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A Secure Search Scheme Of Encrypted Data on Mobile cloud

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Abstract:

As mobile cloud computing become more flexible & effective in terms of economy, data owners are motivated to outsource their complex data systems from local sites to commercial public mobile cloud. But for security of data, sensitive data has to be encrypted before outsourcing, which overcomes method of traditional data utilization based on plaintext keyword search. Due to the increasing popularity of mobile cloud computing, more and more data owners are motivated to outsource their datato mobile cloud servers for great convenience and reduced cost in data management. However, sensitive data should be encrypted beforeoutsourcing for privacy requirements, which obsoletes data utilization like keyword-based document retrieval. In this paper, we present a secure multi-keyword ranked search scheme over encrypted mobile cloud data, which simultaneously supports dynamic update operationslike deletion and insertion of documents. Considering the large number of data users and documents in mobile cloud, it is necessary for the search service to allow multi-keyword query and provide result similarity ranking to meet the effective data retrieval need. Retrieving of all the files having queried keyword will not be affordable in pay as per use mobile cloud paradigm. In this paper, we propose the problem of Efficient Mobile Multikeyword search(EMMS) over encrypted mobile cloud data (ECD), and construct a group of privacy policies for such a secure mobile cloud data utilization system. From number of multi-keyword semantics, we select the highly efficient rule of coordinate matching, i.e., as many matches as possible, to identify the similarity between search query and data, and for further matching we use inner data correspondence to quantitatively formalize such principle for similarity measurement.Searchable encryption allows one to upload encrypted documentson a remote honest-but-curiousserver and query that data at the server itselfwithout requiring the documents to be decrypted prior to searching. Inthis work We first propose a basic Secured multi keyword ranked search scheme using secure inner product computation, and then improve it to meet different privacy requirements. The Ranked result provides top retrieval results. Due to the use of our special structure, the proposed scheme can achieve sub-linear search time and deal with the deletion and insertion of documents flexibly.Extensive experiments are conducted to demonstrate the efficiency of the proposed scheme. Also we propose an alert system which will generate alerts when un-authorized user tries to access the data from mobile cloud, the alert will generate in the form of mail and message.

Keywords — **Multikeyword, secure search, mobile cloud, encrypted data, encrypted mobile cloud, mobile cloud privacy, data retrieval, outsourcing, server, mobile cloud connection .**

I. INTRODUCTION

Mobile cloud computing enables new types of services where the computational and network resources are available online through the Internet. One of the most popular services of mobile cloud computing is data outsourcing. For reasons of cost and convenience, public as well as private organizations can now outsource their large amounts of data to the mobile cloud and enjoy the benefits of remote storage. At the same time, confidentiality of remotely stored data on untrusted mobile cloud server is a big concern. In order to reduce these concerns, sensitive data, such as,

personal health records, emails, income tax and financial reports, etc. are usually outsourced in encrypted form using well-known cryptographic techniques. Although encrypted data storage protects remote data from unauthorized access, it complicates some basic, yet essential data utilization services such as plaintext keyword search. A simple solution of downloading the data, decrypting and searching locally is clearly inefficient since storing data in the mobile cloud is meaningless unless it can be easily searched and utilized. Thus, mobile cloud services should enable efficient search on encrypted data to provide the benefits of a first-class mobile cloud computing environment.Despite of the various advantages of mobile cloud services, outsourcing sensitive information (such as e-mails, personal health records, company finance data, government documents, files, etc.) to remote servers brings privacy concerns. The mobile cloud service providers that keep the data for users may access users sensitive information without authorization.In the literature, searchable encryption techniques [2-4] are able to provide securesearch over encrypted data for users. They build a searchable inverted index that stores alist of mapping from keywords to the corresponding set of files which contain thiskeyword. When data users input a keyword, a trapdoor is generated for this keyword andthen submitted to the mobile cloud server. Upon receiving the trapdoor, the mobile cloud server executesontain this keyword. But, these methods only allow exact single keyword search. Some researchers study the problem on secure and ranked search over outsourced mobile cloud data. Wang et al., [5] propose a secure ranked keyword search scheme. Theirsolution combines inverted index with order-preserving symmetric encryption (OPSE). Interms of ranked search, the order of retrieved files is determined by numerical relevance scores, which can be calculated by TF×IDF. The relevance score is encrypted by OPSEto ensure security. It enhances system usability and saves communication overhead. This solution only supports single keyword ranked search. Cao et al., [6] propose a method thatadopts similarity measure of “coordinate matching” to capture the relevance of files to thequery. They use “inner product similarity” to measure the score of each file. This solutionsupports exact multi-keyword ranked search. It is practical, and the search is flexible. Sunet al., [7] proposed a MDB-tree based scheme which supports ranked multi-keywordsearch.

This scheme is very efficient, but the higher efficiency will lead to lower precisionof the search results in this schemeIn addition, fuzzy keyword search [8-10] have been developed. These methods employ a spell-check mechanism, such as, search for “wireless” instead of “wireiess”, or the data format may not be the same e.g., “data-mining” versus “datamining. Chuah et al., [8] propose a privacy-aware bed-tree method to support fuzzy multi-keyword search. This approach uses edit distance to build fuzzy keyword sets. Bloom filters are constructed for every keyword. Then, it constructs the index tree for all files where each leaf node a hash value of a keyword. Li et al., [9] exploit edit distance to quantify keywords similarity andconstruct storage-efficient fuzzy keyword sets. Specially, the wildcard-based fuzzy set construction approach is designed to save storage overhead. Wang et al., [10] employ wildcard-based fuzzy set to build a private tree-traverse searching index. In the searching phase, if the edit distance between retrieval keywords and ones from the fuzzy sets is less than a predetermined set value, it is considered similar and returns the corresponding files. These fuzzy search methods support tolerance of minor typos and format inconsistencies, but do not support semantic fuzzy search. Considering the existence of polysemy and synonymy [11], the model that supports multi-keyword ranked search and semantic search is more reasonable.comparison between the trapdoor and index, and finally returns the data users all files. A general approach to protect the data confidentiality is to encrypt the data before outsourcing.

However, this will cause a huge cost in terms of data usability. For example, the existing techniques on keyword-based information retrieval, whichare widely used on the plaintext data, cannot be directly applied on the encrypted data. Downloading all the data from the mobile cloud and decrypt locally is obviously impractical. In order to address the above problem, researchers have designed some general-purpose solutions with fully-homomorphic

encryption or oblivious RAMs. However, these methods are not practical due to their high computational overhead for both the mobile cloud sever and user. On the contrary, more practical special purpose solutions, such as searchable encryption (SE) schemes have made specific contributions in terms of efficiency, functionality and security. However, we note that "fine-grained search authorization" is an indispensable component for a secure data outsourcing system. Although the accesses to actual documents can be controlled by separate cryptographic enforced access control techniques such as attribute-based encryption [9], [39], [26],"0-1" search authorization may still lead to leakage of data owners' sensitive information. For example, if Alice is the only patient with a rare disease in a PHR database, by designing the query in a clever way (e.g., submitting two queries with/without the name of that disease and with Alice's demographic info), from the results a user Bob will be certain that Alice has that disease. Thus, we argue that a user shouldonly be allowed to search for some specific sets of keywords; in particular, the authorization shall be based on a user's attributes. For instance, in a patient matching application in health social networks [28], [23], a patient should only be matched to patients having similar symptoms as her, whileshall not learn any information about those who do not. Furthermore, system scalability is an important concern for SE. For symmetric-key based SE schemes, the encryption and search capabilities are not separable, so a multi-owner system would require every owner to act as a capability distributioncenter, which is not scalable. PKC-based schemes do not have this problem, but if every user obtains restricted search capabilities from a central trusted authority (TA) who assumes the responsibility of authorization at the same time, it shall be always online, dealing with large workload, and facing thethreat of single-point-of-failure. In addition, since the global TA does not directly possess the necessary information to check the attributes of users from different local domains, additional infrastructure needs to be employed (such as using a credential chain [27]). It is therefore desirable for the usersto be authorized locally.

Searchable encryption schemes enable the client to store the encrypted data to the mobile cloud and execute keyword search over ciphertext domain. So far, abundant works have been proposed under different threat models to achieve various search functionality, such as single keyword search, similarity search, multi-keyword boolean search, ranked search, multi-keyword ranked search, etc.Among them, multikeyword ranked search achieves more and more attention for its practical applicability. Recently, some dynamic schemes have been proposed to support inserting and deleting operations on document collection. These are significant works as it is highly possible that the data owners need to update their data on the mobile cloud server. But few of the dynamic schemes support efficient multikeyword ranked search.

In order to obtain high search efficiency with the special structure of our data index, the proposed search scheme can flexibly achieve sub-linear search time and deal with the deletion and insertion of documents. we construct a tree-based index structure and propose a "Greedy Depth-first Search" algorithm based on this index tree. The secure kNN algorithm is utilized to encrypt the index and query vectors, and meanwhile ensure accurate relevance score calculation between encrypted index and query vectors. To resist different attacks in different threat models, we construct two secure search schemes: the basic dynamic multi-keyword ranked search scheme in the known cipher text model, and the enhanced dynamic multi-keyword ranked search scheme in the background model. Our contributions are summarized as follows:

a) Due to the special structure of our data index, the search complexity of the proposed scheme is fundamentally kept to logarithmic. And in practice,the proposed scheme can achieve higher search efficiency by executing our "Greedy Depth-first Search" algorithm. Moreover, parallel search can be flexibly performed to further reduce the time cost of search process.

b) We design a searchable encryption scheme that supports both the accurate multi-keyword ranked search and flexible dynamic operation on document collection.

II. RELATED WORK

Organizations, companies store more and more valuable information is on cloud to protect their data from virus,hacking. The benefits of the new computing model includebut are not limited to: relief of the trouble for storageadministration, data access, and avoidance of highexpenditure on hardware mechanism, software, etc. Rankedsearch improves system usability by normal matching filesin a ranked order regarding to certain relevance criteria(e.g., keyword frequency),As directly outsourcingrelevance scores will drips a lot of sensitive informationagainst the keyword privacy, We proposed asymmetricencryption with ranking result of queried data which willgive only expected data.

Searchable encryption has been an active research area and many quality workshave been published [1–6, 9–13, 16, 20–23, 25, 26]. Traditional searchable encryptionschemes usually build an encrypted searchable index such that its content ishidden to the server, however it still allows performing document searching with given search query. Song *et al.* [23] were the first to investigate the techniques for keyword search over encrypted and outsourced data. The authors begin with idea to store a set of plaintext documents on data storage server such as mail servers and file servers in encrypted form to reduce security and privacy risks. The work presents a cryptographic scheme that enables indexed search on encrypted data without leaking any sensitive information to the untrusted remote server. Goh [16] eveloped a per-file Bloom filter-based secure index, which reduce the searching cost proportional to the number of files in collection. Recent work by Moataz *et al.* [21] proposed boolean symmetric searchable encryption scheme. Here, the scheme is based on the orthogonalization of the keywords according to the Gram-Schmidt process. Orencik's solution [22] proposed privacy-preserving multi-keyword search method that utilizes minhash functions. Boneh *et al.* [6] developed the first searchable encryption using the asymmetric settings, where anyone with the public key can write to the data stored remotely, but the users with private key execute search queries. The other asymmetric solution was provided by Di Crescenzo *et al.* in [11], where the authors propose a public-key encryption scheme with keyword search based on a variant of the quadratic residuosity problem.

All secure index based schemes presented so far, are limited in their usage since they support only exact matching in the context of keyword search. Wang *et al.* [25] studied the problem of secure ranked keyword search over encrypted cloud data.

The authors explored the statistical measure approach that embeds the relevance score of each document during the establishment of searchable index before outsourcing the encrypted document collection. The authors propose a single keyword searchable encryption scheme using ranking criteria based on keyword frequency that retrieves the best matching documents. Cao *et al.* [9] presented a multi-keyword ranked search scheme, where they used the principle of "coordinate matching" that captures the similarity between a multi-keyword search query and data documents. However, their index structure is uses a binary representation of document terms and thus the ranked search does not differentiate documents with higher number of repeated terms than documents with lower number of repeated terms.

Searchable encryption schemes enable the clients to store the encrypted data to the cloud and execute keyword search over ciphertext domain. Due to different cryptography primitives, searchable encryption schemes can be constructed using public key based cryptography [5], [6] or symmetric key based cryptography [7], [8], [9], [10]. Song et al. [7] proposed the first symmetric searchable encryption (SSE) scheme, and the search time of their scheme is linear to the size of the data collection. Goh [8] proposed formal security definitions for SSE and designed a scheme based on Bloom filter. The search time of Goh's scheme is O (n), where n is the cardinality of the document collection. Curtmola et al. [10]proposed two schemes (SSE-1 and SSE-2) which achievethe optimal search time. Their SSE-1 scheme is secure against chosen-keyword attacks (CKA1) and SSE-2 is secure against adaptive chosen-keyword attacks (CKA2).These early works are single keyword boolean searchschemes, which are very simple in terms of functionality.Afterward, abundant works have been proposed underdifferent threat models to achieve various search functionality,such as single keyword search,

similarity search[11], [12], [13], [14], multi-keyword boolean search [15],[16], [17], [18], [19], [20], [21], [22], ranked search [23],[24], [25], and multi-keyword ranked search [26], [27],[28], [29], etc.Multi-keyword boolean search allows the users toinput multiple query keywords to request suitable documents.Among these works, conjunctive keyword searchschemes [15], [16], [17] only return the documents thatcontain all of the query keywords. Disjunctive keywordsearch schemes [18], [19] return all of the documentsthat contain a subset of the query keywords. Predicatesearch schemes [20], [21], [22] are proposed to supportboth conjunctive and disjunctive search. All these multi-keyword search schemes retrieve search results basedon the existence of keywords, which cannot provideacceptable result ranking functionality.Ranked search can enable quick search of the mostrelevant data. Sending back only the top-k most relevantdocuments can effectively decrease network traffic. Someearly works [23], [24], [25] have realized the rankedsearch using order-preserving techniques, but they aredesigned only for single keyword search. Cao et al.[26] realized the first privacy-preserving multi-keywordranked search scheme, in which documents and queriesare represented as vectors of dictionary size. With the"coordinate matching", the documents are ranked accordingto the number of matched query keywords.However, Cao et al.'s scheme does not consider theimportance of the different keywords, and thus is notaccurate enough. In addition, the search efficiency of thescheme is linear with the cardinality of document collection.Sun et al. [27] presented a secure multi-keywordsearch scheme that supports similarity-based ranking.The authors constructed a searchable index tree basedon vector space model and adopted cosine measuretogether with TF×IDF to provide ranking results. Sun etal.'s search algorithm achieves better-than-linear searchefficiency but results in precision loss."

Orencik et al. [28]proposed a secure multi-keyword search method whichutilized local sensitive hash (LSH) functions to clusterthe similar documents. The LSH algorithm is suitablefor similar search but cannot provide exact ranking. In[29], Zhang et al. proposed a scheme to deal with securemulti-keyword ranked search in a multi-owner model. Inthis scheme, different data owners use different secretkeys to encrypt their documents and keywords whileauthorized data users can query without knowing keysof these different data owners. The authors proposedan "Additive Order Preserving Function" to retrieve themost relevant search results. However, these works don'tsupport dynamic operations.

Practically, the data owner may need to update thedocument collection after he upload the collection to thecloud server. Thus, the SE schemes are expected to supportthe insertion and deletion of the documents. Thereare also several dynamic searchable encryption schemes.In the work of Song et al. [7], the each document isconsidered as a sequence of fixed length words, andis individually indexed. This scheme supports straightforwardupdate operations but with low efficiency. Goh[8] proposed a scheme to generate a sub-index (Bloomfilter) for every document based on keywords. Then the dynamic operations can be easily realized throughupdating of a Bloom filter along with the correspondingdocument. However, Goh's scheme has linear searchtime and suffers from false positives. In 2012, Kamaraet al. [30] constructed an encrypted inverted index thatcan handle dynamic data efficiently. But, this schemeis very complex to implement. Subsequently, as an improvement,Kamara et al. [31] proposed a new searchscheme based on tree-based index, which can handledynamic update on document data stored in leaf n-odes. However, their scheme is designed only for singlekeywordBoolean search. In [32], Cash et al. presenteda data structure for keyword/identity tuple named "TSet".Then, a document can be represented by a series ofindependent T-Sets. Based on this structure, Cash et al.[33] proposed a dynamic searchable encryption scheme.In their construction, newly added tuples are stored inanother database in the cloud, and deleted tuples arerecorded in a revocation list. The final search result isachieved through excluding tuples in the revocation listfrom the ones retrieved from original and newly addedtuples. Yet, Cash et al.'s dynamic search scheme doesn'trealize the multi-keyword ranked search functionality.

III. PROBLEM BASE

A. System Model

The system model can be considered as three entities, the data owner, the data user and the cloud

server. Before you begin to format your paper, first write and save the content as a separate text file. Keep your text and graphic files separate until after the text has been formatted and styled. Do not use hard tabs, and limit use of hard returns to only one return at the end of a paragraph. Do not add any kind of pagination anywhere in the paper. Do not number text heads-the template will do that for you.

Finally, complete content and organizational editing before formatting. Please take note of the following items when proofreading spelling and grammar:

- *Data Owner*

Data owner has a collection of data documents A set of distinct keywords is extracted from the data collection. The data owner will firstly construct an encrypted searchable index I from the data collection D. All files in D are encrypted and form a new file collection, C .Then, the data owner upload both the encrypted index I and the encrypted data collection C to the cloud server.

- *Data User*

Data user provides *t* keywords for the cloud server. A corresponding trapdoor through search control mechanisms is generated. In this paper, we assume that the authorization between the data owner and the data user is approximately done.

- *Cloud Server*

Cloud server receivedfrom the authorized user. Then, the cloud server calculatesand returns to the corresponding set of encrypted documents. Moreover, to reduce the*Tw*communication cost, the data user may send an optional number*l*along with thetrapdoor*T*so that the cloud server only sends back top-*l*files that are most relevant to the search query.

D. Threat models and Design Goals

The cloud server is considered as "honest-but-curious" in our model. Particularly, the cloud server both follows the designated protocol specification but at the same timeanalyzes data in its storage and message flows received during the protocol so as to learn additional information [12]. In this paper, we purpose to achieve security and ranked search under the above model.The designed goals of our system are following:

Latent Semantic Search: We aim to discover the latent semantic relationship

between terms and documents. We use statistical techniques to estimate the latent

semantic structure, and get rid of the obscuring "noise" [11].The proposed scheme tries to

put similar items near each other in some space in order that it could return the data user

the files contain the terms latent semantically associated with the query keyword.

Multi-keyword Ranked Search: It supports both multi-keyword query and support

result ranking.

Privacy-Preserving: Our scheme is designed to meet the privacy requirement and

prevent the cloud server from learning additional information from index and trapdoor.

1) Index Confidentiality. The *TF* values of keywords are stored in the index. Thus,

the index stored in the cloud server needs to be encrypted;

2) Trapdoor Unlinkability. The cloud server could do some statistical analysis over

the search result. Meanwhile, the same query should generate different trapdoors

when searched twice. The cloud server should not be able to deduce relationship

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3) Keyword Privacy. The cloud server could not discern the keyword in query, index

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3. Proposed Scheme

In this section, we give a detailed description of our scheme. We firstly propose to employ "Latent Semantic Analysis" to implement the latent semantic multi-keyword ranked search.

A. Our Scheme

Data owner wants to outsource *m* data files that he prepares to outsource to the cloud server in encrypted form while still keeping the capability to search *m* through them(Fig 3.1). To do so, data owner firstly builds a secure searchable index from a set of *n* distinct key words extracted from the file collection D

According to the above definition about *LSA*, the data owner builds a term-document matrix **A**□. Matrix **A**□ can be decomposed into the product of three other matrices. And then, we reduce the dimensions

of the original matrix **A**□ to get a new matrix **A** which is calculated the best "reduced-dimension" approximation to the original term-document matrix [16]. With *t* keywords of interest in as input, one binary vector **Q** is generated where each bit indicates whether □W is true or false. The similarity score is expressed as the inner product of data vector *j*[A]and query vector **Q**. Specially, []**A** *j* denotes the *j–th* column of the matrix **A**□ **S e t u p** The data owner generates a2*n* □-bit vector as **X** and two(2) (2)*nn*□ □ □invertible matrices {**M , M**} .The secret key *SK* is the form of a 3-tuple as **M**□ **B u i l d I n d ex(A ,)***SK* □The data owner extracts a term-document matrix12**A**□fromDanddecomposes it into three other matrices **U**□ , *nt* □**S** □,*tt* □ **V** □ . According to our scheme, the data owner adopts statistical techniques to estimate the latent structure, and get rid of the obscuring "noise". To reduce dimensions, we choose previous *tm* □*k* columns of **S**□, and then deleting the corresponding columns of **U** □ and **V** □ respectively. Following, we multiply these three matrices.

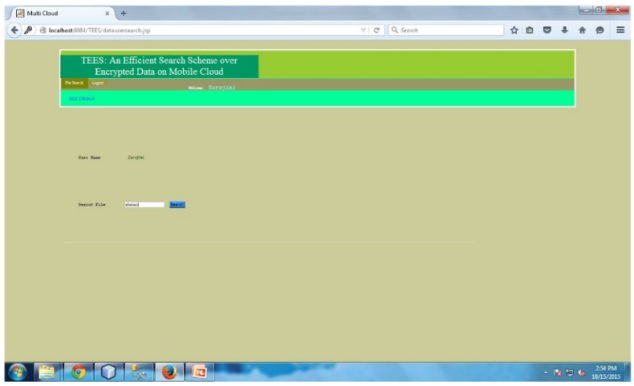


Fig 3.1

4. Performance and Security Analysis

In this section, we show a thorough experimental evaluation of the proposed technique on a real dataset: the *MED* dataset [17] .The whole experiment is implemented by C++ language on a computer with Core 2.83GHz Processor, on Windows 7 system. For the proposed scheme, we will reduce to separate dimensions. The performance of our method is compared with the original MRSE scheme.

D. Effectiveness and Efficiency

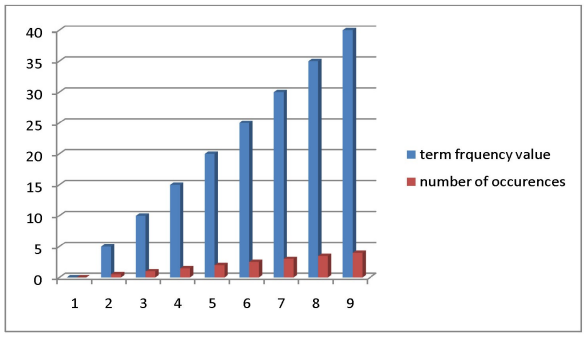
The proposed scheme is depicted in details in previous section, except the Key Gen algorithm. In

our scheme, we adopt Gauss-Jordan to compute the inverse matrix. The time of generating key is decided by the scale of the matrix. Besides, the proposed scheme that processed by *SVD* algorithm will consume time. Other algorithms, such as index construction, trapdoor generation, query, which is put forward by us, are consistent with the original MRSE in time-consuming.

1) Index and Trapdoor Generation: The index generation process is a one-time computation which contains two majorsteps: the Bloom filter generation and the encryption. During the Bloom filter generation, the computation mainly comes from the hash function calculation. Figure 3.2 shows the Bloom filter generation for the search index and the trapdoor Bloom filter. The generation time increases linearly respect to the number of the inserted keywords. The trapdoor generation time is very close to the index generation time due to the identical procedure. The encryption time which involves the matrix multiplications is showed in figure 3.(3). The time cost of encryption increases linearly respect to the number of the files in the dataset.

2) Search over Encrypted Index: The search operation executed at the cloud server side consists of computing the inner product calculation for all the files in the dataset. Figure

3.(c) shows the search time grows linearly with the size of the file set while the number of keywords in the query has little impact as showed in figure 3.(d). This is intuitive because the search process needs to go over all the files in the dataset before the cloud server can get the final result. The inner product computation is only related to the length of the index, so the computation time changes little in figure 3.(d).



E. F-measure of the sceme:

In this paper, we still use the measure of traditional information retrieval. Before the introduction of the F-measure's concept, we will firstly give the brief of the precision and recall. Precision is the fraction of retrieved instances that are relevant, while recall is the fraction of relevant instances that are retrieved. Both precision and recall are therefore based on an understanding and measure of relevance[18]. F-measure that combines precision and recall is the harmonic mean of precision and recall[19]. Here, we adopt F-measure to weigh the result of our experiments.

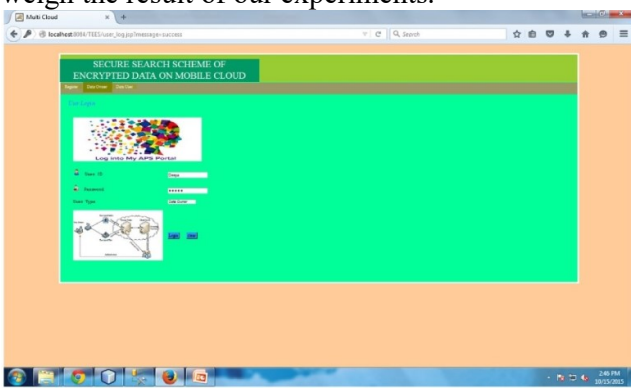


Fig 3.2

B. Result Accuracy

We adopt the definitions of the widely used performance metrics, precision and recall to measure the search result accuracy. Denote tp as true positive, fp as false positive and fn as false negative, then the precision equals to while the recall is tp tp+fn. To generate the fuzzy queries, we randomly pick two keywords and modify them into the fuzzy keywords. Figure 4.(a) shows the performance metrics of our scheme according to k. Note that there is no recall for the exact matching because the false negative doesn't exist. One observation is that precision is very low when k is small, i.e. 5% at k = 1. Because that multiple LSH functions are used together to enlarge the gap between p1 and p. So when the k is small, the gap is not big enough to distinguish the different keywords, and most of the files in the dataset have been returned, which leads to high fp and low fn. The jump at k = 5 is due to the gap between p1 and p2 increases exponentially respect to k. After a certain k, i.e., k = 8, the precision is remained at a high level, which is above 90% for the exact search

and above 80% for the fuzzy search. Another observation is that the recall drops when increasing the k. This is because that increasing the k will cause more false negatives. In general, the false positive and the false negative cannot be improved at the same time. Another important parameter is the number of the keywords in the query. Figure 4.(b) shows the precision of the exact match decreasing slightly, from 100% to 96% while the number of the keywords in the query increases from 1 to 10. This is reasonable because the false positive generated by each keyword accumulates. But the precision for the fuzzy search doesn't show the same pattern. It is slightly increased from 70% to 81% when the number of the keywords in the query increases from 1 to 10. The reason is that the false positive caused by the LSH functions contributes much more tp+fp

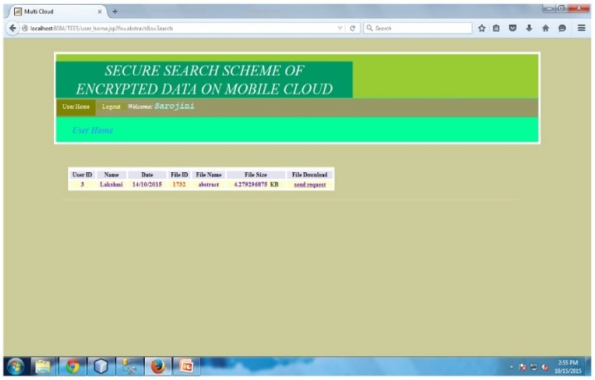


Fig 3.3

I. ALGORITHMS USED

A .RSA Algorithm

This algorithm is used to encrypt n decrypt file contents.It is an asymmetric algorithm. The RSA algorithm involvesthree steps: key generation, encryption and decryption.

Key generation

RSA involves a **public key** and a **private key.** The public key can be known to everyone and is used forencrypting messages. Messages encrypted with the public key can only be decrypted using the private key. The keysfor the RSA algorithm are generated the following way:

1. Choose two distinct prime numbers *a* and *b*.

2. Compute $n = ab$. n is used as the modulus for both the public and private keys

3. Compute $f(n) = (a-1)(b-1)$, where f is Euler'stotient function.

4. Choose an integer e such that $1 < e < f(n)$ and greatest common divisor of $(e, f(n)) = 1$; i.e., $e$andf(n) are co prime.

e is released as the public key exponent. Having a short bit-length .

Encryption

Person A transmits her public key to Person B and keeps the private key secret. Person B then wishes to send message **M** to Person A. He first turns **M** into an integer m, such that by using an agreed-upon reversible protocol known as a padding scheme. He then computes the cipher text corresponding to this can be done quickly using the method of exponentiation by squaring. Person B then transmits to Person A. Note that at least nine values of m could yield a cipher text c equal to m, but this is very unlikely to occur in practice.

Decryption

Person A can recover from by using her private key exponent via computing Given , she can recover the original message **M** by reversing the padding scheme.(In practice, there are more efficient methods of calculating using the pre computed values below.)

C. Predicate Privacy in Searchable Encryption

Shen et al [32] proposed a SKC-based predicate encryption scheme with predicate privacy. However, in a SKC-based scheme with an encryption key one can generate any search capabilities, which is undesirable for search authorization. Under public key setting, [4] proposed a key refreshing solution to randomize the original keywords used in generating the trapdoors in PEKS, but that requires a user to share a secret with all potential encryptors. In contrast, in our enhanced solution some secrets are kept by proxies, thus it does not incur any interaction between owners and users.

VI.CONCLUSION AND FUTURE SCOPE

Thus we proposed the problem of multiple-keyword ranked search over encrypted cloud data, and construct a variety of security requirements. From various multi keyword concepts, we choose the efficient principle of coordinate matching. We first

propose secure inner data computation. Also we achieve effective ranking result using our technique. This system is currently work on single user mobile cloud, In future is will extended up to big computing & Provide better security for multi-user systems.

REFERENCES

[1] Ning Caoy, Cong Wangz, Ming Liy, Kui Renz, and WenjingLouyPrivacy-Preserving Multi-keyword Ranked Search over EncryptedCloud Data

[2] Weifeng Su, Jiying Wang, and Frederick H. Lochovsky, Member,IEEE Computer Society Record Matching over Query Results fromMultiple Web Databases

[3] Y.Srikanth,M.VeereshBabu, P.Narasimhulu Combined KeywordSearch over Encrypted Cloud Data Providing Security andConfidentiality

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[5] A. Singhal, Modern information retrieval: A brief overview, IEEEData Engineering Bulletin, vol. 24, no. 4, pp. 3543, 2001.

[6] R. Ananthakrishna, S. Chaudhuri, and V. Ganti, Eliminating FuzzyDuplicates in DataWarehouses, Proc. 28th Intl Conf. Very LargeData Bases, pp. 586-597, 2002.

[7] R. Baeza-Yates and B. Ribeiro-Neto, Modern Information Retrieval.ACM Press,1999.

[8] I. H. Witten, A. Moffat, and T. C. Bell, Managing gigabytes:Compressing and indexing documents and images, MorganKaufmann Publishing, San Francisco, May 1999.

[9] E.-J. Goh, Secure indexes, Cryptology ePrint Archive, 2003,http://eprint.iacr.org/2003/216.

[10] D. Song, D. Wagner, and A. Perrig, ―Practical techniques forsearches on encrypted data,‖ in Proc. of IEEE Symposium onSecurity and Privacy'00, 2000.

[11] J. Baek, R. Safavi-Naini, and W. Susilo. Public key encryption with keyword search revisited. In *Proceedings of ICCSA, Part I*, ICCSA '08, pages 1249–1259, 2008.

[12] L. Ballard, S. Kamara, and F. Monrose. Achieving efficient conjunctive keyword searches over encrypted data. In *Proc. of ICICS'05*, 2005.

[13] F. Bao, R. H. Deng, X. Ding, and Y. Yang. Private query on encrypted data in multi-user settings. In *ISPEC'08*, pages 71–85, Berlin, Heidelberg, 2008. Springer-Verlag.

[14] J. Benaloh, M. Chase, E. Horvitz, and K. Lauter. Patient controlled encryption: ensuring privacy of electronic medical records. In *CCSW '09*, pages 103–114, 2009.

[15] J. Bethencourt, J. Franklin, and M. Vernon. Mapping internet sensors with probe response attacks. In *Proceedings of the 14th conference on USENIX Security Symposium*, pages 13–13, 2005.

[16] J. Bethencourt, A. Sahai, and B. Waters. Ciphertext-policy attributebased encryption. In *IEEE S& P '07*, pages 321–334, 2007.

[17] D. Boneh, G. D. Crescenzo, R. Ostrovsky, and G. Persiano. Public key encryption with keyword search. In *Proc. of EUROCRYP'04*, 2004.

[18] D. Boneh and B. Waters. Conjunctive, subset, and range queries on encrypted data. In *Proc. of TCC'07*, pages 535–554, 2007.

[19] J. Camenisch, M. Kohlweiss, A. Rial, and C. Sheedy. Blind and anonymous identity-based encryption and authorised private searches on public key encrypted data. In *PKC'09*, pages 196–214. Springer-Verlag.

[20] N. Cao, C. Wang, M. Li, K. Ren, and W. Lou. Privacy-preserving multi-keyword ranked search over encrypted cloud data. In *IEEE INFOCOM*, 2011.

[21] M. Armbrust, "A view of cloud computing", Communications of the ACM, vol. 53, no. 4, **(2010)**, pp. 50-58.

[22] D. Boneh, "Public key encryption with keyword search", Advances in Cryptology-Eurocrypt 2004, Springer, **(2004)**.
[23] R. Curtmola, "Searchable symmetric encryption: improved definitions and efficient constructions",
Proceedings of the 13th ACM conference on Computer and communications security, ACM, **(2006)**.
[24] D. X. Song, D. Wagner and A. Perrig, "Practical techniques for searches on encrypted data. in Security and Privacy", 2000. S&P 2000, Proceedings 2000 IEEE Symposium, IEEE, **(2000)**.
[25] C. Wang, "Secure ranked keyword search over encrypted cloud data", Distributed Computing Systems (ICDCS), 2010 IEEE 30th International Conference, IEEE, **(2010)**.
[26] N. Cao, "Privacy-preserving multi-keyword ranked search over encrypted cloud data", INFOCOM, 2011 Proceedings IEEE, IEEE, **(2011)**.
[27]N. Cao, C. Wang, M. Li, K. Ren, and W. Lou, "Privacy-preserving multi-keyword ranked search over encrypted cloud data," in INFOCOM, 2011 Proceedings IEEE. IEEE, 2011, pp. 829–837.
[28]S.Hou, T. Uehara, S. Yiu, L. C. Hui, and K. Chow, "Privacy preserving multiple keyword search for confidential investigation of remote forensics," in Multimedia Information Networking and Security (MINES), 2011 Third International Conference on. IEEE, 2011, pp. 595–599.
[29]P.Golle, J. Staddon, and B. Waters, "Secure conjunctive keyword search over encrypted data," in Applied Cryptography and Network Security. Springer, 2004, pp. 31–45.
[30]A.Aizawa, "An information-theoretic perspective of tf-idf measures," Information Processing and Management, vol. 39, pp. 45–65, 2003.