Secured and Practical Storing of Data in Cloud Storage

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***Abstract*—Cloud computing is the concept implemented to remedy the Daily Computing Problems. Cloud computing is basically virtual pool of resources and it provides these resources to users via internet. It offers a range of services for end users; among which there's Storage as a service. In recent years, Storage in Cloud gained popularity among both companies and private users. However, data privacy, security, reliability and interoperability issues still have to be adequately solved. But the most important problem is security and how cloud provider assures it. In this paper, we have proposed a simple, secure, and privacy-preserving architecture for inter-Cloud data sharing. This architecture is based on an encryption/decryption algorithm which aims to protect the data stored in the cloud from the unauthorized access.**

***Index Terms*— AES, Cloud Storage, cryptography, Data security, Decryption, Encryption, RSA, SHA256**

I. INTRODUCTION

CLOUD computing is a "new" computer model that allows using remote services through a network using various resources. It is basically meant to give the maximum capacity with the minimum resources. The end user has the minimum hardware requirement, but he uses the maximum capability of computing. This is possible only through this technology which requires and utilizes its resources in the best way. Cloud Computing provides IT services as on-demand services, accessible from anywhere, anytime and by authorized user.

Recently Storage as a service (STaaS) Cloud gained popularity both among private users and companies . STaaS is a Cloud business model in which a service provider rents space in its storage infrastructure to individuals or companies.

The data stored in the cloud can be sensitive to the business. The problematic is that these data are likely to be exploited by the provider or other unauthorized persons. Currently, the most of users of cloud storage protect their data with SLAs contracts and are based on the trust and reputation of the provider. This weakness has motivated us to think about solutions that enable users to secure their data to prevent malicious use.

Cloud storage providers. It is desirable to enable cloud clients to verify the integrity of their outsourced data, in case their data have been accidentally corrupted or maliciously by insider/outsider attacks.

Despite the strengths that represent cloud computing generally and cloud storage specially; there are a number of research challenges such as mobility, interoperability, storage access , security, cost, energy efficiency, etc.

Security is a major obstacle limiting its spread. There are various opinions on the security of cloud computing which deal with the positives and negatives of it.

This document is presented as follows: Firstly, it gives a comprehensive definition and the characteristics of cloud computing. Secondly, it describes layers and their technologies related to this concept. Thirdly, it describes the different types of cloud computing and their characteristics. Fourthly, it describes our model proposed of securing data in cloud storage algorithm for encryption/decryption for outsourcing data in cloud storage and then the general conclusion.

II. ABOUT CLOUD COMPUTING

A. Definition

Cloud Computing is an important concept in computer development in recent years. This concept refers to the use of computing capacity and storage of computers and servers in the world over the Internet. Cloud services allow individuals and businesses to use software and hardware that are managed by third parties at remote locations. Examples of cloud services include online file storage, social networking sites, webmail, and online business applications. Cloud computing provides a shared pool of resources, including data storage space, networks, computer processing power, and specialized corporate and user applications.

B. Essential Characteristics

Cloud model promotes availability and is composed of five essential characteristics:

On-demand self-service

A consumer can unilaterally provision computing capabilities, such as email, applications, and network or server service, as needed automatically without requiring human interaction with each service provider.

Broad network access

Capabilities are available over the network and accessed through standard mechanisms that promote use by heterogeneous thin or thick client platforms (e.g., mobile phones, tablets, laptops, and workstations).

Resource pooling

The provider's computing resources are pooled to serve multiple consumers using a multi-tenant model, with different physical and virtual resources dynamically assigned and reassigned according to consumer demand. Examples of resources include storage, processing, memory, and network bandwidth.

Elasticity

Capabilities can be elastically provisioned and released, in some cases automatically, to scale rapidly outward and inward commensurate with demand.

Measured service

Cloud systems automatically control and optimize resource use by leveraging a metering capability at some level of abstraction appropriate to the type of service (e.g., storage, processing, bandwidth, and active user accounts). Resource usage can be monitored, controlled, and reported, providing transparency for both the provider and consumer of the utilized service.

III. LAYERS OF CLOUD COMPUTING

There are different layers of cloud services that refer to different types of *service model*, each offering discrete capabilities. Apart from management and administration, the major layers are:

A. Infrastructure as a Service (IaaS)

Infrastructure as a service delivers computing resources as a service, servers, network devices, and storage disks are made available to organizations as services on a need-to basis.

Virtualization, allows IaaS providers to offer almost unlimited instances of servers to clients, while making cost-effective use of the hosting hardware.

Companies can use IaaS to build new versions of applications or environments without having to invest in physical IT assets. Some cloud solutions also rely solely on **this layer like the Amazon's product EC2, Amazon S3.**

B. Platform as a Service (PaaS)

This layer provides a platform for creating applications. PaaS solutions are essentially development platforms for which the development tool itself is hosted in the Cloud and accessed through internet. With PaaS, developers can build Web applications without installing any tools on their computers and then deploy those applications without any specialized systems administration skills.

Examples include Google App Engine, Force.com and Microsoft Azure.

C. Software as a Service (SaaS)

This layer includes applications that run off the Cloud and are available on demand to Web and paid for on a per-use basis, anytime-anywhere basis. There is no need to install and run the special software on your computer if you use the SaaS. A more efficient form is fine grained multi-tenancy. The concept of SaaS is attractive and some software runs well as cloud computing, but the delay of network is fatal to real time or half real time applications such as 3D online game . Examples include online word processing and spreadsheet tools, customer relationship management (CRM) services and web content delivery services (Salesforce CRM, Google Docs, etc.). These three are the main layers, although there can also be other forms of service provided, such as business process as a service, data as a service, security as a service, storage as a service (object of our paper), etc.

IV. CLOUD DEPLOYMENTS MODELS

A. Private Cloud

Private cloud is a new term that some vendors have recently used to describe offerings that emulate cloud computing on **private networks. It is set up within an organization's internal** enterprise datacenter. In the private cloud, scalable resources and virtual applications provided by the cloud vendor are pooled together and available for cloud users to share and use. Only the organization and designated stakeholders may have access to operate on a specific Private cloud .

B. Public cloud

A public cloud is a model which allows users access to the services and infrastructure and are provided off-site over the Internet**. It's typically based on a pay**-per- use model, similar to a prepaid electricity metering system which is flexible enough to cater for spikes in demand for cloud optimization. Public clouds are managed by third parties or vendors over the Internet. Public clouds are less secure than the other cloud models because it places an additional burden of ensuring all applications and data accessed on the public cloud are not subjected to malicious attacks. However, security and governance issues must be well planned and ample security controls was put in place.

C. Hybrid cloud

A new concept combining resources from both internal and external providers will become the most popular choice for enterprises. A hybrid cloud is a combination of public and private cloud models that tries to address the limitations of each approach. In a hybrid cloud, part of the service infrastructure runs in private clouds while the remaining part runs in public clouds. Hybrid clouds offer more flexibility than both public and private clouds. Specifically, they provide tighter control and security over application data compared to public clouds, while still facilitating on-demand service expansion and contraction. On the down side, designing a hybrid cloud requires carefully determining the best split between public and private cloud components.

D. Community cloud

This model is rarely offered; the infrastructure is shared by several organizations for a shared cause and may be managed internally or a third party service provider. It brings together, in general, the structures with same interest (mostly security) and may even be in the same field of activity.

V. SECURITY

Security in cloud computing involves concepts such as network security, equipment and control strategies deployed to protect data, applications and infrastructure associated with cloud computing. An important aspect of cloud is the notion of interconnection with various materials which makes it difficult and necessary securing these environments. Security issues in a cloud platform can lead to economic loss, also a bad reputation if the platform is oriented large public and are the cause behind the massive adoption of this new solution. The data stored in the cloud for customers represents vital information. This is why the infringement of such data by an unauthorized third party is unacceptable. There are two ways to attack data in Cloud. One is outsider attack and the other is insider attack. The insider is an administrator who can have the possibility to **hack the user's data. The insider attack is very difficult to be** identified. So the users should be very careful while storing their data in cloud storage. Hence, the need to think of methods that impede the use of data even though the data is **accessed by the third party, he shouldn't get the actual data.** So, all the data must be encrypted before it is transmitted to the cloud storage [11].

Security allows the confidentiality, integrity, authenticity and availability of information. The development of technologies and their standardization makes available a set of algorithms and protocols for responding to these issues.

A. ASYMMETRIC ENCRYPTION

Asymmetric cryptography is a class of cryptographic algorithms which requires two separate keys, one of which is secret (or private) and one of which is public. Although different, the two parts of this key pair are mathematically linked. The public key is used to encrypt plaintext or to verify a digital signature; whereas the private key is used to decrypt cipher text or to create a digital signature. In our paper we used RSA algorithm through its robustness.

RSA Algorithm

The most common Public Key algorithm is RSA, named for its inventors Rivest, Shamir, and Adelman of MIT. RSA is basically an asymmetric encryption/decryption algorithm. Public key distributed to all through which one can encrypt the message and private key which is used for decryption is kept secret and is not shared to everyone. It based on exponentiation in a finite field over integers modulo a prime numbers.

RSA uses Euler's Theorem: $^{\phi()mod(n)} =$ 1 where *gcd(a,n)=1* in RSA we have to that $=(p-1)(q-1)$ one has to carefully chose *e* and *d* to be inverses *mod* $\phi(n)$.

To encrypt a message *M* we have to obtain public key of recipient *Pu=* to calculate the cipher: *C= mod(n)*, *M= mod(n).* is important that the message *M* must be smaller than the modulus *n*. Similarly for decryption the recipient uses their private key *Pr=* and computes:

Fig 1 shows the graph of RSA decryption time by key length.

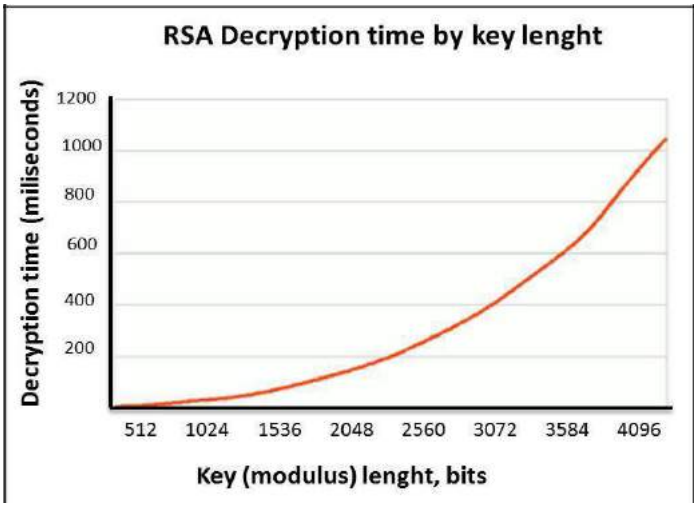

Fig 1: RSA decryption time by key length

B. SYMMETRIC ENCRYPTION

Symmetric- key algorithms are a class of algorithms for cryptography that use the same cryptographic keys for both encryption of plaintext and decryption of cipher text. The keys may be identical or there may be a simple transformation to go between the two keys. The keys, in practice, represent a shared secret between two or more parties that can be used to maintain a private information link. This requirement that both parties have access to the secret key is one of the main drawbacks of symmetric key encryption, in comparison to public-key encryption.

AES Algorithm

AES is a variant of Rijndael which has a fixed block size of 128 bits, and a key size of 128, 192, or 256 bits. The key size used for an AES cipher specifies the number of repetitions of transformations rounds. The number of cycles of repetition is as follows (see fig 2):

- 10 cycles of repetition for 128-bit keys.
- 12 cycles of repetition for 192-bit keys.
- 14 cycles of repetition for 256-bit keys.

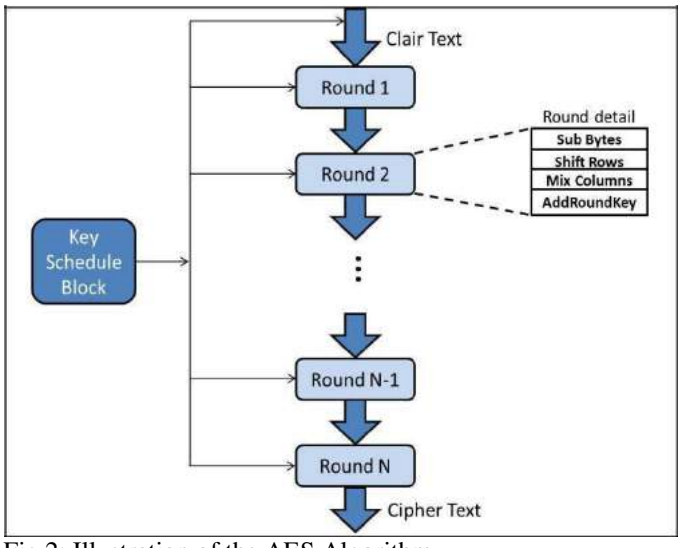

Fig 2: Illustration of the AES Algorithm

The advantages of AES are many. AES is not susceptible to any attack but Brute Force attack. However, Brute Force attack is not an easy job even for a super computer. This is because the encryption key size used by AES algorithm is of the order 128, 192 or 256 bits which results in billions of permutations and combinations. High speed and low RAM requirements were criteria of the AES selection process. Thus AES performs well on a wide variety of hardware; from 8-bit smart cards to high-performance computers. AES is also much faster than the traditional algorithms; therefore in our work AES is adopted. Recently Compact AES S-box is developed to be more efficient.

C. *SHA Algorithm.*

SHA is hash algorithm in which n-bit hash produces a n-bit length finger print from the arbitrary length data. SHA-1, SHA-256, SHA-512 produces message digest 160,256 and 512 respectively. The Secure Hash Algorithm is a family of cryptographic hash functions published by the National Institute of Standards and Technology (NIST) as a U.S. Federal Information Processing Standard (FIPS), including:

- SHA-0: The original version of the 160-bit hash function published in 1993 under the name "SHA".
- SHA-1: A 160-bit hash function which resembles the earlier MD5 algorithm. This was designed by the National Security Agency (NSA) to be part of the Digital Signature Algorithm.
- SHA-2: A family of two similar hash functions, with different block sizes, known as SHA-256 and SHA- 512. They differ in the word size; SHA-256 uses 32-bit words where SHA-512 uses 64-bit words.
- SHA-3: It supports the same hash lengths as SHA-2, and its internal structure differs significantly from the rest of the SHA family.

C. Related work

Security storage in cloud computing has been the object of several researches. In, they have addressed the security issues associated in cloud data storage and have explored many of them. Whenever a data vulnerability is perceived during the storage process, a precision verification across the distributed servers are ensured by simultaneous identification of the misbehaving nodes through analysis in term of security malfunctioning. It is proved that their scheme is effective to handle certain failures, malicious data modification attack, and even server colluding attacks.

The proposed technique emphasizes classical encryption techniques by integrating substitution cipher and transposition cipher. Both substitution and transposition techniques have used alphabet for cipher text.

It suggests the SPKS scheme for cloud storage services to allow users to efficiently access files containing certain keywords in a cloud anytime and anywhere using any device.

VI. PROPOSED ALGORITHM

The proposed system is implemented in Cloud Storage service that is one of the cloud providers. In order to apply security features, RSA algorithm is used which is using RSA Key. In Cloud service, the user need to create an custom application, after the creation it generates unique two keys application key and application secret key helps in authentication for the OAuth Framework.

Both the keys need to be used in the python applet. Initially the applet needs to be authenticate with the cloud storage. Then file needed to be store in cloud is encrypted i**n user's** computer and uploaded with encrypted secret key.

The decryption process is by downloading the encrypted file and the encrypted key. First the key gets decrypted and using the key the original file gets decrypted. (see Fig 3).

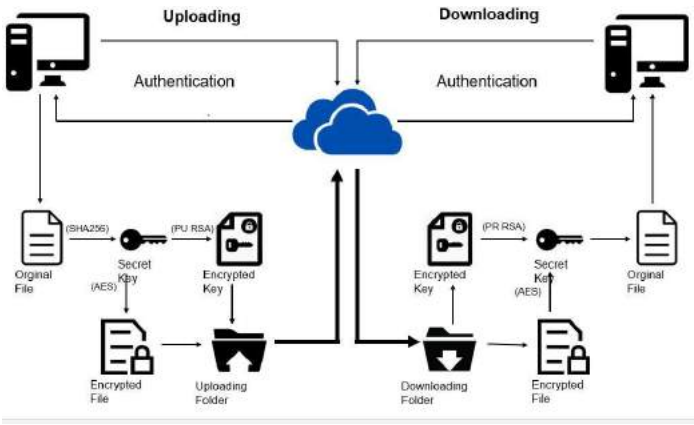

Fig 3: Model proposed of data storage in cloud computing

A. File Upload

The SHA256 algorithm generated the Hash Code for the original file. This Hash code is used as the key for the AES Algorithm and encrypted the original data. Then the Hash Code (i.e. AES Key) is encrypted using the RSA Public Key which is generated for the specific application. Both the encrypted original data and the encrypted key is uploaded in the cloud storage.

B. File Download

The user downloads both the encrypted data and the encrypted key. First the decryption of Hash Code (i.e. AES key) gets done, using the Private Key of RSA Algorithm. Then the decryption of the original file is takes place with the AES key, user now gets the original data.

C. Implement results and analysis

The implementation of results in this section highlights the time of execution in upload and in download of files with different sizes. Our application is developed in Python. This is explained by the addition of key recovery time on server.

Table I
EXECUTION TIME FOR ENCRYPTION AND DECRYPTION

File size (Kb)	128	256	512	1024	2048
Time in Upload (second)	0,2025	0,4051	0,8118	1,6201	3,2903
Time in download (second)	0,4225	0,8452	1,6905	3,3802	6,7711

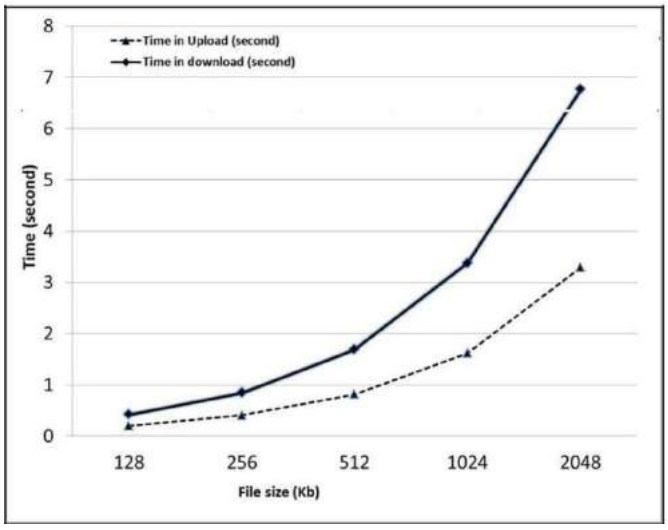

Fig 6: Graph of time execution of our algorithm

Fig 7 and Table 2 show the execution time required by different size text files and different AES key size for encryption process.

Table II
EXECUTION TIME BY FILE SIZE AND SIZE OF THE AES

File size / Key size	128	256	512	1024	2048
128	0,198	0,397	0,794	1,587	3,1744
192	0,224	0,448	0,896	1,792	3,584
256	0,25	0,499	0,998	1,997	3,9936

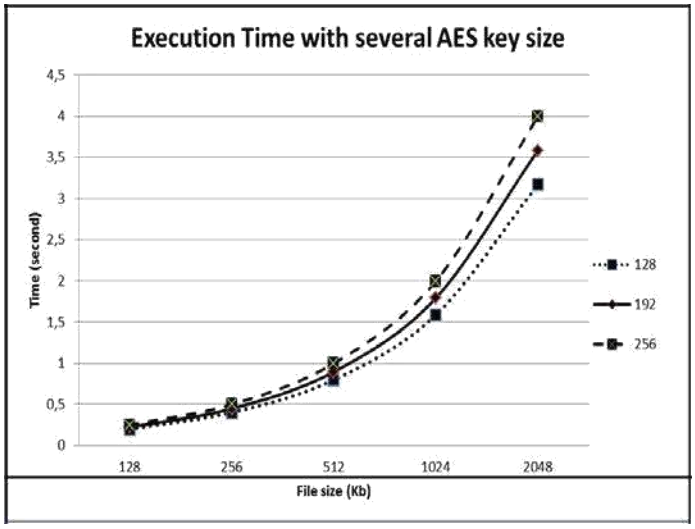

Fig 7: Graph of encryption time execution of our algorithm with different AES key size

Our algorithm has the following advantages and strengths:

- The data sent to cloud is encrypted from the source machine to the destination machine and the decryption key does not exist in the cloud.
- AES algorithm used is a safe, fast symmetric algorithm and is one of the most secure encryption algorithms. It has not been broken to date. It means that our algorithm is fast in both directions: upload and download.
- Ability to change the symmetric key frequently to enhance security.
- The AES key used for encryption of the data is encrypted by RSA-1024 algorithm robust and has never been broken.
- The decryption of data requires double authentication. The user must have access rights to the company's server and cloud storage.

VII. CONCLUSION AND FUTURE WORK

Although Cloud storage has many advantages, there are still many actual problems concerning security that need to be solved. If we can eliminate or master this weakness of security, the future is going to be Cloud storage solutions for large as well as small companies.

In this paper, we have suggested a solution that allows storage of data in an open cloud. Data security is provided by implementing our algorithm. Only the authorized user can access the data. Even if an intruder (unauthorized user) gets the data accidentally or intentionally, he can't decrypt it and needs two keys coming from two different locations. As perspectives, we will focus on several possible directions in this area, especially in the homomorphic encryption

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