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Data Storage in Cloud Environment: Challenges and Issues

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Abstract- Cloud Computing has led to new trends of computing and storing in Information in IT and it has brought change in the IT business with introduction of pay per use model. In this paper, author introduces the evolution of cloud computing and its deployment models which includes Private cloud, Public cloud, Hybrid cloud and Community cloud and in addition, various service models which includes IaaS, PaaS, SaaS, XaaS has been discussed. No doubt cloud computing offers many opportunities but it has lots of concern which IT Community has raised.In this survey article, author also gives insight into types of information stored in cloud and security concerns raised by data owners.

Keywords*: Cloud Computing, Data Security, Symmetric algorithms*

I. INTRODUCTION

The boon of "Cloud Computing" is the result of advancements in network technologies that led to development of three computing models namely Grid Computing, Utility computing and Now cloud computing. According to NIST, "Cloud computing" is a model for enabling ubiquitous computing. It provides on demand access to a shared pool of configurable computing resources with minimal management effort or service provider interaction. Cloud computing framework has changed everyone's perception about the software delivery, infrastructure architectures and development models. The evolution of cloud computing is the result of improvement in technologies as shown in Figure 1.1[1, 2]. The users of IT Companies have started migrating to cloud platform because of its feature like rental based services, need based services and easy release of the resources, when there is no requirement.

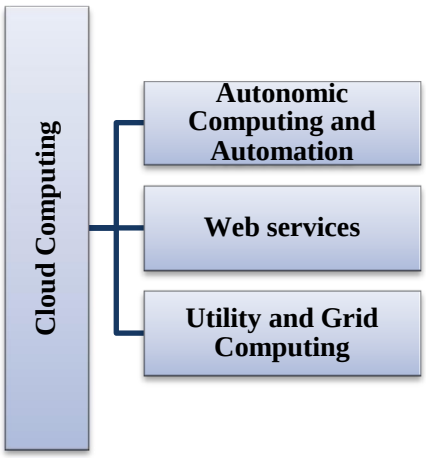

Figure 1.1: Evolution of Cloud Computing [1, 2]

II. MODELS AND SERVICES OF CLOUD COMPUTING

The United Nation's National Institute of Standards and Technology (NIST) has a set of working definition, separating cloud computing into services and deployment model as depicted in Figure 1.2. It can be inferred that Cloud computing categories are based on strategies of deployment and Service usage [3, 4].

There are five essential characteristics and 3-service models (based on service of Software, Platform and Infrastructure), and 4-deployment models (Private, Community, Public and Hybrid Cloud). It has 5- characteristics of On-Demand Self-Service (ODSS), Broad Network Access (BNA), Resource Pooling (RP), Rapid Elasticity (RE) and Measured Service (MS).

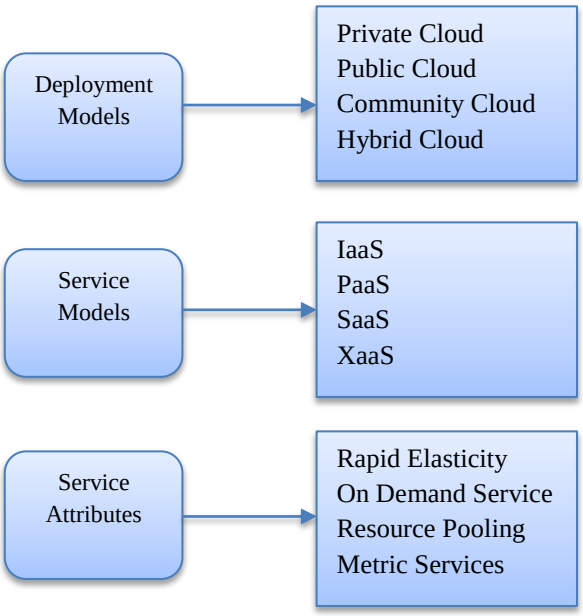

Figure 1.2: Depicting relationships between Cloud Models and their Characteristics

2.1 Cloud Service delivery Models

Cisco and other IT Industries are moving to an internet of everything (IoE). Apart from this, in literature, Several studies reveals three basic models of services in Cloud Computing (i) Software as a Service (SaaS) (ii) Platform as a Service (PaaS) (iii) Infrastructure as a Service (IaaS). Recently, anything as a Service (XaaS) has been accepted as a new member [5].

The brief description is given in subsequent subsections.

2.1.1. Infrastructure as a Service (IaaS)

IaaS is intended to offer virtualized resources like high Computational and Scalable Storages. It provides users to get on demand availability of various resources like storage servers, networking components. (For example, Amazon Web Services offering VM Ware with customized software stacks).

The IaaS Service providers manage the entire infrastructure whereas client is responsible for deployment services, which includes operating system, applications. IaaS finds suitability in IT investment for businesses. Elastic cloud compute (ECC) is offering services (Virtual Private servers) on minute mode by paying only as per the requirement [6].

2.1.2 Platform as a Service (PaaS)

PaaS is for developers to create, deploy their applications without knowing or bothering about the architecture or configurations of Platforms. For example, GoogleAPP Engine acts as middleware for cloud users to build their own application by providing development tools, platforms and frameworks where users can run their applications [6].

PaaS model has been in much demand than SaaS because of providing more user ready features. Even for upgrades, users need not worry as PaaS service providers manage upgradation. Examples of PaaS are Google App Engine, Amazon Web Services, and Microsoft Azure [6].

2.1. 3 Software as a Service (SaaS)

The SaaS has reduced the burden of software maintenances for various users. It uses applications residing on the top of stack and users can access this layer through web portals, say Social Network, CRM and Video Processing. Examples of SaaS are Google Docs, Cloud Drive, and Salesforce.com CRM application [6].

2.1.4 Anything as a service (XaaS)

Anything as a service (XaaS) supports clients to offer and support anything in the form of services ranging from specific requirements to large requirement of storage, computing power etc [6].

2.2 Cloud Deployment Models

Cloud service users look into various deployment models to examine their merits and demerits in terms of elasticity, migration, pricing, security etc. In the literature, five models have been described namely Public cloud, Private cloud, Hybrid cloud, community cloud and virtual private cloud [7]

2.2.1 Private cloud (PC)

Private Cloud has a proprietary infrastructure usually kept in data centre of an organization managed under firewall. Therefore, management and security responsibilities in case of private cloud are much easier to carry out.

In other words, Private cloud is like an internal data centre of an organization that is not available to public like Banks data centre. In this type of cloud, infrastructure is operated for a private organization. It is managed by the organization or a third party and may exist on premise or off premises [7].

2.2.2 Hybrid Cloud (HC)

When private cloud is supplemented with computing capacity from public clouds, it shapes to New Cloud known as Hybrid Cloud. The cloud infrastructure is composition of two or more clouds (private, community, or public) that remain unique entities, but are bound together by standardized or proprietary technology, that enables data and application portability (e.g., cloud bursting for load-balancing between clouds).In most cases, Hybrid clouds have been mixture of public and private clouds, bringing together their advantages and overcoming their obstacles.

Hybrid models are managed by both organisation and third party and is placed in both offsite and onsite locations [7]**.**

2.2.3 Community cloud (ComC)

The cloud infrastructure is shared by several organizations and supports a specific community that has common concerns (e.g., mission, security requirements, policy, and compliance considerations). It may be managed by the organizations or a third party, and may exist on premise or off premise. The Community clouds eliminate security risks of public cloud [7].

2.2.4 Public Cloud (PC)

The cloud infrastructure is made available to the public or a large industry group and is owned by an organization selling cloud services. Multiple tenants can access a Public cloud from different locations. The model is based on pay per use approach and offering scalable services [8].Since, resources and infrastructure, providing services to customers can reside at geographically separated places within or outside the country, which turns this model into less secured and more risky than any other deployment model. This model has highlighted issues of designing service level agreements between Cloud Service Providers and service seekers [7].

2.2.5 Virtual Private Cloud (VPC)

Virtual Private Cloud is mentioned in very less sources of literature .It is created by using Virtual Private Network (VPN) connectivity among various devices.VPC is a particular case of private cloud existing within any other. This Model encourages customers to use cloud services without worrying about operating in shared or public environment [7].

2.3 Offerings of Cloud Computing

The cloud computing has changed the way IT companies invest on Hardware's, Softwares etc. It has reduced the cost of computing, marketing, investment etc. Some of the offerings of cloud computing are:

2.3.1 Automatic Elasticity

Elasticity permits the automatic assignment of dynamic number of resources to a task. This feature gives illusion to clients about unlimited availability of resources Irrespective of task or service. This is typically employed to ensure that availability criteria of a service or resource are always granted with best resource utilization. As the applications on cloud need to scale up or scale down according the varying requirements as per the conditions. Therefore, elastic behavior is the key features under IaaS category [8]. When the number of servers are increased by automatic scaling, incoming load i.e., traffic is also distributed accordingly. Ideally, Cloud Computing gives the illusion of infinite computing resources available on demand. The users can rapidly provision computing resources, as needed, without human interaction. Capabilities can be rapidly and elastically provisioned in some cases automatically, to quickly scale out or up [8].

2.3.2 Reduced IT costs and Access to automatic updates

Migration of various companies to the cloud has reduced the cost of computing, managing and maintaining IT systems of the companies. The various enterprises, customers intended to purchase expensive systems and equipment for their business, which will reduce their budget by using the unlimited and flexible resources of cloud service provider on need basis [9].

The cost may be reduced because of the following reasons:

a) The Cloud Users need not to pay for system upgrades, new hardware and software and this could include up-to-date versions of software, as well as upgrade servers and computer processing power. It has been found that in UK alone, companies are spending 18-20 working days per month managing on-site security alone but the cloud has reduced the same.
b) The Cloud Users need not to employ experts for their companies as cloud manages most of the things.
c) Less Hardware at user's level reduces electricity consumption and cost [9].

2.3.3 Scalability

One of the biggest advantages of cloud computing is scalability because business can scale up or scale down depending upon the requirement , operation and storage needs to suit situation, allowing flexibility as per the needs change. Rather than purchasing and installing expensive upgrades at user level, cloud service provider can manage all this for the customers.

2.3.4 Securing and Making Data available all the time

For a competitive environment, Protection of data and systems is an important part of business. Migrating data into cloud and using other resources like computing Power, infrastructure is safe as cloud service providers ensures secure and safe location. Even in case of natural disaster, power failure or other crisis, data stored in the cloud is secure because of encryption and backup [10].

2.3.5 Collaboration efficiency and Flexibility of work practices

Collaboration is another useful aspect in any business. Therefore, cloud environment provides ways to communicate and share more easily outside of the traditional methods for business purpose. If employees of different companies are working on a project across different locations, Companies can use cloud computing to give their employees, contractors and third parties access to the same files. Companies can choose a cloud computing model that makes it easy for them to share their records.

Cloud computing allows employees to be more flexible in their work practices and now's a day concept of virtual office has been started where employees have the ability to perform official work from home using internet [11].

2.4 A Green Choice and environment friendly

No doubt, Cloud Computing model encourages SME's to move into cloud by providing high computing resources, infrastructure and Platforms which cuts in energy use and carbon emissions(small companies) likely to be 80-90%.Big Data Centers require a lot of electricity, and it is still a lot less than the thousands of office-grade computers it would take to perform the same big tasks. Large cloud computing providers can also optimize their datacenters for energy efficiency much more precisely than manufacturers of desktops and laptops.

III. ISSUES IN ADOPTION OF CLOUD COMPUTING

Cloud computing offers a great deal of attractive benefits but infact it can deviate from the ideals mentioned above in many ways.

3.1 Data Security and Privacy

When we move our data into cloud storage, we are isolated from our data, we do not know about geographic location of our data, and relying on CSP is very tough. It is one of the major concerns in adoption of the cloud computing which discourages enterprises from moving to cloud. Closely tied in with security, enterprises are concerned about data protection. Many governments place strict data protection requirements on large companies.

Data Protection is definitely a big consideration for larger companies. However, it is not necessary, a barrier to cloud computing, just something for businesses to take into account when evaluating suppliers. It makes sense to start by moving non-critical services which don't contain sensitive customer data to the cloud first, giving the company's legal team time to perform due diligence on suppliers. To ensure data privacy and security in cloud, various CSP are adopting private encryption, firewalls methods. Cryptographic perspective and analysis is rarely available in the literature. This Proposed research work is in this direction [12, 13].

3.2 Bandwidth Cost, Time and Complexity of Moving data into cloud

The growth of cloud computing is predicated on the return on investment (ROI) that accrues. It seems intuitive that by sharing resources to smooth out peaks, paying only for what is used, and cutting upfront capital investment in deploying IT solutions, the economic value will be there[14]. Although adoption of cloud involves cost earlier which includes internet speed and approx 42% of the enterprises feel the same as a concern .There will be a need to balance all costs and benefits associated with cloud computing in both the short and long terms. A recent survey by Research in Action found that 41% of global IT managers were worried about losing revenue because of cloud service problems, while nearly 80% were worried about hidden costs such as damage to their brand due to downtime and poor performance [14].

3.3 Customization and No control on Service level agreement

Losing control over data and resources is a big concern of an enterprises .When system goes down, it's invariably the IT Peoples who are blamed, so it's no surprise that they are nervous about handing over responsibility for infrastructure to somebody they don't even know and according to survey 18% of enterprises believes the same is an issues which prevents them to adopt cloud.

Service level agreements are in infancy still need to be standardized in order to appeal to majority of customers [15].

3.4 Reliability of cloud storage

Enterprise applications are now so critical that they must be reliable and available to support 24/7 operations. In the event of failure or outages, contingency plans must take effect smoothly, and for disastrous or catastrophic failure, recovery plans must begin with minimum disruption. The interoperability and portability of information between private clouds and public clouds are critical enablers for broad adoption of cloud computing by the enterprise. Reliability of cloud storage is still a serious concern [15, 16].

3.5 Issues in Migration into the cloud

A customer running his application in his premises may need to move to cloud for some of its applications. Therefore, it should be always be kept in mind that all applications are not equally fit for Cloud environment. The architectural choices of the infrastructure thereby influence immensely what kind of qualities can be expected for the different application is not yet fully understood [17, 18, 19].

3.6 Vendor Lock-in

Since there is strong divergence among different cloud service providers due to the lacking generality in the approaches of Cloud interfaces. It has been experienced that Applications developed for one Cloud Platform are not portable for other clouds, which prevents cloud users form changing their vendors. In case of cloud service provider vendor lock in increases moving from IaaS to SaaS and then to PaaS computing platform [20].

3.7 Shared technology vulnerabilities

Since multitenancy feature of cloud computing allows multiple users to share various resources in the IaaS model. However, the components such as disk partitions, CPU cash memory, Graphics Processing Units (GPUs) were not originally designed to be shared in multitenant architecture. As a result, some breaches have been seen and in order to avoid this threat, cloud service providers must monitor and enforce computing, storage and network security techniques. CSP must isolate the boundary of tenant's data, network, and so on [21].

4 Information Types over Cloud

In cloud based Environment, various types of data is stored, processed, organized and distributed according to the need of specific clients and service providers. These cloud information is infact, processed client's data which improves the knowledge and supports in decision making process. The versatility of cloud computing makes it usable to manage variety of data types as shown in figure 1.3

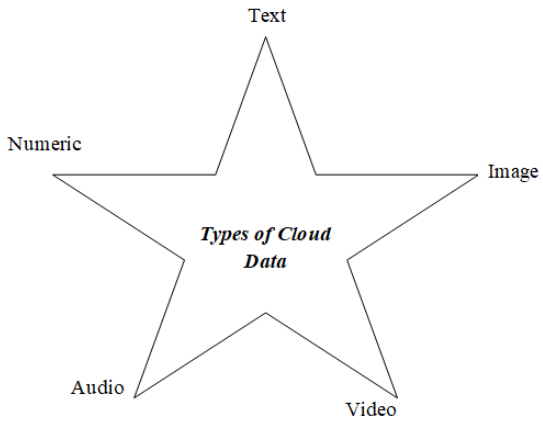

Figure 1.3: Types of Clients Data stored on Cloud platform

4.1 Text

Article, Blog, codes, e-books, Research manuscripts etc. are part of text Data. In Google Docs or online word processing applications, rough draft of text is typed using the keyboard and can be formatted with option of Justify, center alignment, italic or bold, inserting hyperlinks and spell checking etc. These are sting of characters or simply text. The output is well-formatted online text with neat appearance. Using cloud based text-processing tools, detection of grammar checking and

suggestion of better alternative statement can be achieved. In Figure 1.4, the usage of cloud based text information storage in presented for Cloud based platform [22].

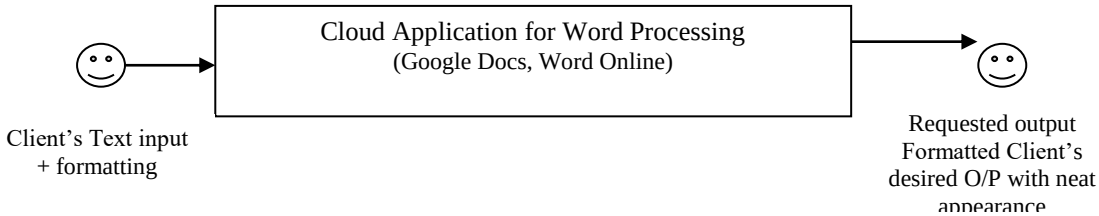

Figure 1.4: Text Data of Client is stored on Cloud depicts various types of Text information stored in cloud

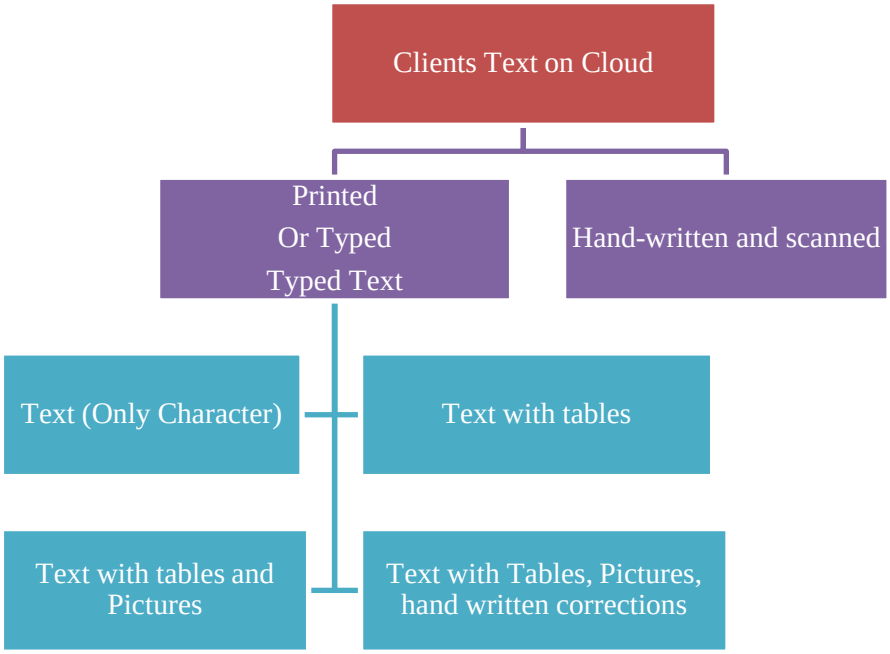

Figure 1.5: Variants of Clients Text information stored on Cloud platform

4.2 Image/Photos/Pictures

Clients capture photographs (black & white and color), Map, fingerprint, images, Medical scanned documents including X-ray. In thesis the term picture, photo and image is used interchangeably. Images are now integral component of Blogs, Websites, News and Social media communications [23].

4.2.1 Representation of a typical Image

The format of Image is depicted below in Figure 1.6.

Image Size
Header Information and Color Palette
Pixel value or Scanned pixels (say 24 bits pixels)

Figure 1.6: An Image Format in Cloud

An image is collection of pixels. For an Image /Picture pixel are represented with different encoding schemes depicted in Table 1.1.

Table 1.1: Image encoding schemes and bit size

S.No.	Bit-Size	Description
1.	1-bit	B&W Image
2.	8-bit	Monochrome picture with 256 grey level
3.	24-bit	Color picture

On cloud environment, varieties of image information is supported as per the need of clients. Some popular image files formats are described in the Table 1.2.

Table 1.2: Various Image File formats in cloud

Image File Type	Extension File	Applications	Benefits	Features
Bit map	.bmp	Uncompressed output of scanners	All information in	High storage requirements needs to be compressed
Tagged Image	.tiff	Exchange image files.	Widely used image format	Not usually compressed but may be compressed
Graphical Interchange	.gif	Exchanging compressed files. Used for transmitting medical, animation	Reasonable compression, High compression speed , Lossless compression of 1:6 to 1:10	Limited color palette
JPEG Compression	.jpg and .jpeg	For Compression of color picture with high details Mostly useful for WWW transmission of image	High compression with low quality and low compression for high quality	Uses complex compression algorithm, for generative and cognitive images with lossy compression

4.2.2 Optimized Image files for cloud

The storage of image information with varied types and extension are processed for cloud storage is presented in Figure 1.7

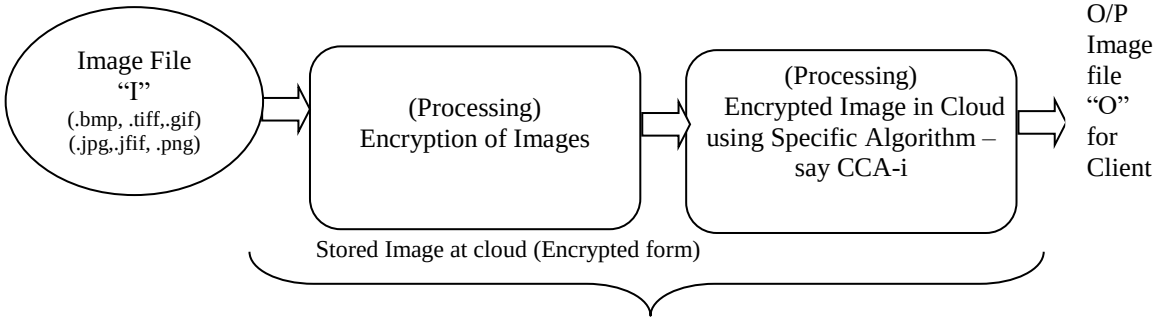

Figure 1.7: Clients image information stored in Cloud

Algorithm "CCA-i" represents any cryptic algorithm applied at the image to store images economically with faster rate. They will exploit the redundancy and irrelevancy of information. Some of the issues associated with CCA-i algorithm.

- How to estimate of best cryptic algorithm?
- Estimation of time for Encryption and Decryption.
- Which "CCA-i" is suitable for which type of file?
- What is the O/P of "C" is universally accepted for exchange?

4.3 Audio/Sound

The term audio represents "Sound". It may be taken from anyone component from figure 1.8 .It may be taken from any one of the source specified in the figure. Any audio "A" is a continuous function of time "t" i.e. ***A= f (time).***

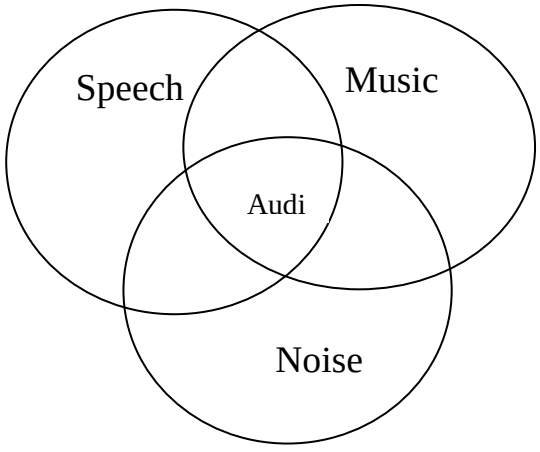

Figure 1.8: Various sources of audio data

Speech, songs, conversations, noise as and when recorded for usage of clients. Usually they are waveform with time varying amplitude. Some common type of client's input files may be from output of voice recorder, music etc [24].

4.3.1 Representation of Audio

The scheme of storing audio files in secure way is presented in the Figure 1.9. The processing of audio input "A" is done at client device with the binary representation is explained in next section.

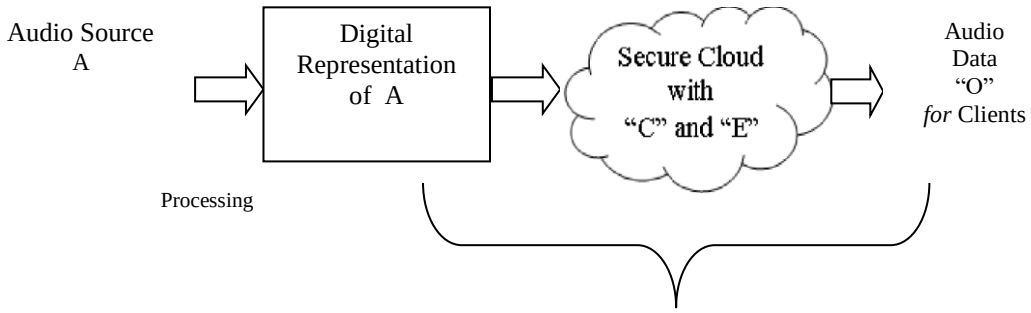

Figure 1.9: Storage of audio data at cloud

C stands for cryptic algorithm and E Stands for Encryption process.

4.3.2 Audio files accessing in cloud infrastructure

Cloud user may access the stored files in the flow described below with processing audio files from cloud infrastructure as shown in fig 1.10.

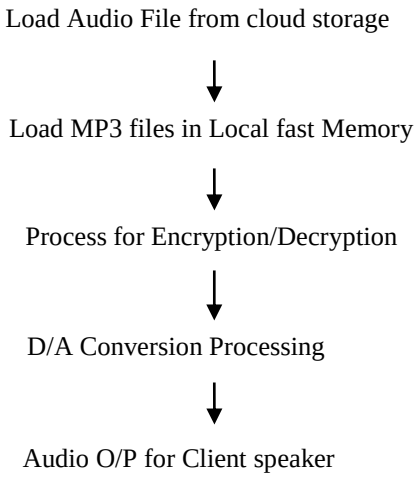

Figure 1.10: Accessing of audio data from cloud

4. 4 Video/Moving pictures/Animation

A video represents collection of pictures displayed with high speed Several times per second to give illusion of movement (Greater then persistence of vision of human eye).In other words, slightly different pictures shown with speed greater then persistence of vision of human eyes provides view of real-time scene. Animation based lectures and tutorials and web based Image Morphing repository are one of the sources of client's video. Recently 360degree videos and VR videos are part of YouTube web channel [25].

1.4.5 Storage and Optimization of Video storage at cloud

Figure 1.11 and Figure 1.12 presents captured video from clients devices and it's storage at cloud infrastructure .The conventional compression algorithm is used to compress the file.

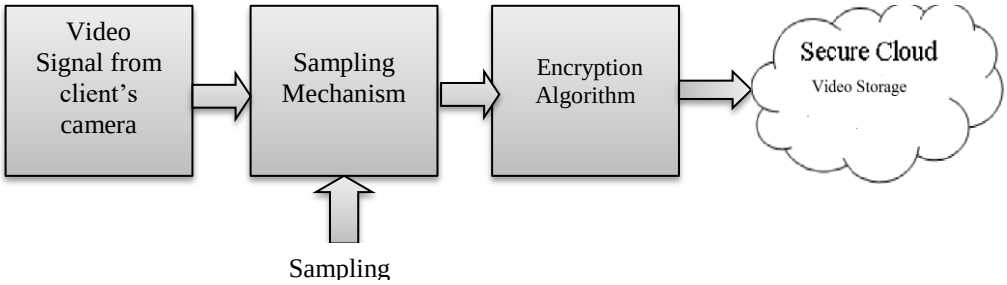

Figure 1.11: Storage of video data in cloud

The suitable samples of input video signals supplied by sampler is encoded and compressed before storage at cloud. This is depicted in figure 1.12.

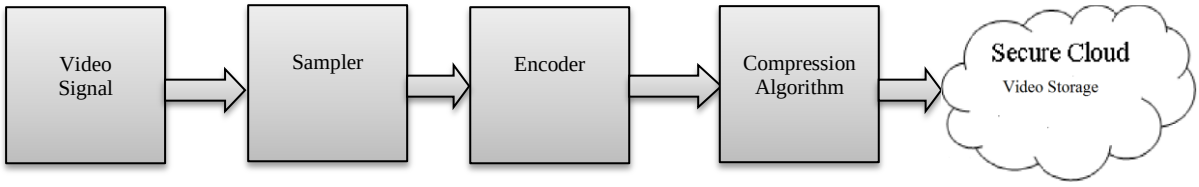

Figure 1.12: Optimization by compression of Video Storage at cloud

V. CRYPTOGRAPHY ALGORITHMS FOR SECURE INFORMATION OVER CLOUD

The procedure that transforms Client's input (Plain text) into Cipher text and vice-versa are popularly known as cryptographic algorithms. There are mainly two categories of cryptic procedures based on the type of security keys exists, Symmetric key encryption and Asymmetric key encryption procedure. Out of these two symmetric key based algorithms are primarily used in cloud for exchanging huge files. These cryptic algorithms/techniques are discussed in subsequent sections.

5.1 Symmetric Key Based Cryptic Algorithm in Cloud

In this type of cryptic algorithms, client and cloud/server both uses a shared secret key to encrypt and decrypt the data respectively, Figure 1.13 shows working of symmetric key based cryptic algorithms.

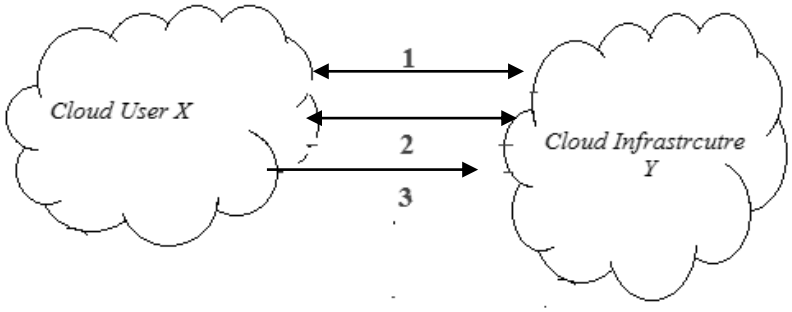

Figure 1.13: Symmetric Key Encryption process

Steps of Symmetric Key Encryption

Communicating node X and Y agree on a common cryptosystem

1. Client X and cloud Y agree on a key to be used for encryption/decryption.
2. Client X encrypts data using the shared key.
3. Algorithm at cloud Y decrypts the ciphered data using the shared key.

Major issue behind this type of encryption is the sharing of secret keys between two devices. If the secret key gets revealed by any mean then the entire system may get fail [26, 27, 28, 29].

5.1.1 DES Symmetric Key Cryptic Algorithm

Data Encryption Standard (DES) is designed by Horst Festal (1970) for input 64-bit block size, 64-bit key; it transforms plain text into cipher text. Out of 64 bits key only 56 bits are used by the algorithm. DES has been one of the most widely used encryption algorithm in the world [31].

5.1.2 3-DES Symmetric Key Cryptic Algorithm

Triple DES (3DES) applies the DES algorithm three times to each data block. Since DES has only 56 bits key size and DES cipher was vulnerable to attack due to increased computational power of resources. Therefore, 3DES has been designed to remove the drawbacks of DES. It uses a key bundle that has three DES keys, for example K_1 -Key_1, K_2-Key_2 and K_3 -Key_3. Each key is about 56 bits excluding extra parity bits. The encryption algorithm is $ciphertext = E_{K_3}\left(D_{K_2}\left(E_{K_1}\left(plaintext\right)\right)\right)$.

DES encrypts plaintext with K_1, then DES decrypt it with K_2, and after that DES encrypts it with K_3. The decryption process is just opposite to the encryption. The $plaintext = D_{K_1}\left(E_{K_2}\left(D_{K_3}\left(ciphertext\right)\right)\right)$ is the flow to recover plaintext. That is, first decrypt cipher text with K_3, encrypt it with K_2, and at last decrypt it with K_1. One block of 64 bits of data is encrypted by 3DES. In all cases, the middle operation is the reverse of the first and last operation. 3DES is sensitive to differential and related key attacks [32].

5.1.3 Blowfish Algorithm

Blowfish (16-round Festal cipher) is a symmetric-key algorithm, which works on 64-bit block size and variable key length between 32-448 bits. Generally, it is a fast block cipher except when changing keys. With weak keys in four rounds, it is exposed to differential attack with large number of weak keys [33].

5.1.4 Twofish Algorithm

Two fish (designed by David Wagner, John Kelsey, Bruce Schneider, Niles Ferguson, Doug Whiting, and Chris Hall), is related to the earlier block cipher Blowfish. It is a symmetric key block cipher (128 bits) with key sizes up to 256 bits. One half of n-bit key is used as the actual encryption key and the other half of the n-bit key is used to modify the encryption algorithm. Two fish was slightly slower AES (128-bit keys) on most software platforms, but it is somewhat faster for 256-bit keys. It is sensitive to chosen key attacks that affect reduction in security, when applied to hash function [34].

5.1.5 AES

AES was developed by two Belgian cryptographers Joan Diemen and Vince Ragmen to overcome issues of DES. It supports block of 128 bits and key lengths of 128, 192 and 256 bits. For the respective key lengths, there exist three versions of AES namely AES-128, AES-192 and AES-256. There are 10, 12 and 14 rounds of algorithm executed for respective AES. More the length of key more will be the security. The plain text represented in hexadecimal form is known as 'state' in AES. Most of the work is done on this only [35, 36].

VI. CONCLUSION

It has been found that cloud computing is going to bring innovation in storage and computations. But one of major concerns is of data security in public platform and even algorithms cryptic algorithm may not resolve the concern unless it is identified the right approach for right dataset to be applied before putting the data into public cloud. Deep research in the concern field can be carried out.

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