key update to cloud servers.
Each user obtains two keys after the registration: a group signature key and an attribute key. Thus, any user is able to encrypt a data file using attribute-based encryption and others in the group can decrypt the encrypted data using their attribute keys. Meanwhile, the user signs encrypted data with her group signature key for privacy preserving and traceability. Compared with the existing works, Mona offers unique features as follows:
1. Any user in the group can store and share data files with others by the cloud.
2. The encryption complexity and size of ciphertexts are independent with the number of revoked users in the system.
3. User revocation can be achieved without updating the private keys of the remaining users.
4. A new user can directly decrypt the files stored in the cloud before his participation.

3 PRELIMINARIES

3.1 Bilinear Maps

Let G_1 and G_2 be an additive cyclic group and a multiplicative cyclic group of the same prime order q, respectively [11]. Let $e : G_1 \times G_1 \rightarrow G_2$ denote a bilinear map constructed with the following properties:

1. Bilinear: For all $a, b \in Z_q^*$ and $P, Q \in G_1$, $e(aP, bQ) = e(P, Q)^{ab}$.
2. Nondegenerate: There exists a point P such that $e(P, P) \neq 1$.
3. Computable: There is an efficient algorithm to compute $e(P, Q)$ for any $P, Q \in G_1$.

3.2 Group Signature

The concept of group signatures was first introduced by Chaum and van Heyst. In general, a group signature scheme allows any member of the group to sign messages while keeping the identity secret from verifiers. Besides, the designated group manager can reveal the identity of the signature's originator when a dispute occurs, which is denoted as traceability. In this paper, a variant of the short group signature scheme [12] will be used to achieve anonymous access control, as it supports efficient membership revocation.And here any group members can access to any group by considering group signatures.

3.3 Dynamic Broadcast Encryption

Broadcast encryption [16] enables a broadcaster to transmit encrypted data to a set of users so that only a privileged subset of users can decrypt the data. Besides the above characteristics, dynamic broadcast encryption also allows the group manager to dynamically include new members while preserving previously computed

4 SYSTEM MODEL AND DESIGN GOALS

4.1 System Model

We consider a cloud computing architecture by combining with an example that a company uses a cloud to enable its staffs in the same group or department to share files.
The system model consists of three different entities: the cloud, a group manager (i.e., the company manager), and a large number of group members
Cloud is operated by CSPs and provides priced abundant storage services. However, the cloud is not fully trusted by users since the CSPs are very likely to be outside of the cloud users' trusted domain. Similar to [3], [7], we assume that the cloud server is honest but curious.

Group members are a set of registered users that will store their private data into the cloud server and share them with others in the group. In our example, the staffs play the role of group members. Note that, the group membership is dynamically changed, due to the staff resignation and new employee participation in the company.

4.2 Design Goals

In this section, we describe the main design goals of the proposed scheme including access control, data confidentiality, anonymity and traceability, and efficiency as follows:
Access control: The requirement of access control is twofold. First, group members are able to use the cloud resource for data operations. Second, unauthorized users cannot access the cloud resource at any time, and revoked users will be incapable of using the cloud again once they are revoked.

5 THE PROPOSED SCHEME
The group signature scheme enables users to anonymously use the cloud resources, and the dynamic broadcast encryption technique allows data owners to securely share their data files with others including new joining users.

we let the group manager compute the revocation parameters and make the result public available by migrating them into the cloud. Such a design can significantly reduce the computation overhead of users to encrypt files and the ciphertext size.

5.1 File Generation

To store and share a data file in the cloud, a group member performs the following operations:
1. Getting the revocation list from the cloud. In this step, the member sends the group identity IDgroup as a request to the cloud. Then, the cloud responds the revocation list RL to the member.
2. Encrypting the data file M. This encryption process can be divided into two cases according to the revocation list.

5.2 File Deletion

File stored in the cloud can be deleted by either the group manager or the data owner (i.e., the member who uploaded the file into the server). To delete a file ID_{data}, the group manager computes a signature $\gamma f_1(ID_{data})$ and sends the signature along with ID_{data} to the cloud. The cloud will delete the file if the equation $e(\gamma f_1(ID_{data}), P) = e(W, f_1(ID_{data}))$ holds.

Algorithm (1). Signature Generation

Input: Private key (A, x), system parameter (P, U, V, H, W) and data M.

Output: Generate a valid group signature on M.

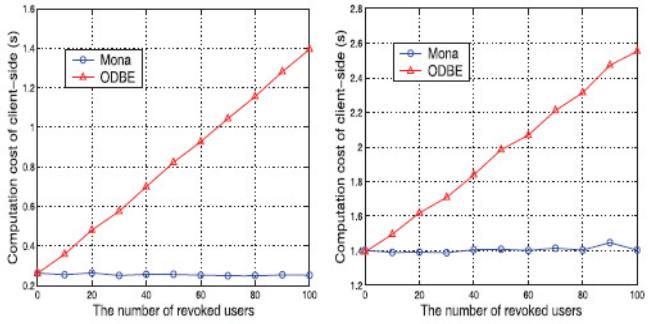
begin

Select random numbers $\alpha, \beta, r_\alpha, r_\beta, r_x, r_{\delta_1}, r_{\delta_2} \in Z_q^*$
Set $\delta_1 = x\alpha$ and $\delta_2 = x\beta$
Computes the following values

$$\begin{cases} T_1 = \alpha \cdot U \\ T_2 = \beta \cdot V \\ T_3 = A_i + (\alpha + \beta) \cdot H \\ R_1 = r_\alpha \cdot U \\ R_2 = r_\beta \cdot V \\ R_3 = e(T_3, P)^{r_x} e(H, W)^{-r_\alpha - r_\beta} e(H, P)^{-r_{\delta_1} - r_{\delta_2}} \\ R_4 = r_x \cdot T_1 - r_{\delta_1} \cdot U \\ R_5 = r_x \cdot T_2 - r_{\delta_2} \cdot V \end{cases}$$

6 PERFORMANCE EVALUATION

Without loss of generality, we set q ¼ 160 and the elements in G1 and G2 to be 161 and 1,024 bit, respectively. In addition, we assume the size of the data identity is 16 bits, which yield a group capacity of 2^{16} data files. Similarly, the size of user and group identity are also set as 16 bits.



(a) Generating a 10 MB file (b) Generating a 100 MB file

7 CONCLUSION
In this paper, we design a secure data sharing scheme, Mona, for dynamic groups in an untrusted

cloud. In Mona, a user is able to share data with others in the group without revealing identity privacy to the cloud. Additionally, Mona supports efficient user revocation and new user joining.

More specially, efficient user revocation can be achieved through a public revocation list without updating the private keys of the remaining users, and new users can directly decrypt files stored in the cloud before their participation. Moreover, the storage overhead and the encryption computation cost are constant. Extensive analyses show that our proposed scheme satisfies the desired security requirements and guarantees efficiency as well.

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