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A STUDY ON CLOUD COMPUTING AND DATA STORAGE COMPRESSIONS

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Abstract: Enterprises are driving towards less cost, more availability, agility, managed risk - all of which is accelerated towards Cloud Computing. Cloud is not a particular product, but a way of delivering IT services that are consumable on demand, elastic to scale up and down as needed, and follow a pay-for-usage model. Out of the three common types of cloud computing service models, Infrastructure as a Service (IaaS) is a service model that provides servers, computing power, network bandwidth and Storage capacity, as a service to their subscribers. Cloud can relate to many things but without the fundamental storage pieces, which is provided as a service namely Cloud Storage, none of the other applications is possible. This paper describes the concept, architecture, characteristics of cloud computing as well as the types of models and issues of cloud computing. In this paper, section 2 also describes useful of Application Programming Interface **(API)** in cloud storage and the issues of cloud storage. This paper focuses the data compression types as well as techniques briefly in section 3. We clearly implicit compression technologies are used to improve the storage capacity in cloud storage.

Keywords: Cloud Computing, Data Compression, lossy and lossless data compression

I. INTRODUCTION

Cloud Computing," to put it simply, means "Internet Computing" [9]. The Internet is commonly visualized as clouds; hence the term "cloud computing" for computation done through the Internet. With Cloud Computing users can access database resources via the Internet from anywhere, for as long as they need, without worrying about any maintenance or management of actual resources. Besides, databases in cloud are very dynamic and scalable. Cloud computing is unlike grid computing, utility computing, or autonomic computing. In fact, it is a very independent platform in terms of computing. The best example of cloud computing is Google Apps where any application can be accessed using a browser and it can be deployed on thousands of computer through the Internet. Cloud computing provides the facility to access shared resources and common infrastructure, offering services on demand over the network to perform operations that meet changing business needs. The location of physical resources and devices being accessed are typically not known to the end user. It also provides facilities for users to develop, deploy and manage their applications 'on the cloud', which entails virtualization of resources that maintains and manages itself.

a) CLOUD COMPUTING ARCHITECTURE

Many organizations and researchers have defined the architecture for cloud computing [8]. Basically the whole system can be divided into the core stack and the management. In the core stack, there are three layers: (1) Resource (2) Platform and (3) Application. The resource layer is the infrastructure layer which is composed of physical and virtualized computing, storage and networking resources. The platform layer is the most complex part which could be divided into many sub layers. E.g. a computing framework manages the transaction dispatching and/or task scheduling. A storage sub-layer provides unlimited storage and caching capability. The application server and other components support the same general application logic as before with either on-demand capability or flexible management, such that no components will be the bottle neck of the whole system. Based on the underlying resource and components, the application could support large and distributed transactions and management of huge volume of data. All the layers provide external service through web service or other open interfaces.

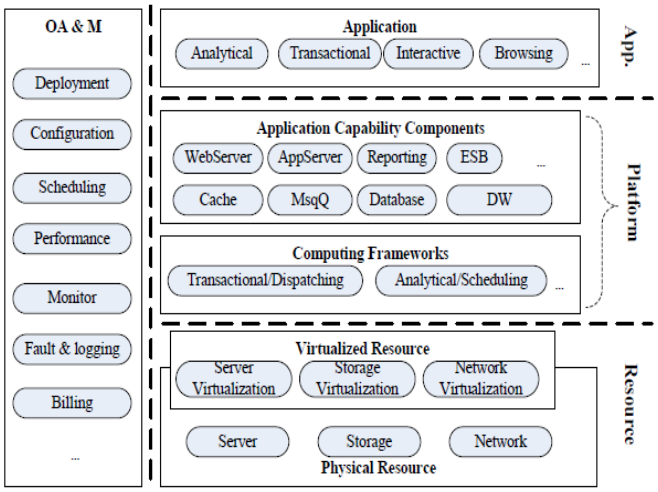

Figure 1. The Reference architecture

b) ESSENTIAL CHARACTERISTICS

In this section we describe the essential characteristics that a cloud must possess. Any cloud is expected to have these five characteristics that are being described below.

- ***On-demand self-service-*** A consumer can unilaterally provision computing capabilities, such as server time and network storage, as needed automatically without requiring human interaction with each service's 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, laptops, and personal digital assistants (PDAs)).

- **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. There is a sense of location independence in that the subscriber generally has no control or knowledge over the exact location of the provided resources but may be able to specify location at a higher level of abstraction (e.g., country, state, or data centre). Examples of resources include storage, processing, memory, network bandwidth, and virtual machines.
- **Rapid elasticity-** Capabilities can be rapidly and elastically provisioned, in some cases automatically, to quickly scale out and rapidly released to quickly scale in. To the consumer, the capabilities available for provisioning often appear to be unlimited and can be purchased in any quantity at any time.
- **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.

c) TYPES OF CLOUDS

There are different types of clouds that you can subscribe to depending on your needs. As a home user or small business owner, you will most likely use public cloud services.

- **Public Cloud -** A public cloud can be accessed by any subscriber with an internet connection and access to the cloud space.
- **Private Cloud -** A private cloud is established for a specific group or organization and limits access to just that group.
- **Community Cloud -** A community cloud is shared among two or more organizations that have similar cloud requirements.
- **Hybrid Cloud -** A hybrid cloud is essentially a combination of at least two clouds, where the clouds included are a mixture of public, private, or community.

d) CLOUD COMPUTING MODELS

Cloud Providers offer services that can be grouped into three categories.

- **Software as a Service (SaaS):** In this model, a complete application is offered to the customer, as a service on demand. A single instance of the service runs on the cloud & multiple end users are serviced. On the customers" side, there is no need for upfront investment in servers or software licenses, while for the provider, the costs are lowered, since only a single application needs to be hosted & maintained. Today SaaS is offered by companies such as Google, Salesforce, Microsoft, Zoho, etc.
- **Platform as a Service (Paas):** Here, a layer of software, or development environment is encapsulated & offered as a service, upon which other higher levels of service can be built. The customer has the freedom to build his own applications, which run on the provider's infrastructure. To meet manageability and scalability requirements of the applications, PaaS providers offer a predefined combination of OS and application servers, such as LAMP platform (Linux, Apache, MySql and PHP), restricted J2EE, Ruby etc. Google" s App Engine, Force.com, etc are some of the popular PaaS examples.
- **Infrastructure as a Service (Iaas):** IaaS provides basic storage and computing capabilities as standardized services over the network. Servers, storage systems, networking equipment, data centre space etc. are pooled and made available to handle workloads. The customer would typically deploy his own software on the infrastructure. Some common examples are Amazon, GoGrid, 3 Tera, etc.

e) ISSUES IN CLOUD COMPUTING

More and more information on individuals and companies is placed in the cloud; concerns are beginning to grow about just how safe an environment it is? Issues of cloud computing [1] can summarize as follows:

- **Privacy-**Cloud computing utilizes the virtual computing technology, users' personal data may be scattered in various virtual data centers rather than stay in the same physical location, users may leak hidden information when they are accessed cloud computing services. Attackers can analyze the critical task depend on the computing task submitted by the users.
- **Reliability-**The cloud servers also experience downtimes and slowdowns as our local server.
- **Legal Issues-**Worries stick with safety measures and confidentiality of individual all the way through legislative levels.
- **Compliance-**Numerous regulations pertain to the storage and use of data requires regular reporting and audit trails. In addition to the requirements to which customers are subject, the data centers maintained by cloud providers may also be subject to compliance requirements.
- **Freedom-**Cloud computing does not allow users to physically possess the storage of the data, leaving the data storage and control in the hands of cloud providers.
- **Long- Term Viability-**You should be sure that the data you put into the cloud will never become invalid even your cloud computing provider go broke or get acquired and swallowed up by a larger company.

II. CLOUD STORAGE

Rapid data growth and the need to keep it safer and longer will require organizations to integrate how they manage and use their data, from creation to end of life. Now there is an opportunity to store all our data in the internet. Those off-site storages are provided and maintained by the third parties through the Internet which is represented in Figure 2. Cloud storage offers a large pool of storage was available for use, with three significant attributes: access via Web services APIs on a non persistent network connection, immediate availability of very large quantities of storage, and pay for what you use. It supports rapid scalability [2].

a) EVOLUTION OF CLOUD STORAGE

Cloud storage is an offering of cloud computing. Figure 3 shows the evolution of Cloud Storage based on traditional network storage and hosted storage. Benefit of cloud storage is the access of your data from anywhere. Cloud storage providers provide storage varying from small amount of data to even the entire warehouse of an organization. Subscriber can pay to the cloud storage provider for what they are using and how much they are transferring to the cloud storage.

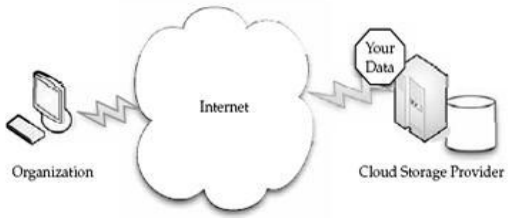

Figure 2. Simple cloud storage model

Basically the cloud storage subscriber copies the data into any one of the data server of the cloud storage provider. That copy of data will be made available to all the other data servers of the cloud storage provider featuring redundancy in the availability which ensures that the data of the subscriber is safe even anything goes wrong. Most systems store the same data on servers that use different power supplies.

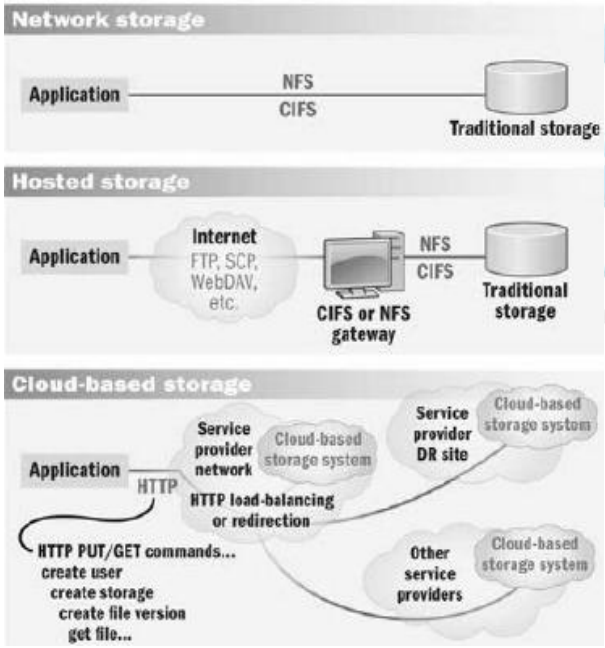

Figure 3. Evaluation of cloud storage

Benefits of Cloud storage:

- No need to invest any capital on storage devices.
- No need for technical expert to maintain the storage, backup, replication and importantly disaster management.
- Allowing others to access your data will result with collaborative working style instead of individual work.

b) CLOUD STORAGE ARCHITECTURE

Cloud storage architectures [3] are primarily about delivery of storage on demand in a highly scalable and multi-tenant way. Generically (see Figure 4), cloud storage architectures consist of a front end that exports an API to access the storage. In traditional storage systems, this API is the Small Computers System Interface(SCSI) protocol; but in the cloud, these protocols are evolving. There, you can find Web service front ends, file-based front ends, and even more traditional front ends (such as Internet SCSI, or iSCSI). Behind the front end is a layer of middleware that I call the *storage logic.*

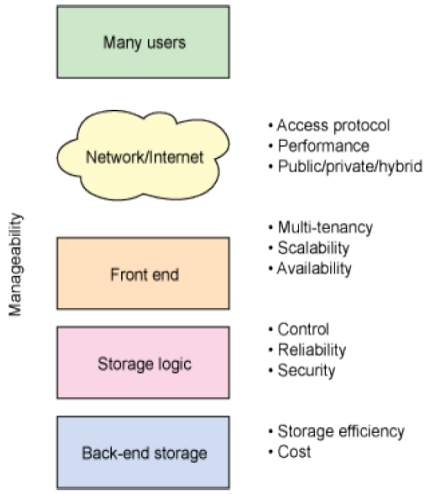

Figure 4. Cloud storage architecture

This layer implements a variety of features, such as replication and data reduction, over the traditional data-placement algorithms (with consideration for geographic placement). Finally, the back end implements the physical storage for data. This may be an internal protocol that implements specific features or a traditional back end to the physical disks.

c) CLOUD STORAGE API (APPLICATION PROGRAMMING INTERFACE)

A Cloud Storage Application Programming Interface (API)[4] is a method for access to and utilization of a cloud storage system. The most common of these kinds are REST (Representational State Transfer) although there are others, which are based on SOAP (Simple Object Access Protocol). All these APIs are associated with establishing requests for service via the Internet. REST is a concept widely recognized as an approach to "quality" scalable API design. One of the most important features of REST is that it is a "stateless" architecture. This means that everything needed to complete the request to the storage cloud is contained in the request, so that a session between the requestor and the storage cloud is not required. It is very important because the Internet is highly latent (it has an unpredictable response time and it is generally not fast when compared to a local area network).REST is an approach that has very high affinity to the way the Internet works. Traditional file storage access methods that use NFS (network files system) or CIFS (Common Internet File System)[4] do not work over the Internet, because of latency. Cloud Storage is for files, which, some refer to as objects, and others call unstructured data. Think about the files stored on your PC, like pictures, spreadsheets and documents. These have an extraordinary variability, thus unstructured. The other kind of data is block or structured data. Think data base data, data that feeds transactional system that require a certain guaranteed or low-latency performance. Cloud Storage is not for this use case. Industrial Design Centre (IDC) estimates that approximately 70% of the machine stored data in the world is unstructured, and this is also the fastest growing data type. So, Cloud Storage is storage for files that is easily accessed via the

Internet. This does not mean you cannot access Cloud Storage on a private network or LAN, which may also provide access to a storage cloud by other approaches, like NFS or CIFS. It does mean that the primary and preferred access is by a REST API. REST APIs are language neutral and therefore can be leveraged very easily by developers using any development language they choose. Resources within the system may be acted on through a URL. So, an API is not a "programming language", but it is the way a programming language is used to access a storage cloud. REST APIs are also about changing the state of resource through representations of those resources. They are not about calling web service methods in a functional sense. The key differences between different Cloud Storage APIs are the URLs defining the resources and the format of the representations. Amazon S3 APIs, Eucalyptus APIs, Rack space Cloud Files APIs, Mezeo APIs, Nivanix APIs, Simple Cloud API, along with the standards proposed by the Storage Networking Industry Association (SNIA) Cloud Storage Technical Work Group, and more.

d) CLOUD DATA STORAG ISSUES

The cloud computing does not provide control over the stored data in cloud data centers. The cloud service providers have full of control over the data, they can perform any malicious tasks such as copy, destroying, modifying, etc. The cloud computing ensures certain level of control over the virtual machines. The only encryption doesn't give full control over the stored data but it gives somewhat better than plain data. The characteristics of cloud computing are virtualization and multi tenancy also has various possibilities of attacks than in the generic cloud model [10].

Data privacy and Integrity: Even though cloud computing provide less cost and less resource management, it has some security threats. As we discussed earlier cloud computing has to ensure integrity, confidentiality, privacy and availability of data in generic cloud computing model but the cloud computing model is more vulnerable to security threats in terms of above conditions. Because of simplicity cloud users are increasing exponentially and applications are hosted in cloud is very high. These situations lead to greater security threats to cloud clients. If any attack is successful on data entity will leads to data breach and takes an unauthorized access to data of all cloud users. Because of this integrity violation cloud data lost multi-tenant nature. Especially SaaS providers may also lost their technical data and they have great risk over data storage. Apart from these risks, data processing also has great risk while data being transformed among multiple tenants. Because of virtualization multiple physical resources are shared among the users. This leads to launch attacks by malicious insiders of the CSP and/or organization. These situations may allow the malicious user to perform attacks on stored data of other customer while processing their data. Other major risk is when data is outsourced to third party storage by the CSP [5]. The key generation and key management in cryptography for cloud computing is not standardized up to the mark. But without standard and secure key management for the cloud doesn't allow the standard cryptography algorithms to perform well in generic cloud computing model. Such that cryptography may also ensures the potential risks to cloud computing.

Data recoverability and vulnerability: Due to resource pooling and elasticity characteristics, the cloud ensures dynamic and on-demand Resource provisioning to the users. The resource allocated to a particular user may be assigned to the other user at some later point of time. In case of memory and storage resources, a malicious user can employ data recovery techniques to obtain the data of previous users [6]. The authors in were able to recover Amazon machine images files 98 % of the times. The data recovery vulnerability can pose major threats to the sensitive user data.

Improper media refinement*:* The storage medias are sanitize because of following reasons (i) the disk may needs to replace with other disk (ii) No need to maintain the disk or no longer to maintain (iii) massacre of services. Improper refinement ensures great risk to stored data. In multi-tenant cloud it is not possible to refine as it is earlier tenant.

Data backup: The data backup is an important when accidental and/or intentional disasters. The CSP has to perform regular backups of stored to ensure the data availability. In fact, the backup data should be keeping with security guidelines to prevent malicious activities such as tampering and unauthorized access.

III.DATA COMPRESSION

Data compression is a process by which a file (Text, Audio, and Video) may be transformed to another (compressed) file, such that the original file may be fully recovered from the original file without any loss of actual information. This process may be useful if one wants to save the storage space. For example if one wants to store a 4MB file, it may be preferable to first compress it to a smaller size to save the storage space. Also compressed files are much more easily exchanged over the internet since they upload and download much faster. We require the ability to reconstitute the original file from the compressed version at any time. Data compression is a method of encoding rules that allows substantial reduction in the total number of bits to store or transmit a file. The more information being dealt with, the more it costs in terms of storage and transmission costs. In short, Data Compression is the process of encoding data to fewer bits than the original representation so that it takes less storage space and less transmission time while communicating over a network [7].

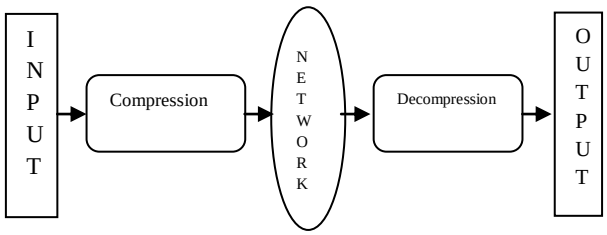

Figure 5.Compression and Decompression

Data Compression is possible because most of the real world data is very redundant. Data Compression is basically defined as a technique that reduces the size of data by applying different methods that can either be Lossy or Lossless [1]. A compression program is used to convert data from an easy-to-use format to one optimized for compactness. Likewise, an

uncompressing program returns the information to its original form.

a) TYPES OF DATA COMPRESSION

As of now, two essential classes of Data Compression are connected in diverse areas. One of these is lossy Data Compression, which is generally used to pack picture information documents for correspondence or files purposes. The other is lossless data compression that is regularly used to transmit or file content or parallel records needed to keep their data in place whenever. Data Compression algorithm can be classified in two ways:

- Lossy Data Compression
- Lossless Data Compression

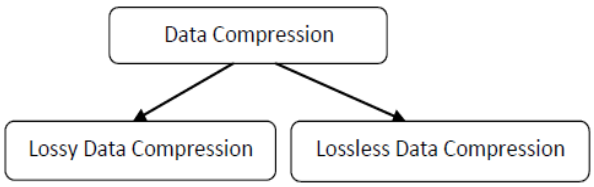

Figure 6: Classification of Data Compression

Lossy data compression: A lossy data compression system is one where the data recovers after decompression may not be precisely same as the first data, but rather is "sufficiently close" to be valuable for particular reason. After one applies lossy data compression to a message, the message can never be recuperated precisely as it was before it was packed. At the point when the compacted message is decoded it doesn't give back the first message. Data has been lost. Since lossy compression can't be decoded to yield the definite unique message, it is not a decent system for compression for basic data, for example, printed data. It is most valuable for Digitally Sampled Analog Data (DSAD). DSAD comprises for the most part of sound, feature, illustrations, or picture documents. In a sound document, for instance, the high and low frequencies, which the human ear can't listen, may be truncated from the record.

Lossless data compression: Lossless data compression is a procedure that permits the utilization of data compression calculations to pack the content data furthermore permits the precise unique data to be remade from the compacted data. This is in as opposed to the lossy data compression in which the careful unique data can't be recreated from the compacted data. The prevalent ZIP record organizes that is being utilized for the compression of data documents is likewise a use of lossless data compression approach. Lossless compression is utilized when it is vital that the first data and the decompressed data be indistinguishable. Lossless content data compression calculations typically abuse factual excess in such a path in order to speak to the sender's data all the more briefly with no blunder or any kind of loss of vital data contained inside of the content information data. Since the majority of this present reality data has factual excess, thusly lossless data compression is conceivable. Case in point, In English content, the letter "an" is a great deal more basic than the letter 'z', and the likelihood that the letter "t" will be trailed by the letter "z" is little. So this sort of repetition can be evacuated utilizing lossless compression. Lossless compression techniques may be classified by kind of data they are intended to pack. Compression calculations are essentially utilized for the compression of content, pictures and sound. Most lossless compression projects utilize two various types of calculations: one which creates a factual model for the info data and another which maps the information data to bit strings utilizing this model as a part of such a route, to the point that as often as possible experienced data will deliver shorter yield than improbable(less continuous) data.

b) COMPRESSION TECHNIQUES

As cloud storage is increasing these days due to increasing of different types of data over internet. A compression algorithm is prime approach for making improved cloud storage capacity .Basic compression techniques are available for cloud data's.

- **LZW(Lempel-Ziv-Welch) Compression : This** technique compress the content character by character replace the repeated occurrences of data with references to a dictionary that is pre-initialized with all possible symbols. In case of image data it checks the input pixels and runs the dictionary in order to find its correspondence.
- **Run Length Encoding:** In this method for compressing image data, sequences of repetitive pixels values are replaced by token whose one part includes the value of pixel and other include the number of repetitive values. For example 2223337777 can be replaced with (2,3)(3,3)(7,4) and results in lossless compression.
- **Huff man Coding:** Huffman coding is lossless compression technique that is based on probability of occurrences of data symbols and builds the table according to probability of occurrences of data symbols and variable length bit code is assigned to each data symbol.
- **Null compression:** Replaces a series of blank spaces with a compression code, followed by a value that represents the number of spaces.
- **GDI / BMP:** The bitmapped graphics or the BMP format is used by the Microsoft Windows graphics subsystem or GDI as a simple graphic information representation format internally. As the popularity of the platform increases, thus increases the use of this file format. The BMP format does not include any compression technique, thus it remains lossless [11].
- **DEFLATE / PNG:** The Portable Network Graphics or the PNG is a bitmap format, which uses a lossless data compress. The compression algorithm is called DEFLATE compression algorithm, which is a combination of LZ77 algorithm and Huffman Coding algorithm [11].
- **DWT:** Discrete Wavelet Transform (DWT) has gained wide spread acceptance in signal processing and image compression because it provides an extremely flexible multi-resolution image and can decompose an original image into different sub band images including low- and high- frequencies. The high frequency components provides with the information about the fine edges of the image which is very constructive for recovering the original image at the receiver end. The original image is converted to YCbCr color space so that the Discrete Wavelet transform can be applied to the luminance (Y) component. Then the image containing the low pass sub-band, diagonal sub-band information and Cb& Cr component information is processed further [12].

- **K-Means:** K-means algorithm is a form of vector quantization which makes the use of K-means clustering in which a set of vectors are taken as input. It is a grouping method of bunching analysis which aims at partitioning „n" groups into „k" clusters in which each group of pixels belongs to the cluster with the nearest mean. A similar method is that of LBG Technique which also comes under Vector Quantization. Also the algorithm of LBG technique is quite similar to the below explained K-means algorithm [13].
- **3D Spiral JPEG 2000 Encoding:** In 3D Spiral JPEG 2000 encoding, 2-D image is initially divided into a set of 8*8 pixel blocks. Then an 8*8*8 dimensional 3-D cube is formed simply using spiral scanning procedure on each 8*8 pixel block starting from the center of the graphic and going outwards [14].
- **TIFF:** The Tagged Image File format or TIFF is majorly intended to store image with dense information like photograph and line art. The major reason for popularity is to be used for high color depth in image manipulation tools or image processing tools for optical character recognition. The compression technique used for TIFF is LZW for majority of the cases [11].
- **Discrete Cosine Transform (DCT):** Discrete Cosine Transform can be used for speech compression because of high correlation in adjacent coefficient. We can reconstruct a sequence very accurately from very few DCT coefficients. This property of DCT helps in effective reduction of data.
- **LZ77:** The LZ77 compression algorithm is the most used compression algorithm, on which program like PkZip has their foundation along with a few other algorithms. LZ77 exploits the fact that words and phrases within a text file are likely to be repeated. When there is repetition, they can be encoded as a pointer to an earlier occurrence, with the pointer followed by the number of characters to be matched. It is a very simple technique that requires no prior knowledge of the source and seems to require no assumptions about the characteristics of the source.

IV.CONCLUSION

Data storage in cloud is more advantageous than traditional storage because of its availability, scalability, performance, portability and its functional requirements. Cloud storage strategies and service models are still in its early stages. Standardization of service provider's service levels, pricing plans, data access methods, operational and security processes, emergency plans for data migration if the enterprise sooner or later wish to change vendors, improving the performance by opting better load balancing methodology are some of the thrust areas where future works on cloud storage can be focused. In this paper briefly explained the basics of cloud computing, cloud storage and data compression to improve the capacity of cloud storage.

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