

**DATA RECOVERY IN CLOUD COMPUTING BY  
USING ENRICHED GENETIC ALGORITHM  
(EGA)**

**PHYU PHYU THANT**

**M.C.Sc.**

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**By**

**PHYU PHYU THANT**

**B.C.Sc.**

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## **STATEMENT OF ORIGINALITY**

I hereby certify that the work embodied in this thesis is the result of original research and has been submitted for a higher degree to any other University or Institution.

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Date

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Phyu Phyu Thant

## **ABSTRACT**

This system implements data recovery in cloud computing by using Enriched Genetic Algorithm (EGA). Cloud computing provides various kinds of services to its users. Storage-as-a-service is one of the services provided by cloud infrastructure in which large amount of electronic data is stored in cloud. As valuable and important data of enterprises are stored at a remote location on cloud it is assured that the data is safe and be available at any time. In situations like flood, fire, earthquakes or any hardware malfunction or any accidental deletion the data may no longer remain available. To maintain the data safety, there must be some data recovery technique for cloud platform to recover valuable and important data efficiently in such situations mentioned above. In this system, a multi servers system based on Enriched Genetic Algorithm to recover the lost data by using four cloud backup servers is discussed. To achieve reliability, the proposed system provides the flexible for the user to accumulate data (data restore) from the backup server at the same time when main cloud server loses its data and is unable to provide data to user. This system is implemented using ASP.Net programming language with Microsoft SQL Server 2017 on cloud server.

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**Keywords:** Cloud Computing, Data Recovery, Backup, Data Restore

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# CHAPTER 1

## INTRODUCTION

Cloud computing is the transport of shared on-demand computing services over the net ('the cloud'), to provide faster advancement, adaptable assets, and economies of scale. Cloud services encompass servers, storage, databases, networks, software program, analytics, intelligence, and extra. The user typically pay best for what is operate, assisting decrease the running costs, operate the infrastructure more efficiently, and scale as one's business needs change. This allows community to access and share news at any time from diversified devices; rapidly redistribute computing services without buying hardware, temporarily leverage massive computing power and more.

The impact of cloud computing has had on the data enterprise and end-customers in popular is tough to overstate. Innovative digital solutions have changed and transformed many aspects of our daily lives. Instances of advertising cloud suppliers include Amazon Web Services, Google and Microsoft Azure Services Platform separated from to open source cloud frameworks. Cloud computing administrations might be separated into SaaS (Software as a Service), PaaS (Platform as a Service), and IaaS (Infrastructure as a Service) as indicated by the kinds of assets gave.

One of ultimate important offerings which are being provided is storage as a service. Storage as a service STaaS is a managed service where a storage supplier supplies a client with storage space. In the STaaS model, the storage provider handles most of the muddled pieces of long stretch mass data stockpiling hardware costs, security, and information respectability.

Most STaaS vendor will utilize a public cloud to keep information. There are many benefits to utilizing cloud storage, not least the way that cloud-based storage is not difficult to incorporate with cloud-based applications that utilization this information. Assuming organizations are utilizing cloud-based accounting programming, for example, connecting this to a cloud-based STaaS system can reduce the latency required to work with these information [18].

Cloud backups, additionally insinuate to as online backups or remote backups, are a procedure for sending a reproduction of physical or virtual documents or data

sets to a secondary offsite region for capacity in case of device failure or disaster. Secondary servers and information storage systems are by and large facilitated by a third gathering specialist organization who charges the backup clients fundamentally based absolutely on the amount of storage space or limit utilized, information transmission transfer speed, the scope of clients, number of servers, or scope of times information is gotten to.

Cloud customers can save massive quantities in cloud storage which means that massive quantities of data are saved in the data center. Cloud customers carry out vital operations withinside the cloud and cannot experience downtime because of data availability issues. Whether the problem is a natural disaster, an outage or a human error, reliable and comprehensive data recovery. Data recovery is achieved through reliable backups.

Today, information is being created in enormous amounts and requires information recovery services or methods. In this manner, there is a requirement for planning an effective information recovery strategy to recover the lost information. Numerous researchers have proposed various information recovery methods. This proposed system mentioned a multi-server system based on the Enriched Genetic Algorithm for recovering lost information by utilizing four cloud backup servers. To accomplish reliability the proposed strategy gives the adaptability to the client to gather data from any backup server when the main cloud server loses its information and can't give information to the client.

## **1.1 Objectives of the Thesis**

The main objectives of the thesis are as follows:

- To implement a data reliable system based on multiple backup servers
- To support data availability in the cloud server
- To provide the adaptability for the client to recuperate their lost information from any backup server
- To recover the lost data through the use of Enriched Genetic algorithm efficiently

## 1.2 Related Work

Suhas C, Tarun R, Vinu Kumar H M, Sangappa G, and Suresh Kumar K R, 2016 have proposed the DR-Cloud version which is fault tolerant multi cloud storage, it makes use of DR XOR codes which affords data redundancy and uses minimum repair traffic during data transmission. DR-Cloud acts as the interface between the user applications and multi cloud servers [1].

Yogesh Gite, Ankush Pawar, and Dr. Shashikant Ghumbre, 2018 have presented the Advanced Encryption Standard (AES) and Seed Block Algorithm (SBA) technique to carry out the smart remote data backup in cloud computing surroundings [2]. The proposed method makes use of the AES and seed block algorithm. If the data gets deleted via way of means of the mistake then we can get it from the remote server. This method takes much less time to recover the data and solves the time related issues. Thus the method offers an efficient security mechanism for the data saved in the cloud environment.

Shilpi U. Vishwakarma and Praveen D. Soni, 2015 have proposed the cloud mirroring methodology [3]. The technique affords to help user to retrieve information from any mirror server when server lost his data and unable to provide data to the user. To achieve the recovery, many different techniques have been proposed till date. In situations like any hardware malfunction, data may get corrupted or any accidental deletion our data may no longer remain available. To maintain the data safety there must be some data recovery technique for cloud platform to recover valuable and important data efficiently in such situations mentioned above. Thus this system provides a new technique of data recovery by “Cloud Mirroring”.

S.S.Ganorkar et al, 2014 have proposed a novel data recovery service framework for cloud infrastructure, the Parity Cloud Service (PCS) provides a privacy protected personal data recovery service [4]. In this proposed framework user data is not required to be uploaded on to the server for data recovery. All the necessary server-side resources that provide the recovery services are within a reasonable bound.

Chi-won Song et al, 2011 proposed the innovative file back-up concept HS-DRT that makes use of an effective ultra-widely distributed data transfer mechanism and a high-speed encryption technology [5]. This system consists of two sequences one is Backup sequence and other is Recovery sequence. The data to be backed-up is

received In Backup sequence. The recovery sequence is used when there is a disaster or any data loss occurs the Supervisory starts the recovery sequence.

Eleni Palkopoulou et al, 2011 proposed The Cold and Hot back-up strategy that performs backup and recovery on trigger basis of failure detection [6]. In CBSRS (i.e. Cold Backup Service Replacement Strategy) recovery process, it is triggered when a service failure is detected and it will not be triggered when there is no failure. The HBSRS (i.e. Hot Backup Service Replacement Strategy), is a transcendental recovery strategy for service composition that is used for dynamic network. During the implementation of process, the backup services remains in the activated state and the first returned results of services will be used to ensure the successful implementation of service composition.

### **1.3 Motivation**

Data saved on the datacenter is fostering every day it leads to an enormous measure of information storage in the cloud and results to issues comprising of information loss, information break, and so on. There is a requirement for an effective method assuming the information get destroyed or erased through misstep to recover the information from any backup server. In enterprises continuity, on the off chance that the system crashed or any kind of normal or human made disaster happened then, there might be the danger of information misfortune and it might likewise cause financial misfortune. By utilizing a portion of the information recovery methods the original information can be recovered. However, the current recovery procedures are not efficient and reliable. In this manner, to get better lost unique information, an efficient and reliable recovery procedure is required.

### **1.4 Overview of the Thesis**

In this system, cloud computing includes networks of gatherings of servers with specific connections that spread information processing storage across them. This shared cloud infrastructure contains huge pools of systems that are connected together. These backup servers are utilized to maximize the power of cloud computing and information is stored in the structure of distributed replicated data store.

## **1.5 Organization of the Thesis**

The book is organized in five chapters. In Chapter 1, the introduction to the system along with the aim of the thesis, system overview and related works are expressed. Chapter 2 expresses the background theory of the proposed system. In Chapter 3, data recovery in cloud computing by using Enriched Genetic Algorithm (EGA) is described. Chapter 4 discusses the implementation of the system with system design, process flow, detailed designs, and system implementation. Finally, Chapter 5 concludes this thesis with the advantages of using Enriched Genetic Algorithm (EGA), its limitation and further extension.

## **CHAPTER 2**

### **THEORETICAL BACKGROUND**

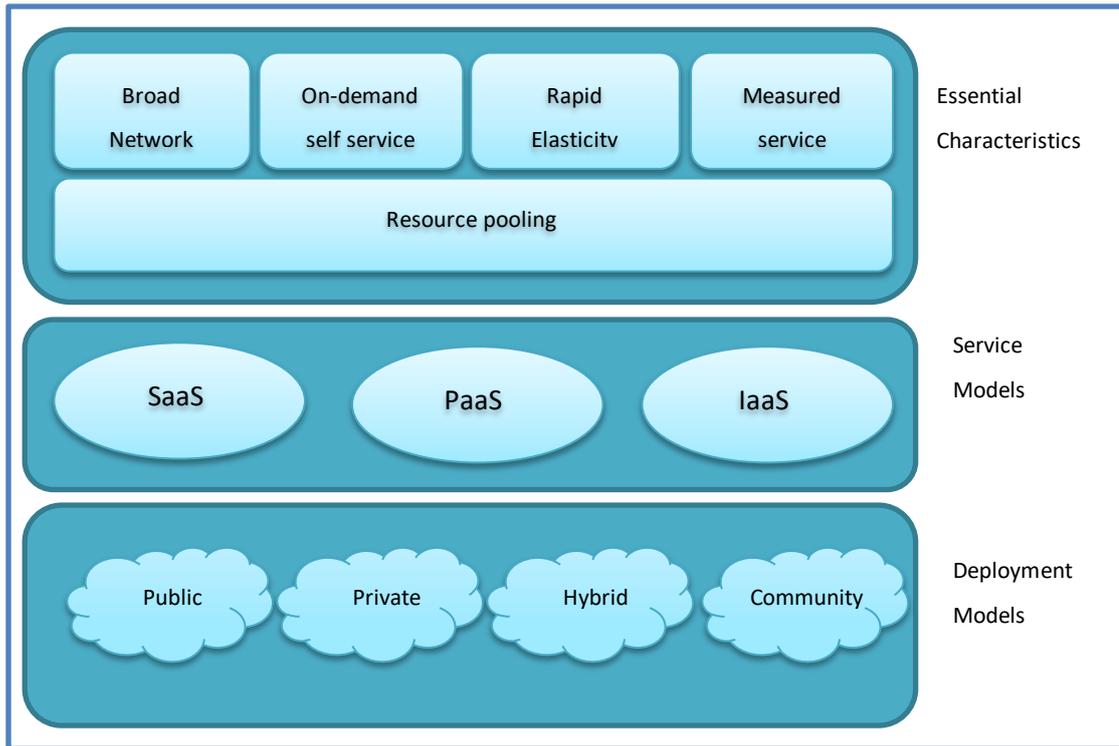
The exciting field of Cloud Computing has experienced explosive growth. This transformative technology has not only altered the way business operate, but it has also shaken up the traditional structure of the IT department and placed new demands on staff members who are faced with reinventing their own careers. With organizations rapidly moving their infrastructures and services to the cloud, jobs are growing at a breakneck pace, with many positions being left unfilled [1].

#### **2.1 Cloud Computing Concept**

Cloud computing is an entire arrangement of assets and contributions related to the Internet. These contributions are given through data centers situated across the world. We use it to represent the net in the flowcharts and various charts. Cloud computing is principally founded absolutely on a virtualization innovation where programming, called a hypervisor runs on a genuine gadget and makes a virtual working framework on these virtual machines.

Cloud customers can run any software on these virtual machines. This simplifies using cloud offering by end users. With the adjustments of time, the scale of cloud computing has additionally increased making it feasible to access this data from everywhere without being based upon a geographical location. As the amount of data develops, the administration issue rises. However, on the contrary hand, the virtualization, the board, and programming layers help on this respect that makes strong control of servers.

There is no need to develop additional infrastructure to access cloud computing. Instead, event organizers should train their staff for the furthest down the line updates to this innovation. Cloud computing essentially offers types of assistance in view of pay as you go approach. The concept of cloud computing consists of five essential characteristics, three service models and four deployment models as shown in figure 2.1.



**Figure 2.1 The Concept of Cloud Computing**

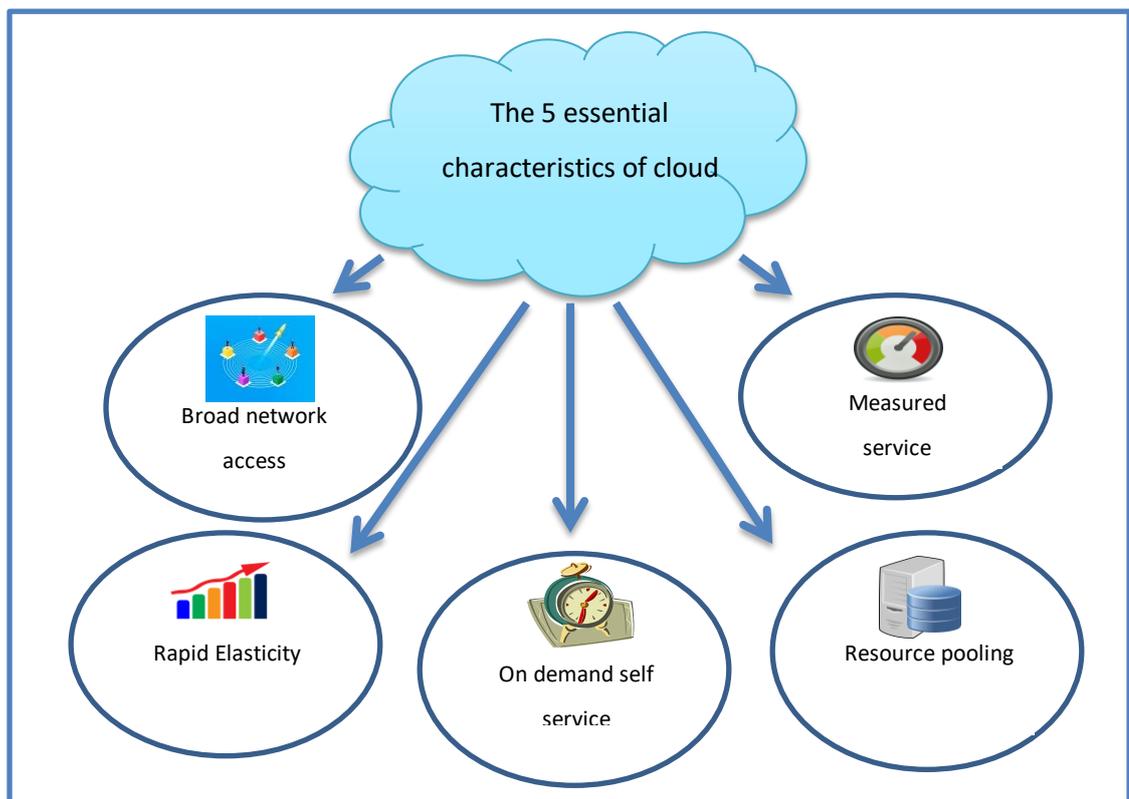
### **2.1.1 Essential Characteristics of Cloud Computing**

Cloud Computing is a prototype for empowering universal, helpful, on stand by for local area get passage to a common pool of configurable figuring assets (e.g., networks, servers, capacity, applications, and administrations) that might be out of the blue provisioned and delivered with insignificant control attempt or specialist organization cooperation [20].

- **On Demand Self Services:** Cloud computing contributions are to be had on demand and don't need a great deal of human connection.
- **Broad Network Access:** Cloud computing is realistic for an organization, normally over the web. Likewise, private cloud offering might be gotten to from wherever with inside the organization.
- **Resource Pooling and Multi-tenancy:** like organizations, servers, capacity, applications, and administration might be pooled to serve more than one clients by safely disengaging the resources on a sensible stage.

- **Rapid Elasticity and Scalability:** Resource capabilities might be flexibly provisioned and launched to fulfill immediate requirements. Likewise, these might be eliminated or downsized while at this point not needed.
- **Measured Service:** The usage of the asset is followed, noticed, controlled, and referred to for every occupant.

The National Institute of Standards and Technology (U.S. Department of Commerce) identifies five essential characteristics of cloud computing environment in figure 2.2.



**Figure 2.2 Essential Characteristics of Cloud Computing**

### 2.1.2 Cloud Services Models

Cloud computing is presented in three different assistance models which each fulfill a special arrangement of business requirements. These three models are referred to as Software as a Service (SaaS), Platform as a Service (PaaS), and Infrastructure as a Service (IaaS).

### **2.1.2.1 Software as a Service (SaaS)**

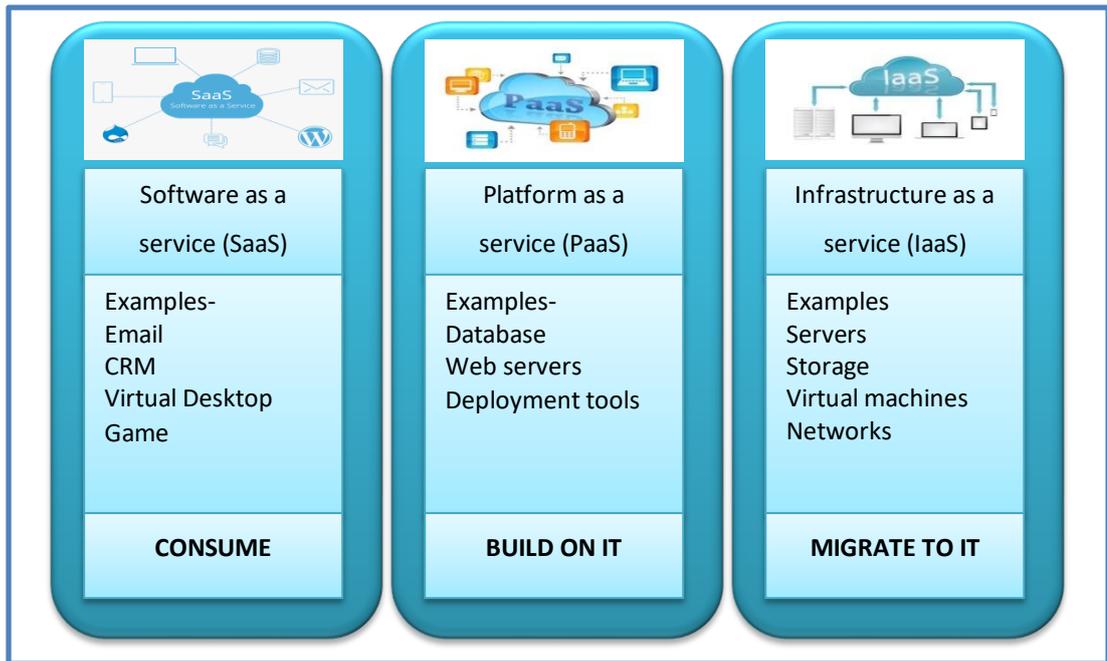
SaaS is a service model where programming applications are presented over the net. In the buyer region, models incorporate Gmail, Facebook and Dropbox - those contributions are prepared to apply, no coding required, those shopper simply use them. With SaaS the total stack is managed for the shoppers; however one will regularly have a restricted extension to arrange the assistance as per their necessities.

### **2.1.2.2 Platform as a Service (PaaS)**

Developers love PaaS as it removes more complexity and operational overhead from them. With PaaS, the cloud service provider manages the infrastructure layer and also the middleware, development tools, business intelligence (BI) services, database management systems and more. This allows developers to concentrate on their code without needing to manage the environment in which it runs. Developers simply upload their code to build web applications. PaaS is designed to support the complete web application life cycle: building, testing, deploying, managing, and updating. PaaS is currently the most popular cloud computing service model, comprising around 32% of all enterprise workloads and is expected to grow in 2020.

### **2.1.2.3 Infrastructure as a Service (IaaS)**

Infrastructure as a service offers a standardized way of acquiring computing capabilities on demand and over the web. Such resources include storage facilities, networks, processing power, and virtual private servers. These are charged under a “pay as you go” model where the users are billed by factors such as how much storage the consumer use or the amount of processing power consume over a certain time span. In this service model, customers do not need to manage infrastructure, it is up to the provider to guarantee the contracted amount of resources and availability [19]. Cloud computing describes its three well accepted service model as these are shown in figure 2.3.



**Figure 2.3 Cloud Service Models**

### 2.1.3 Cloud Deployment Models

Cloud deployment models show how cloud administrations are made accessible to clients. The four deployment models related to cloud computing is as per the following:

#### 2.1.3.1 Public Cloud

Public Cloud is a type of cloud hosting that allows the accessibility of systems & their services to its clients/users easily. Some of the examples of those companies which provide public cloud facilities are IBM, Google, Amazon, Microsoft, etc. This cloud service is open for use. This type of cloud computing is a true specimen of cloud hosting where the service providers render services to various clients. Server infrastructure belongs to service providers that manage them and administer pool resources, which is why there is no need for user companies to buy and maintain their hardware.

#### 2.1.3.2 Private Cloud

There is little to no difference between a public and a private model from the technical point of view, as their architectures are very similar. However, opposed to a

public cloud that is available to the general public, only one specific company owns a private one. That is why it is also called an internal or corporate cloud.

### 2.1.3.3 Hybrid cloud

In a hybrid cloud, an organization makes use of interconnected private and public cloud infrastructure. Many organizations make use of this model when they need to scale up their IT infrastructure rapidly, such as when leveraging public clouds to supplement the capacity available within a private cloud. For example, if an online retailer needs more computing resources to run its Web applications during the holiday season it may attain those resources via public clouds.

### 2.1.3.4 Community cloud

This deployment model supports multiple organizations sharing computing resources that are part of a community; examples include universities cooperating in certain areas of research, or police departments within a county or state sharing computing resources. Access to a community cloud environment is typically restricted to the members of the community [21]. According to figure 2.4, there are four deployment models available to end users.

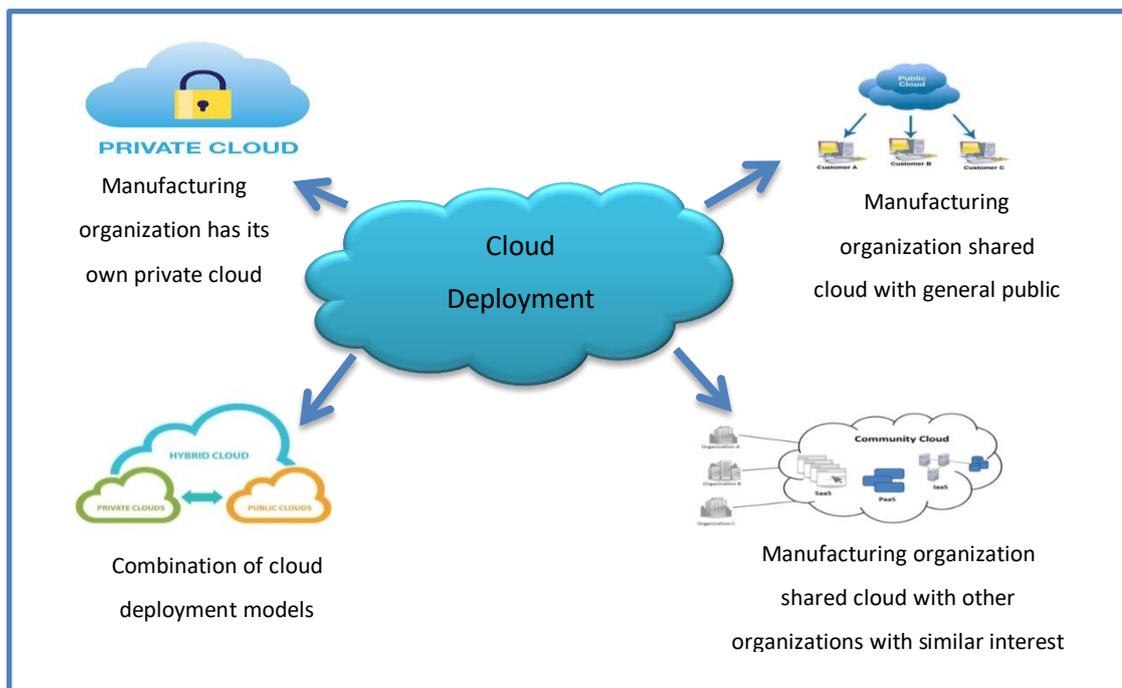


Figure 2.4 Cloud Deployments Models

### 2.1.4 Benefits of Cloud Computing

Cloud computing offers one business many benefits. It allows the user to set up what is essentially a virtual office to give one the flexibility of connecting to the customer's business anywhere, any time. Some important advantages of cloud computing are as follows:

- **High Speed – Quick Deployment:** Developers can easily check new thoughts and layout application structure without the dependency on on-web online hardware obstacles or slow procurement strategies.
- **Automatic Software Updates and Integration:** It is quite a trouble to preserve updating the software program and structures from time to time. In the case of local structures, guide updating of the system is required.
- **Efficiency and Cost Reduction:** By using cloud infrastructure, the customers don't must spend big quantities of cash on shopping and retaining device. Cloud primarily based totally services are also much cheaper to use, as those people are typically deployed on a pay-per-use foundation.
- **Data Security:** Cloud gives many superior protection functions that assure that records is securely saved and handled. Features like granular permissions and get admission to control through federated roles can limitation get admission to touchy records best to the personnel that want get admission to it, and via way of means of that lowering the assault floor for malicious actors.
- **Scalability:** Cloud technology is designed to be scaled to fulfill commercial enterprise's changing IT requirements. As a company grows, extra storage space and bandwidth will inevitably be required to cope with increasing traffic to the website.
- **Collaboration:** The cloud surroundings have been proven to significantly increase collaboration among companies and groups who've get admission to the identical documents. It gets rid of the conversation obstacles of conventional IT fashions and makes it a lot faster and simpler for personnel operating in distinct places to get admission to data and collaborate with crew individuals and key personnel.
- **Backup and Restore Data:** The facts that information might be saved in the cloud without limit constrains likewise empowers with backup and fix purposes. As end-clients information changes over time and wishes to be

followed for guidelines or consistence reasons, more established programming program varieties man is put away for later stages, in cases some may be required for recovery or rollback.

- **Mobility:** Cloud computing lets in cellular get admission to company records through smartphones and gadgets, that's an amazing manner to make certain that no person is ever unnoticed of the loop [3].

## **2.2 Cloud Storage**

Cloud storage is a way for associations and clients to store information safely online all together that it could be gotten to whenever from any area and handily imparted to the people who are allowed authorization. Cloud storage additionally offers a method for backup information to work with recovery off-site.

Cloud storage extends a basic method for putting away and additionally moving information safely and securely. It permits people and organizations to keep their documents put away with the cloud administrations supplier for on-request access on any of their devices.

### **2.2.1 The Benefits of Cloud Storage to Business**

Cloud storage assists organizations with significant information storage necessities to save a lot of space and cash by wiping out the requirement for information capacity foundation on the business premises. The cloud storage supplier claims and keeps up with all the important equipment and programming so the cloud clients don't need to. Further, organizations can in a flash increase or down how much cloud storage others approach as their storage needs change.

The cloud likewise enable representatives to team up with associates and work from a distance and outside of customary business hours-while working with smooth record coordinated effort by permitting approved workers easy access to the most updated version of a document.

### **2.2.2 Cloud Storage Security**

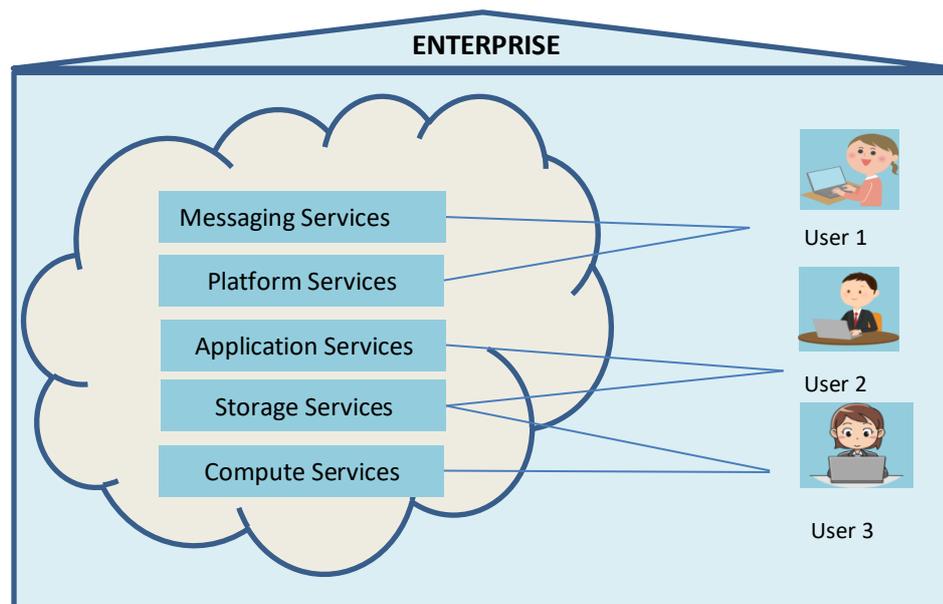
There is so much attention on cloud storage today in the digital era because so much of our sensitive personal data is stored in the cloud whether we voluntarily store it there or whether a company we do business with decides to store it there. As

a result, cloud security has become a major concern. Users wonder whether their information is safe, and increasing data breaches have demonstrated that sometimes it isn't. Users are also concerned about whether the data they have stored on the cloud will be accessible when they need it.

While cloud storage may seem vulnerable due to the prevalence of hacking, the alternatives, such as onsite storage, have security vulnerabilities, too. Company-provided cloud storage can actually improve security by giving employees an alternative to using their personal accounts to back up and transfer files that they need to access outside the office [5].

### 2.2.3 Private Cloud Storage

A private cloud is an interest for cloud development model wherein the cloud computing contributions and infrastructure are facilitated privately inside an organization's very own web or data center the utilization of exclusive sources. Today, corporations are shifting to cloud for his or her maximum crucial commercial enterprise programs. It is a high-quality manner to supply IT offerings extra speedy and value-successfully. When seeking out a steady cloud alternative, companies regularly select private clouds. Although businesses were a little reluctant to migrate to private cloud earlier, it quickly emerged as the most secure cloud model. Public clouds are cloud services provided within the enterprise as shown in figure 2.5.



**Figure 2.5 Private Cloud Functions**

## 2.2.4 Public Cloud Storage

Public cloud is the supply of computing offerings through third-party companies. In a public cloud, IT sources, which include compute, storage, improvement platforms, programs, are to be had as a carrier over the net. The offerings on public cloud are to be had to everyone who desires to use or buy them. Public cloud refers to computing offerings presented through third-celebration companies over the net. Unlike personal cloud, the offerings on public cloud are to be had to everyone who desires to use or buy them. These offerings might be loose or offered on-call for, in which customers most effective must pay consistent with utilization for the CPU cycles, garage, or the bandwidth that the user consume.

A public cloud is operated through a cloud carrier issuer whose offerings are presented over the net. Public clouds successfully meet the collaborative desires of today's international team of workers through providing scalability and flexibility, and therefore, considerable commercial enterprise price to establishments. Public cloud allows corporations shop on shopping, dealing with, and retaining on-premises infrastructure for the reason that cloud carrier issuer is answerable for dealing with the machine. Public clouds additionally provide scalable RAM and bendy bandwidth, making it simpler for corporations to scale their garage desires. Public cloud are fully hosted and managed by the cloud provider as shown in figure 2.6.

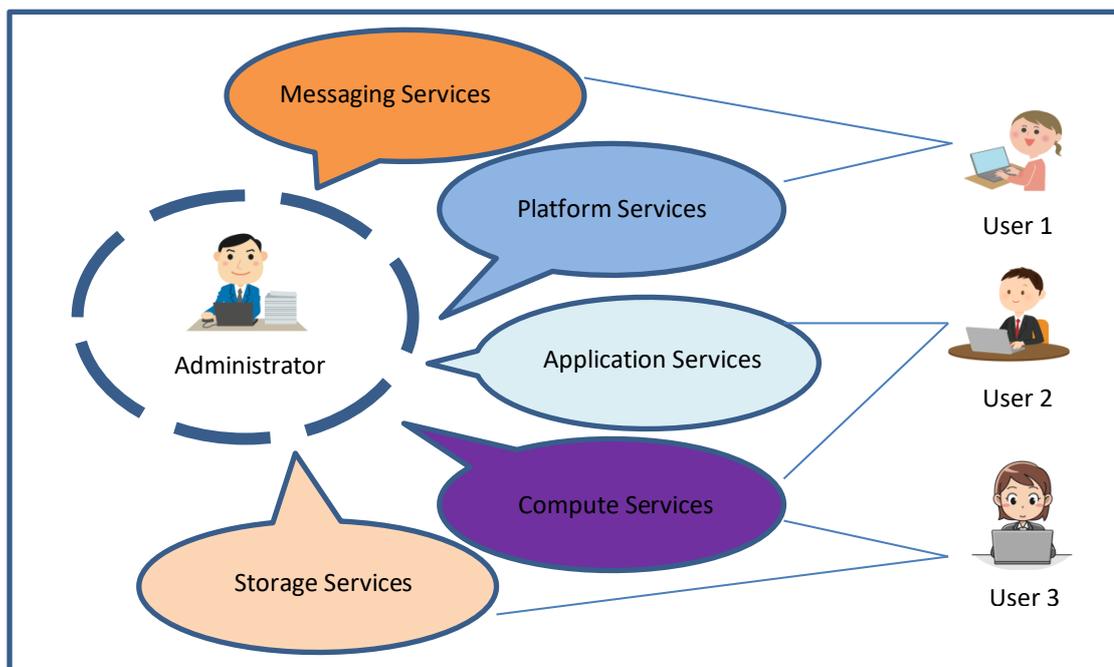


Figure 2.6 Public Cloud Functions

## 2.2.5 Data Recovery and Backup in Cloud Computing

Today, Cloud Computing is itself a gigantic technology which is surpassing all the previous technology of computing of this competitive and challenging IT world. The need of cloud computing is increasing day by day as its advantages overcome the disadvantage of various early computing techniques. Cloud storage provides online storage where data stored in form of virtualized pool that is usually hosted by third parties. The hosting company operates large data on large data center and according to the requirements of the customer these data center virtualized the resources and expose them as the storage pools that help user to store files or data objects. As number of user shares the storage and other resources, it is possible that other customers can access one's data. Either the human error, faulty equipment's, network connectivity, a bug or any criminal intent may put our cloud storage on the risk and danger [10].

### 2.2.5.1 Remote Data Backup Server

Remote Data Backup server is a server that stores a copy of the main cloud whole information all in all. This Backup server is then positioned far away from the cloud. On the off chance that in light of a couple of reasons, the main server lost its information, a far off information backup server might be utilized to keep up with the information. The backup server should be modern step by step with the latest information for the total security of information.

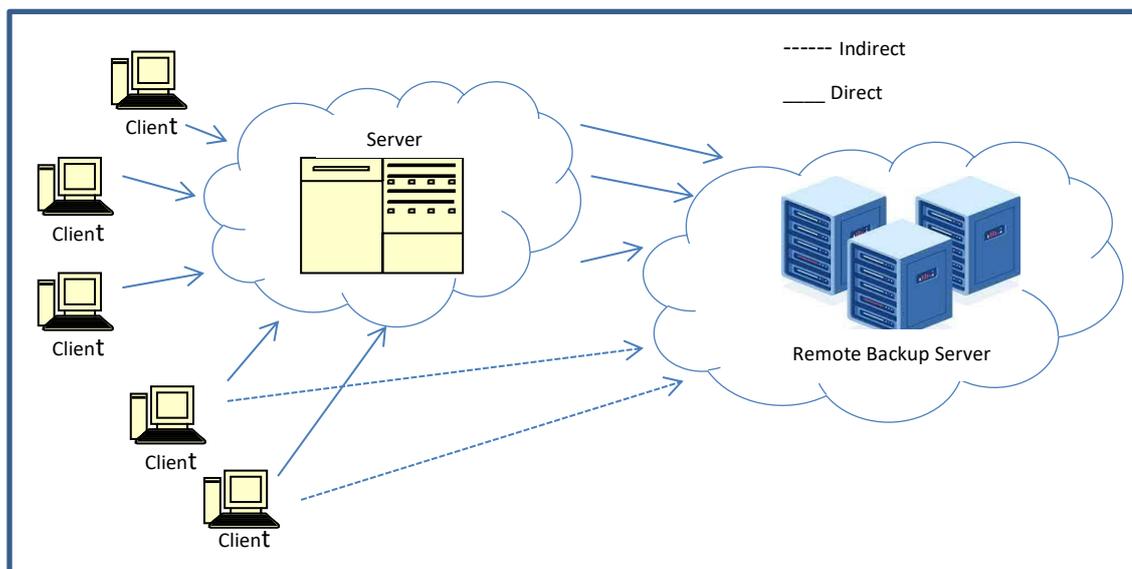


Figure 2.7 Remote Data Backup Server

According to figure 2.7, if clients found that data is not available on central repository, then clients are allowed to access the files from remote repository. The Remote Data Server can undergo the subsequent issues.

- **Data Privacy** – There will be many users who will access the remote server. The owner of the data should only be able to access his private data. So, the privacy and security of the data should be maintained at a remote server.
- **Data Security** – At the Remote Data Server, the client's data should be provided complete protection as is provided in the main server. Data shouldn't be accessed by any other third-party client.
- **Relocation of server** – Relocation is the transfer of main server data to the other server. The new server's location is kept private. The client should access their data without getting the location of the server. There should be location transparency of the relocated servers to the clients.
- **Cost-effective** – The cost for remote server stabilization should be the minimum. Everyone must afford such a system at a cheap rate whether it is a small business or large business.
- **Reliability** – The data should be provided seamlessly whether it is a remote backup server or the main cloud server. For the client, immediate access to the data must be there.

### 2.3 Chapter Summary

In this chapter, a detail of cloud technology is discussed. The detail explanation of essential characteristics of cloud computing, cloud computing service models and deployment models are presented. A general of cloud storage including private cloud storage and public cloud storage are presented. Finally what is the need of remote data backup server are described.

# **CHAPTER 3**

## **DATA RECOVERY IN CLOUD COMPUTING BY USING ENRICHED GENETIC ALGORITHM (EGA)**

### **3.1 Introduction to Data Recovery in Cloud Computing**

Data is the current association's most extremely valuable resource. Losing it might reason hopeless damage in the business venture, including the loss of productivity, revenue, reputation and the clients. It is hard to expect when a disaster will emerge and how serious its impact can be. However, the clients have control how to respond to a disaster and how successful their organization will recover from the disaster. An accident can result in the loss of all the customer important files. Most companies can't accept these risks. Therefore, cloud disaster recovery has become very important over time [11].

Cloud-based recovery and storage servers will help one in supporting basic modern enterprise documents. Subsequently, the client might reestablish those documents in the event of a data break. Cloud innovation is adaptable naturally. In this way, the client can make a more proficient calamity recuperation plan. Everything insights may be saved in a high accessibility foundation. Likewise, the client can get those contributions on request. The individual can involve it in creating DR arrangements as per its business endeavor needs. The cloud-based DR arrangements are remarkable from conventional arrangements. The individual can easily control these arrangements. The cloud will help them in automating this total interaction. This will help with ensuring fast information recuperation [23].

Backup is the method involved with making reproductions of information to safeguard it from accidental or malicious deletion, corruption, equipment disappointment, ransomware assaults, and various types of information misfortune. Information backup might be made locally, from a cloud, or both. Offsite backups are a key piece of own special business continuity/disaster recovery plan.

Recovery and restore times can differ fundamentally relying upon the backup format chose and information recovery technique. Individuals likewise have different recuperation prerequisites (for instance, single record or whole server reestablish).

Finally, sensitive data can be stored on workstations, local servers, and in the cloud. This is an important consideration when choosing a backup and recovery solution.

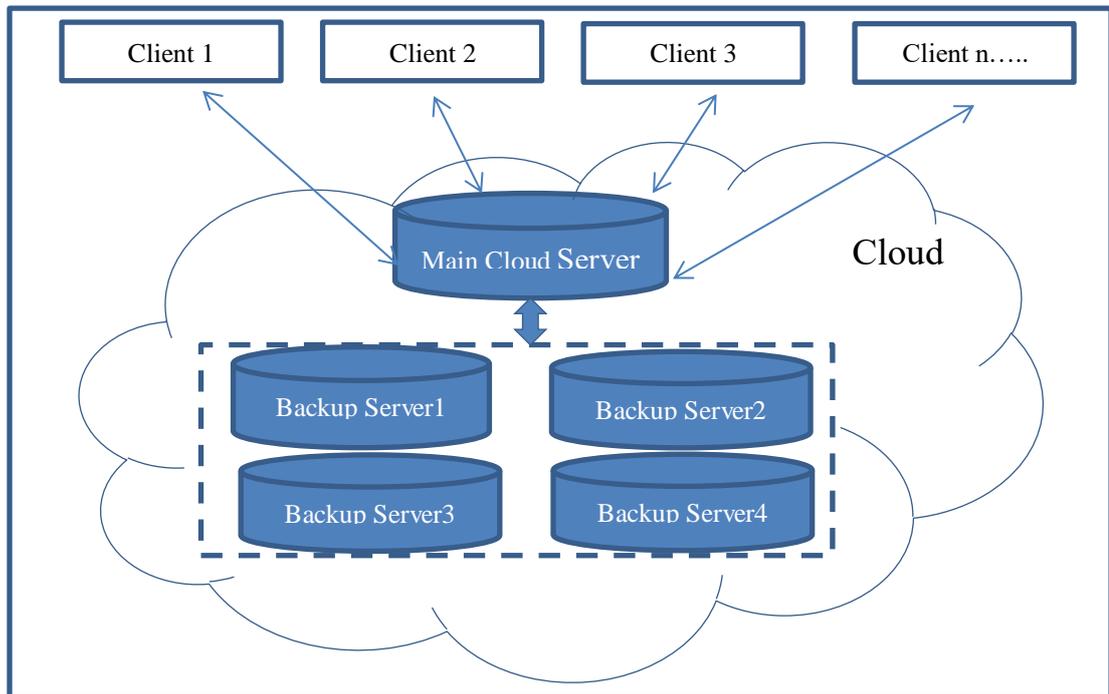
### **3.1.1 Cloud Computing and Data Security**

Data security is a not unusual place situation to all technologies. However, it will become a primary challenge when implemented to an out of control surroundings. It is fundamental to separate among the security takes a chance with connected with all IT foundations and those presented by the utilization of Cloud Computing. These dangers are normally connected with open, shared and distributed environments. Consequently, while dissecting the risks, it is critical to isolate existing issues from the ones raised through method of method for cloud computing.

One of the boundaries to the adoption of cloud computing is data security, that is observed via way of means of problems along with compliance, privacy, trust and legal matters. Data security will becomes especially critical in the cloud computing surroundings due to the fact data are scattered in different machines and storage devices which includes wireless sensor networks and smartphones as data security in the traditional information systems [2].

Data security has been a primary problem in Information Technology (IT) enterprise. In cloud computing, it is serious due to the fact data is located in different places. As data security and privacy protection become more critical for the future improvement of Cloud Computing technology in enterprise, industry and business.

### 3.2 Proposed Data Recovery Technique in Cloud Computing



**Figure 3.1 Overview Architecture of Proposed Data Recovery Technique**

The proposed architecture imbibes three modules inclusive of

- Remote Backup Server
- Main Cloud Server
- The number of clients

as shown in figure 3.1. The Remote Backup server keeps the reproduced duplicates of the main server and is identified as a central repository it stores all the client information. The client transfers the document to the main cloud server stores every one of the information in the backup servers. If the client has any desire to recover the document from the cloud then the record is looked at in the main cloud server first and foremost, on the off chance that the information is absent in the main server then it is checked in the backup server to recover lost information.

Assuming that the loss of information or information crash happens in light of natural disasters or human-made disasters in the main server, to recovery the lost data, a recovery method is essential. Recovery of information can be accomplished using the proposed algorithm efficiently. To give reliability two or four backup data cloud storage could be used.

### **3.2.1 File Upload with Hashing**

Uploading refers to the exchange of data starting with one PC framework then onto the next over an organization. Normal methodologies of uploading incorporate transferring through internet browsers, FTP clients, and terminals (SCP/SFTP). Uploading might be used with regards to (possibly many) clients that send records to a central server. While uploading may likewise be characterized inside the setting of sending records between distributed clients, for example, with a peer-to-peer (P2P) document sharing convention like BitTorrent, the term document sharing is a ton of normally used for the situation.

In the proposed system, the client needs to choose the document to upload to the cloud by choosing the number of copies of replication required to store. While uploading charm application will read the record size in kb. Then it will choose the best cloud storage server in view of the capacity accessibility, estimating cost, indicator, size, and so for the integrity Verification process it will create the Hash Key (HK1) utilizing the MD5 calculation and it will keep it in the client DB. At last in light of the Replication subtleties, the File will be stored in the Cloud storage server.

### **3.2.2 File Recovery**

File recovery might be in a word characterized as a drive or folder scanning to find deleted entries in the root folder or the root file table then for a specific erased passage characterizes a chain of groups to recover and duplicate the substance of those groups to the newly created file. File recovery is the way of reestablishing record that has been lost, accidentally deleted, corrupted or made inaccessible. In big business IT, data recovery generally refers to the restoration of data from a backup to a desktop, laptop, server or secondary storage system.

In the proposed system, when the user request the file from the main cloud server he has to select the file from the Data Recovery Application then the data Recovery Server will select the corresponding cloud sever details from the DB and also it will check for the cloud availability for recovering the file, if cloud server is not available then it will be recovered from another cloud server. While recovering it will generate the HASH Key (HK2), then it will check for the HK1 &HK2 for the integrity check. Finally, the file is recovered from the backup server.

### **3.2.3 MD5 Hash Generator**

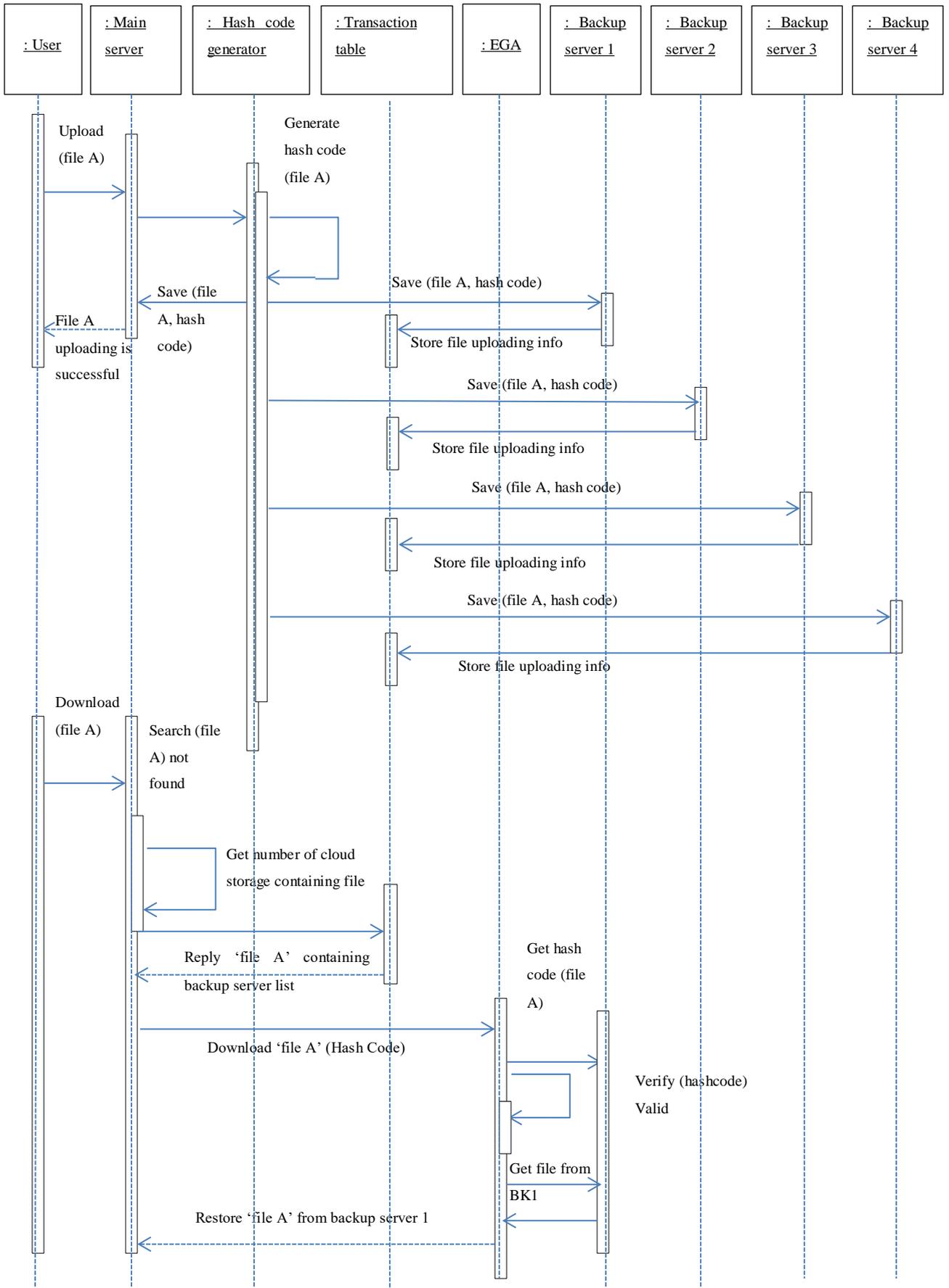
The MD5 message digest calculation is a cryptographically however regardless comprehensively utilized hash work creation a 128-bit hash esteem. Despite the fact that MD5 become as a matter of first importance intended for use as a cryptographic hash work, it's been seen to be beset by gigantic weaknesses. It stays appropriate for various non-cryptographic purposes, as an example for sorting out the parcel for a specific key in an apportioned information base, and might be favored on account of lessening computational necessities than more noteworthy current Secure Hash Algorithms calculations [16].

Message digest work is utilized to make computerized condensation of data called a message digests. Message digests are regularly 128 to 160 pieces extensive and offer a computerized identifier for each virtual record or document. The message digest trademark is a numerical capacity that processes data to supply an exceptional message digest for each novel report.

### **3.3 Sequence Diagram of the system**

The sequence diagram of the system presents four backup servers. The repeated duplicates of information are kept up with in more than one server to recover information. Whenever information misfortune happens at one area it tends to be recovered from another backup server utilizing an Enriched Genetic Algorithm (EGA). The EGA activity can momentarily be made sense of as guzzling the accompanying advances:

- Initialization - Cloud Initialization
- Evaluation - Total document in the cloud for example computing size and cloud specialist co-op status.
- Selection - Selection of client.
- Crossover - Comparing documents for the client in the cloud server.
- Mutation - The deleted document is getting reestablished.
- Termination - Completion of reestablishing.



**Figure 3.2 Sequence Diagram of the System**

According to figure 3.2, at the beginning of the algorithm, the user has to sign up first by entering individual data. After effective finish of enrollment client can login into the system with the help of the username and secret word which can be assigned. The client data is saving inside the system's servers. The subsequent stage after the login is uploading the document. After the client uploads the document, the system creates the hash code H1 naturally for a specific document involving the MD5 calculation and stores that document in the system's server. To recover the document from the cloud then the system looks in the main cloud server firstly and downloads from the main server. On account of information misfortune because of any explanation, for example, normal disaster, man-made attacks, and server crash document on the main cloud server gets erased or crashed.

On the off chance that the information is absent in the main server then the system looks through the record from any backup server and creates hash code H2. To download the erased record, the client should type hash code H2 in the text box first and foremost. The client can observe hash code H2 from the mail box. In the wake of typing the hash code H2, the system gets the hash code H1 from the database. Assuming the hash codes H1 and H2 are matched, the client can recover the original file and the system restores the original file in the main server.

### **3.4 Chapter Summary**

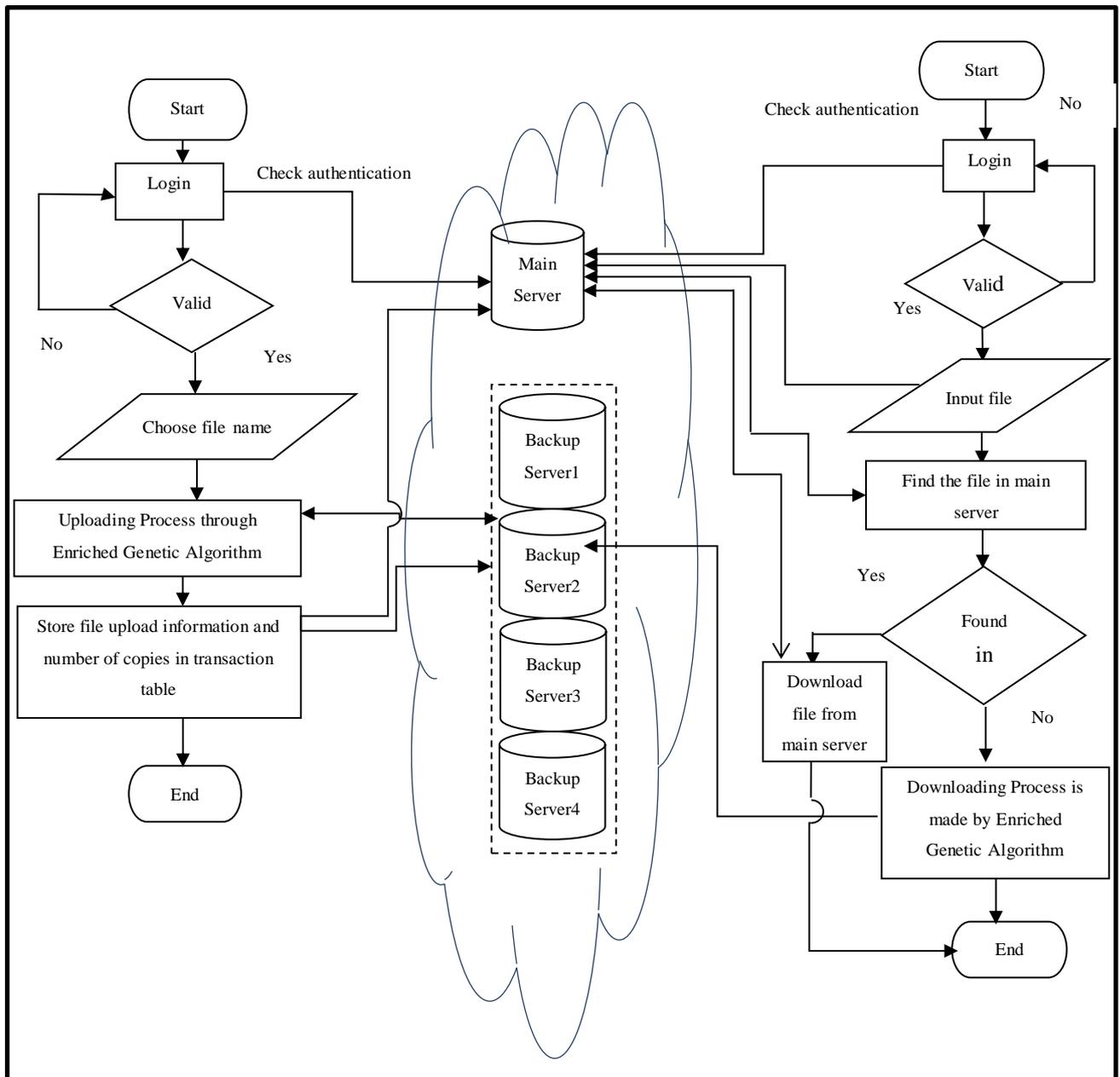
In this chapter, a detail of data recovery in cloud computing by using Enriched Genetic Algorithm (EGA) is discussed. The detail explanation of cloud computing and data security, file uploading with hashing, file recovering are presented. Finally, about the MD5 algorithm is explained and sequence diagram of the proposed system are described.

# CHAPTER 4

## SYSTEM DESIGN AND IMPLEMENTATION

### 4.1 Overview System Architecture

The system architecture illustrates four backup servers as shown in figure 4.1. The replicated copies of data are maintained in more than one server to recover data. When data loss occurs at one location it can be retrieved from another backup server using an Enriched Genetic Algorithm (EGA).

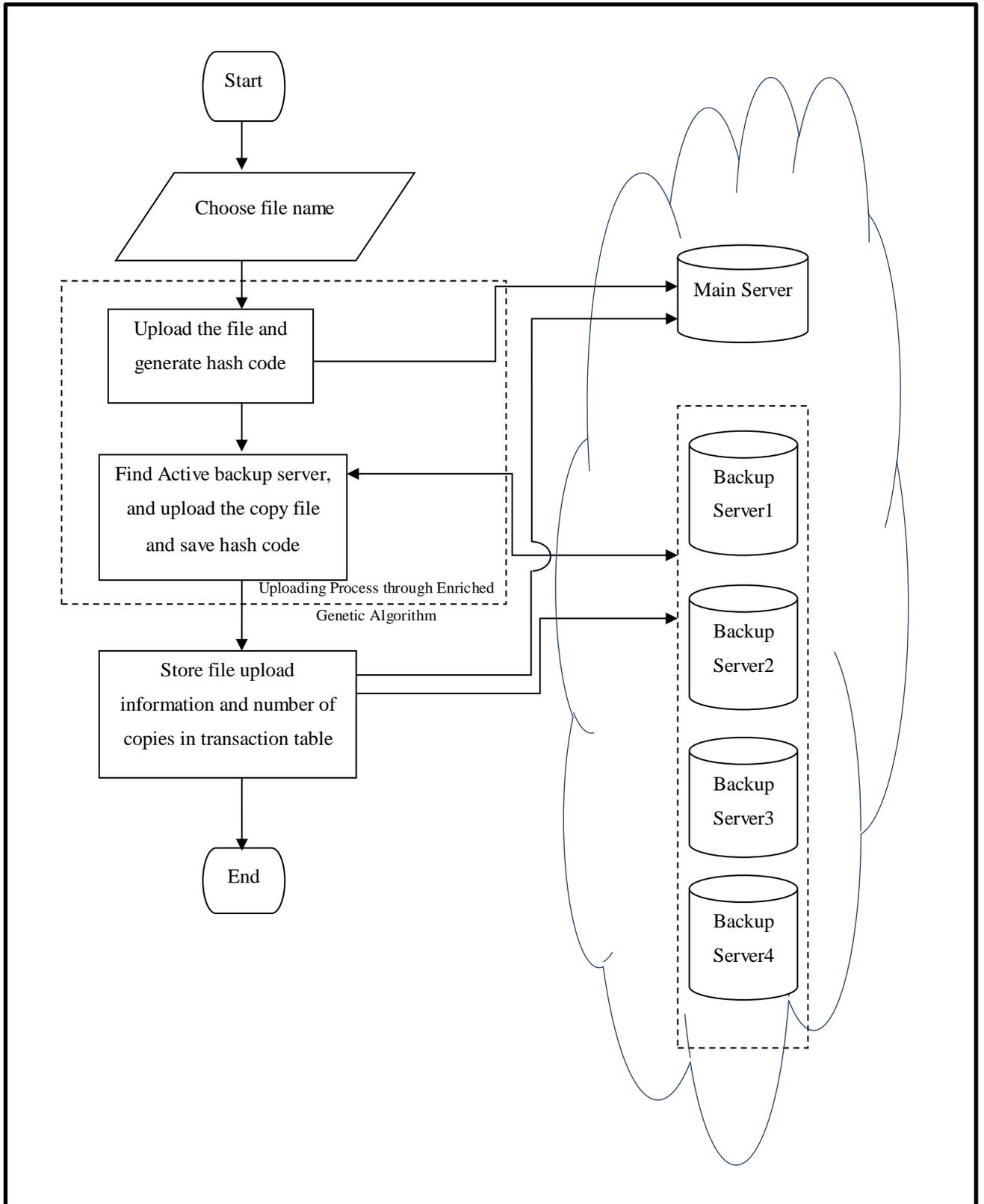


**Figure 4.1 Overview System Architecture**

### 4.1.1 File Uploading Algorithm

```
Let N be the number of copies needed.
BEGIN
    User uploads the file F to the cloud server.
    Let N = the number of copies needed [Server count included Main
        Server and Backup server]
    File F generates hash code H1 and store in database for integrity
    checking.
    For (i=1; i<=N; i++)
        {Select ith server and its available balance;
        New Balance = Available Balance – Request Balance of
            Uploaded File;

        If (New Balance <0)
            {Display “No Space to upload file”;
            Break;
            }
        Else
            {Upload the file to server and update the balance;
            Store the file upload information and number of copies
            in transaction table;
            }
        }
    End If
}
End For
End
```



**Figure 4.2 File Uploading Architecture**

According to figure 4.2, user uploads the file F to the main cloud server and four backup servers. After uploading file F, the system generates hash code H1 and stores file upload information in database.

#### 4.1.2 File Recovering Algorithm

```
BEGIN
  Select the file to be downloaded.
  From the transaction table get the numbers of cloud storage containing the file
  and N server configuration details.
  For (i=1; i<N; i++)
    {Select ith server status,
      If (status is activated)
        {Download file from ith server;
          Generate hash code H2 from the file;
          Fetch the hash code from Database;
          If (H1 = H2)
            {Display “File Integrity check is successful”;
              Display “File recovered successful”: STOP
            }
          Else
            {Display “File Integrity check is not successful”;
            }
          End If
        }
      End If
    }
  End for
End
```

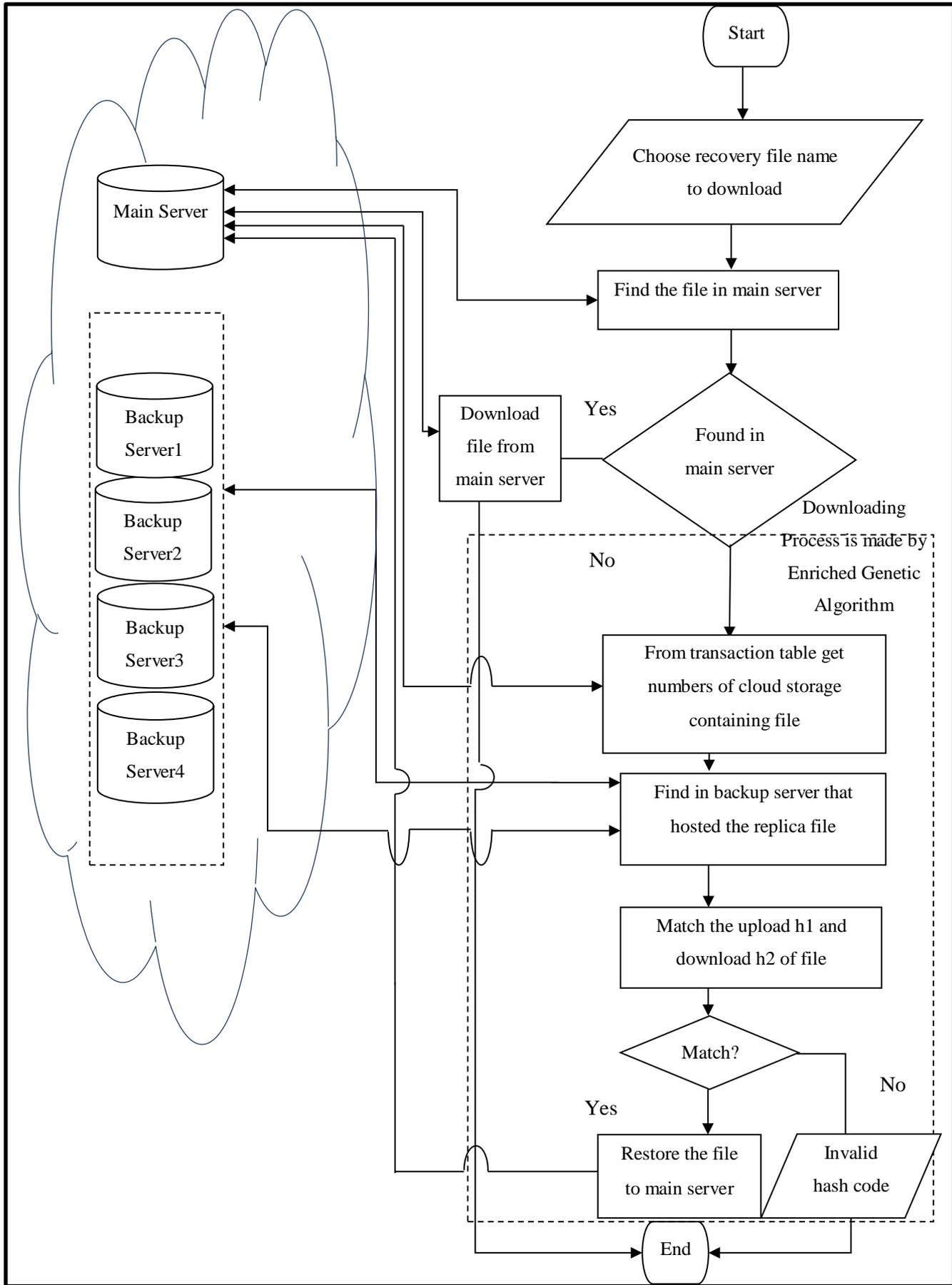


Figure 4.3 File Recovering Architecture

In file recovering algorithm, user has to select the file to be downloaded. If the file is deleted in main server then it is retrieved from the backup server. Then select the file to be downloaded and generate the hash code H2. If both the hash codes are same then we retrieved the original file as shown in figure 4.3.

## 4.2 Deploying Website (ASP.Net) to Google Cloud

The software requirements for this system are as follows:

- Google Cloud SDK (<https://cloud.google.com/sdk>)
- .NET Core 3.1 SDK (<https://dotnet.microsoft.com/download>)
- Visual Studio 2015 (<https://visualstudio.microsoft.com/vs/>), Visual Studio Code (<https://code.visualstudio.com/>) or any other editor and have basic familiarity with Google Cloud Platform (GCP) and .NET Core with a GCP account to use [25].

### 4.2.1 Creating the ASP.NET Core Web Application

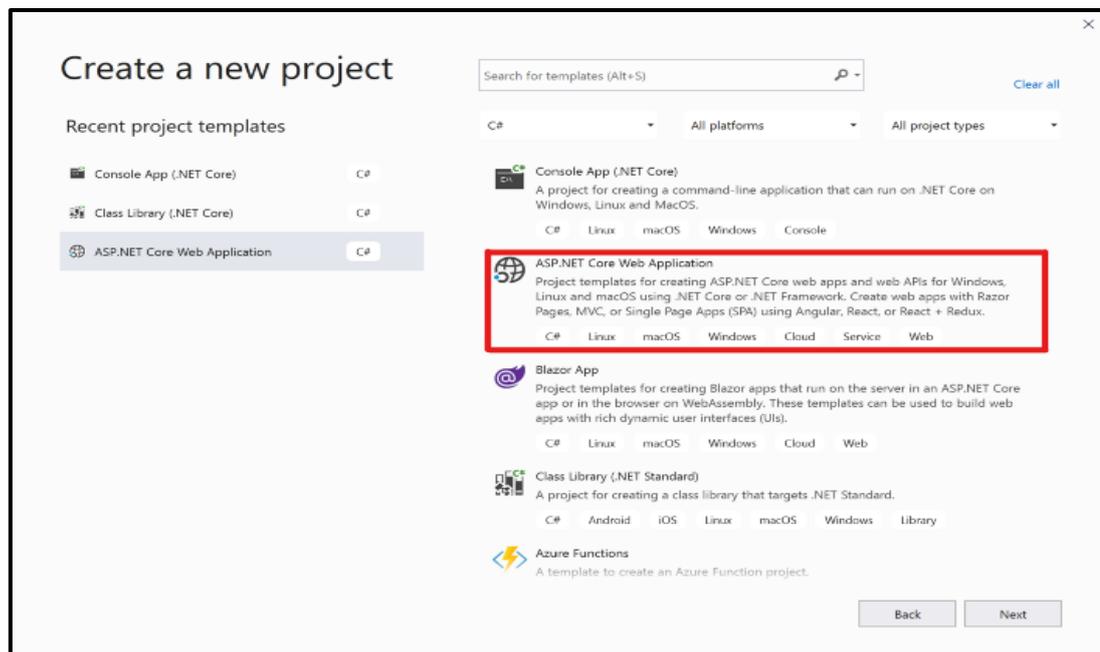
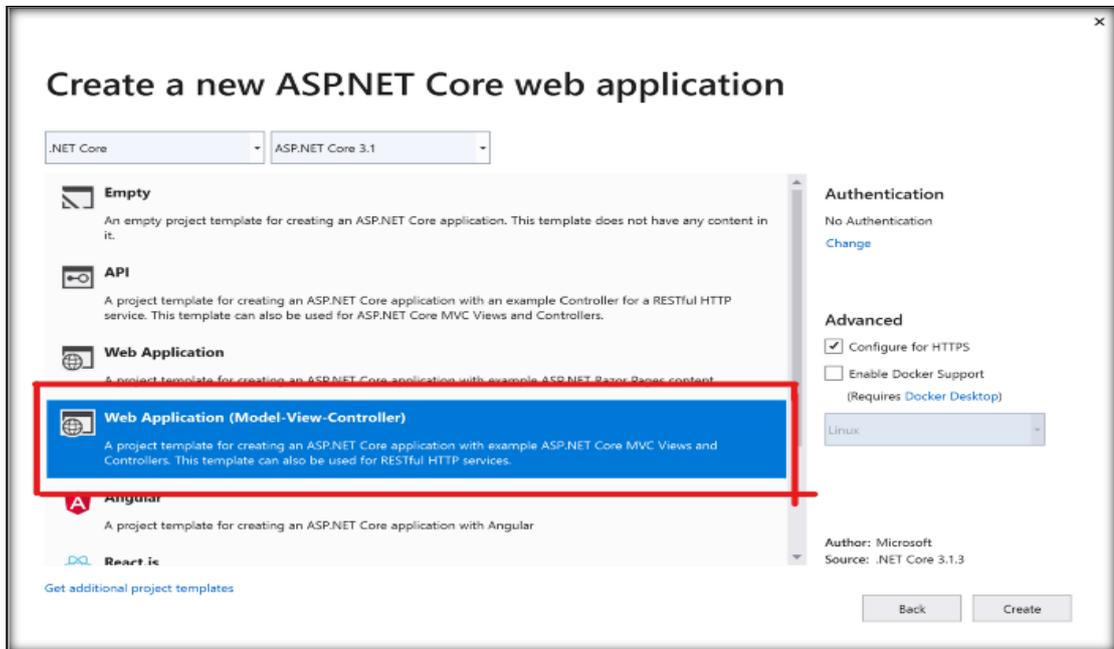


Figure 4.4 Create a New Project in Asp.net Editor

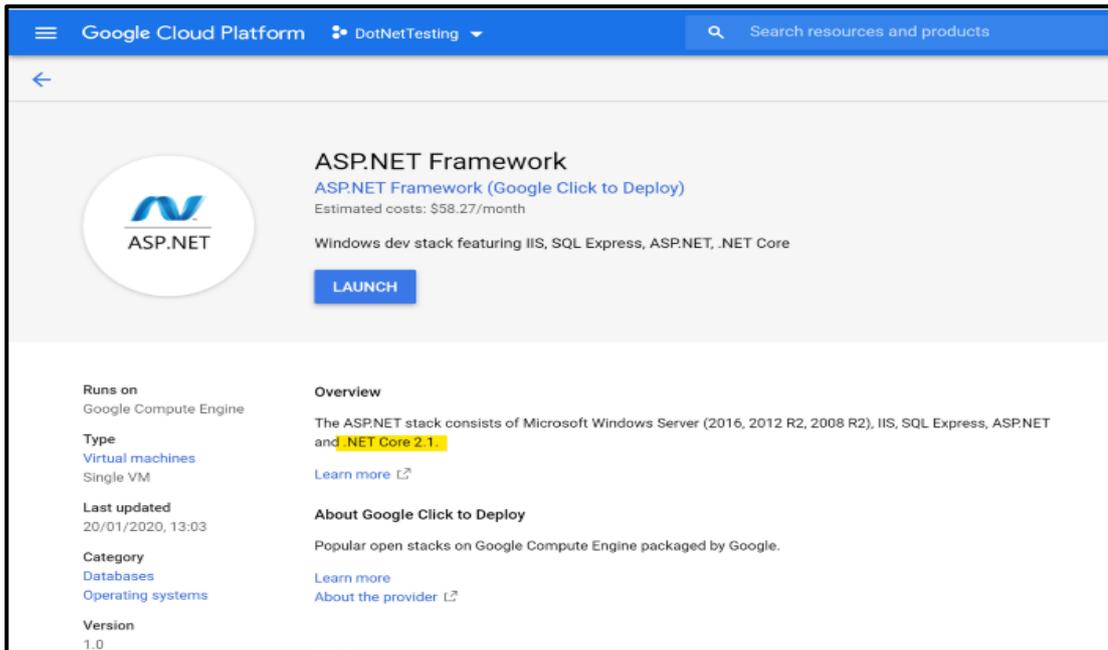
First of all, the user needs to create an ASP.NET Core Web application. Once the user clicks on the Create a new project box, it will open the “Create a new project” window as shown in figure 4.4. In the “Create a new project” dialog, select ASP.NET Core Web App (Model – View – Controller) in figure 4.5.



**Figure 4.5 Choose ‘Web Application (model view controller)’**

## 4.2.2 Creating Google Compute Engine IIS VM

The users will need the IIS server. Could spin up a custom GCE Windows Server VM, install IIS and configure it, but it would be a lengthy process and probably overkill for someone getting started or that just wants to run their application. The suggested way on the official documentation is to use a blueprint image ready to deploy on GCP Marketplace, the ASP.NETFrameworkMarketplace Image which will create a VM with IIS, .NET, .NET Core & SQL Express preinstalled and configured. As the user can see from the figure 4.6, the image comes with **.NET Core 2.1** and it hasn’t been updated yet to **.NET Core 3.x**.



**Figure 4.6 First Point of the Process**

Then pressing “Launch”, the user will be shown a classic VM config screen. The client can change the name of the VM and chose the Zone in the district nearer to the client. Since will be using RDP to access the server, while it’s not needed, the user may want to select a slightly bigger “Machine Type” for own instance, so that the client will have a smoother experience when remoting to it as shown in figure 4.7.

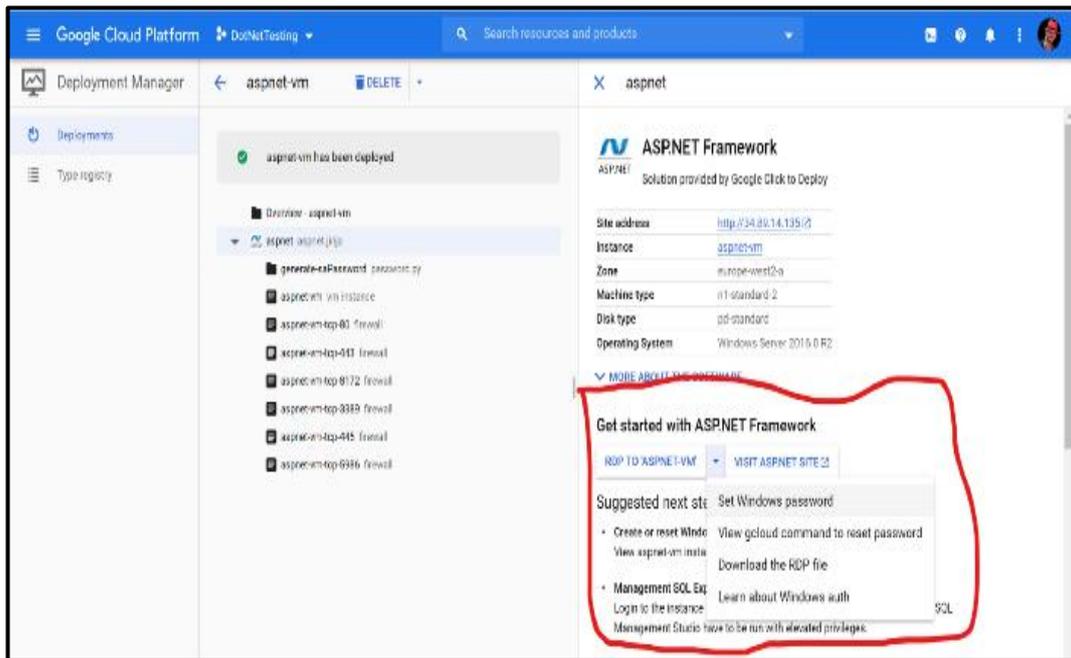
The screenshot displays the 'New ASP.NET Framework deployment' configuration page in the Google Cloud Platform. The page is titled 'New ASP.NET Framework deployment' and features a blue header with the Google Cloud Platform logo and the user name 'DotNetTesting'. The configuration is organized into several sections:

- Deployment name:** A text input field containing 'aspnet-vm'.
- Zone:** A dropdown menu set to 'europe-west2-a'.
- Machine Type:** A dropdown menu set to '1 vCPU', with '3.75 GB memory' and a 'Customise' link displayed next to it.
- Windows Server OS Version:** A dropdown menu set to '2016'.
- Boot Disk:** A section containing:
  - Disk type:** A dropdown menu set to 'Standard Persistent Disk'.
  - Disk size in GB:** A text input field containing '100'.
- Networking:** A section containing:
  - Network:** A dropdown menu set to 'default'.
  - Subnetwork:** A dropdown menu set to 'default (10.154.0.0/20)'.
- Firewall:** A section with the heading 'Add tags and firewall rules to allow specific network traffic from the Internet'. It contains a list of six checked items:
  - Allow HTTP traffic
  - Allow HTTPS traffic
  - Allow WebDeploy traffic
  - Allow RDP traffic
  - Allow Netlogon Service traffic
  - Allow WinRM traffic

A blue 'Deploy' button is located at the bottom left of the configuration area.

**Figure 4.7 Classic VM Config Screen**

Then press “Deploy” and wait for the machine to be created and initialized. It should take less than a minute, but it’s a good idea to wait for it to be properly booted before proceeding to create a Windows Account. After the machine has been created “Get Started with ASP.NET Framework” window as figure 4.8.

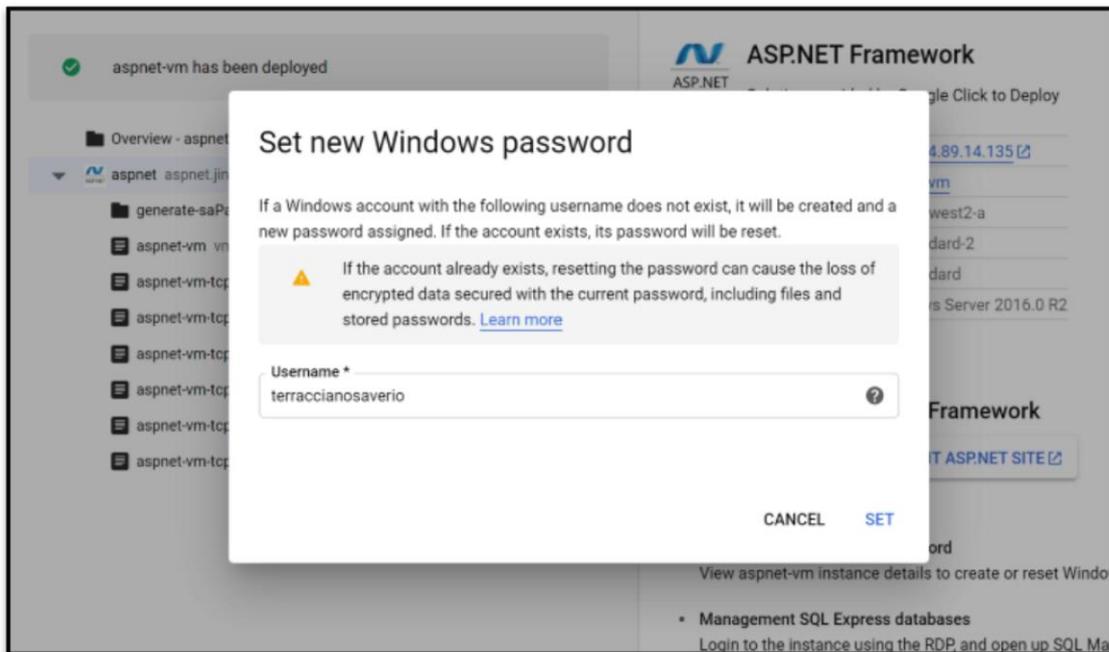


**Figure 4.8 Get Started with Asp.net Framework Screen**

It will then ask the user to choose a Username and give a password as shown in figure 4.9 and 4.10.



**Figure 4.9 Choose a Username**

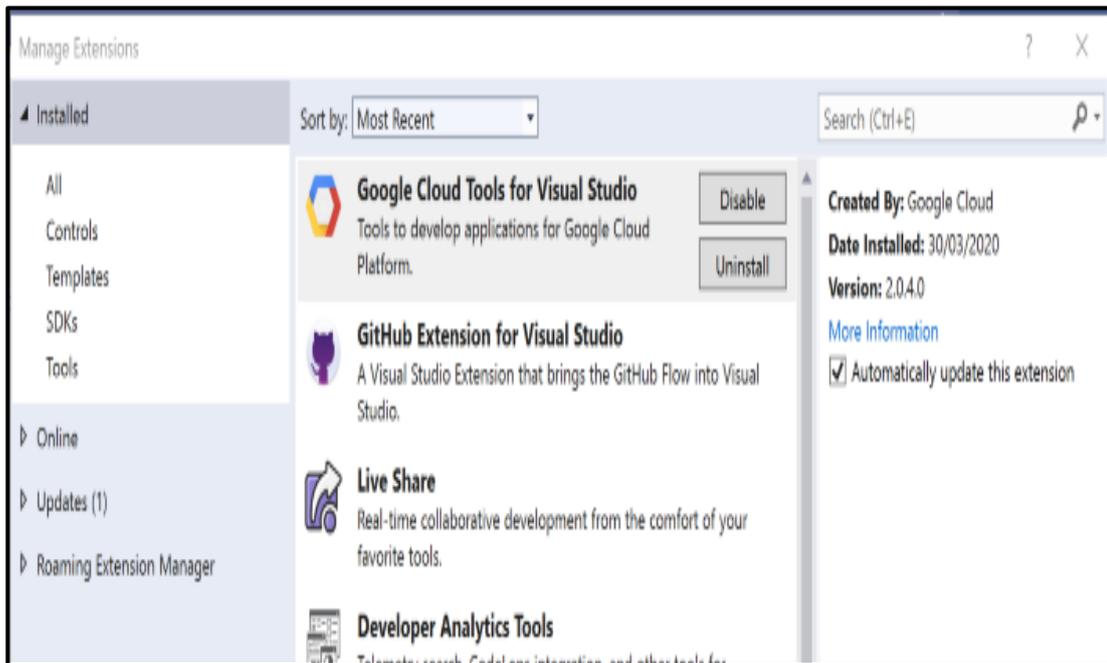


**Figure 4.10 Give a Password**

The user will need them to RDP to their new VM with either the Chrome RDP for Google Cloud Platform extension or any other RDP client like Windows Remote Desktop Connection.

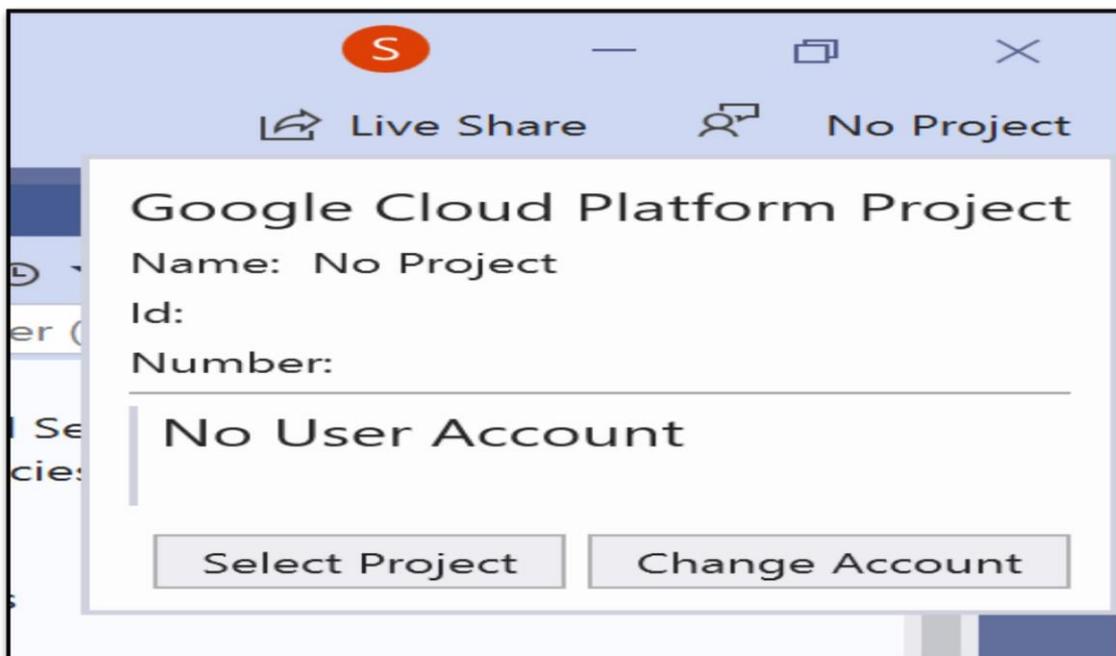
#### **4.2.3 Deploying with Google Cloud Tools for Visual Studio**

Firstly the user needs to install “**Google Cloud Tools for Visual Studio**” from “Extensions > Manage Extensions” as shown in figure 4.11.



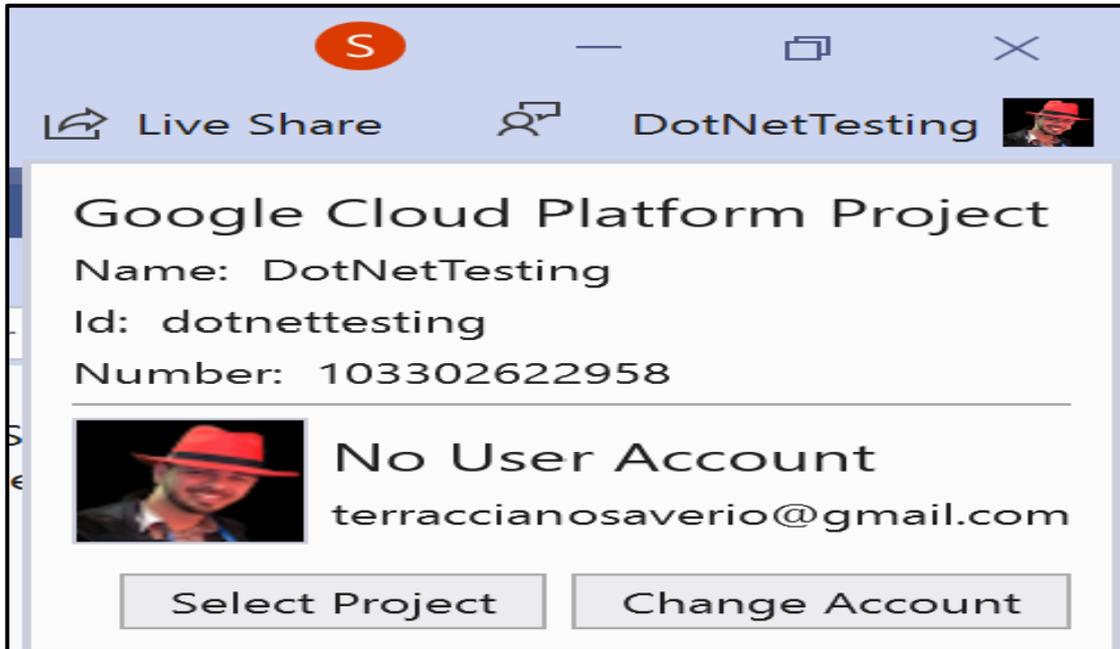
**Figure 4.11 Install Google Cloud Tool**

Once the extension is installed, the user will find a new plugin in the upper right part of Visual Studio, let's click on it and start by logging in with their GCP account as shown in figure 4.12.



**Figure 4.12 Login for GCP Account**

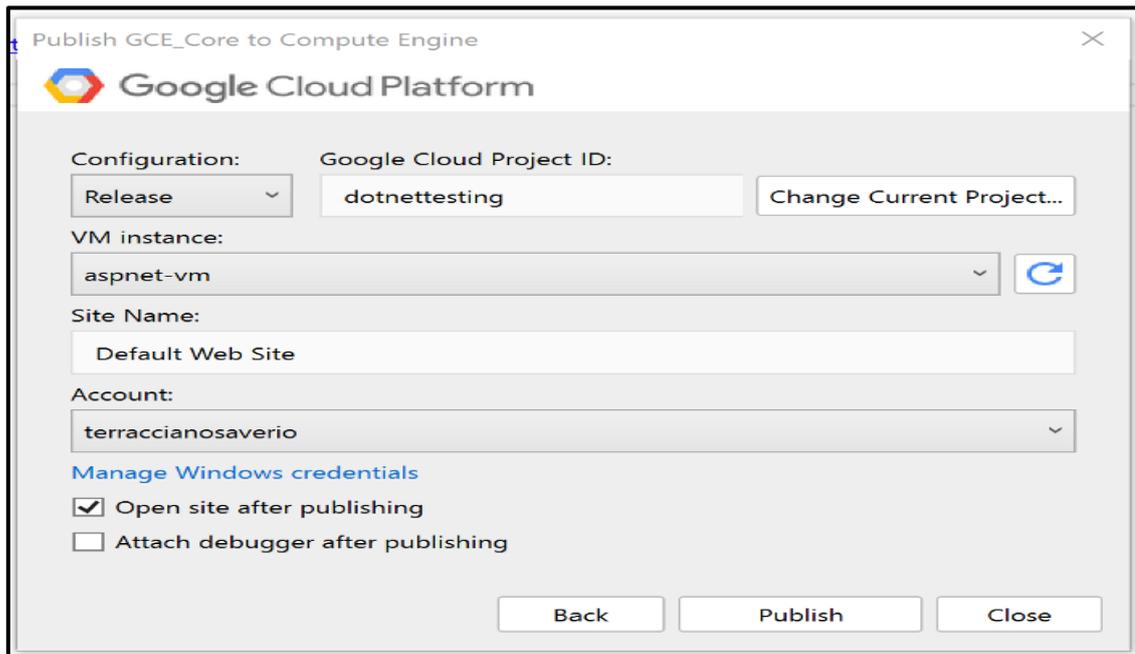
Pressing Change Account will trigger an OAuth process that will allow the plugin to connect to GCP as shown in figure 4.13. After authenticating, the user will want to also select the Project on which the customers have created their VM.



**Figure 4.13 Set Up for GCP Account**

Client can continue to right-click on the project from the solution explorer and select "Publish to Google Cloud" and then "Google Compute Engine" after that is set up.

The user will be notified that App Engine or GKE are preferred ways to deploy the project, but that just in case the ones should use the ASP.NET Marketplace Image.



**Figure 4.14 Choose Credentials for Publishing**

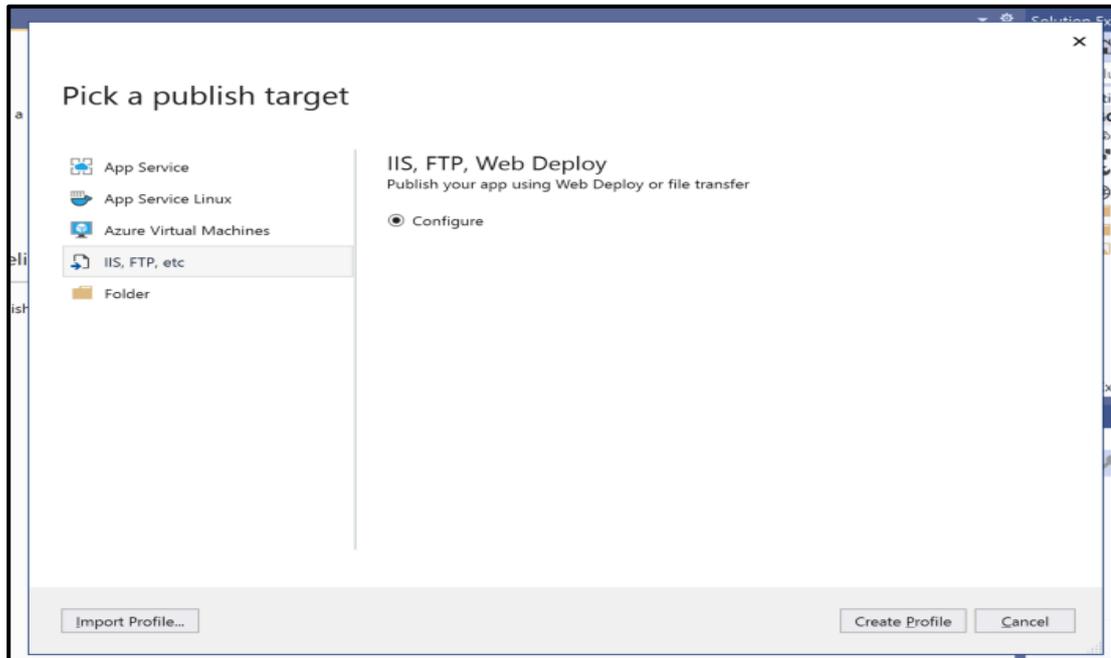
The user needs to fill in the details for the instance and credentials on which to deploy as figure 4.14. It's a straightforward process but a few clarifications are in order:

- The user can use the account credentials he/she set up in the previous step, but he/she could also create or reset them from the “Manage Windows Credentials” option.
- “Site Name” is probably the trickiest bit as it's not explained anywhere and the user would be led to think that is just a name he/she wants to give to his/her application, but this has to be the name of an application already created in IIS. The ASP.NET Image will initialize IIS with one called “**Default Web Site**”. Unless the one RDP first to its VM and create a new one, he/she will have to settle for “**Default Web Site**”, or use that as root to have something like “**Default Web Site/GCP\_Core**”.
- If the user created his/her project via CLI, the user may be prompted to create a Solution file in which to include his/her project.

Upon pressing “Publish” the user's project will be compiled and pushed to GCE. By default, a browser instance should be launched pointing at the newly deployed application. If the user doesn't want to use Google Cloud Tools, the user has

the option to use the Standard Web Deploy (MSDeploy) that comes built-in with Visual Studio. In this case, the client will have a few more details to fill in.

- Right-click on his/her project and select “Publish...” After click “Publish” Pick a publish target screen as shown in figure 4.15.



**Figure 4.15 Pick a Publish Target**

- The first time the user access it, he/she will have to create a Profile. Select “Internet Information Service (IIS), File Transfer Protocol (FTP), etc.” and then “Create Profile” screen as figure 4.16.

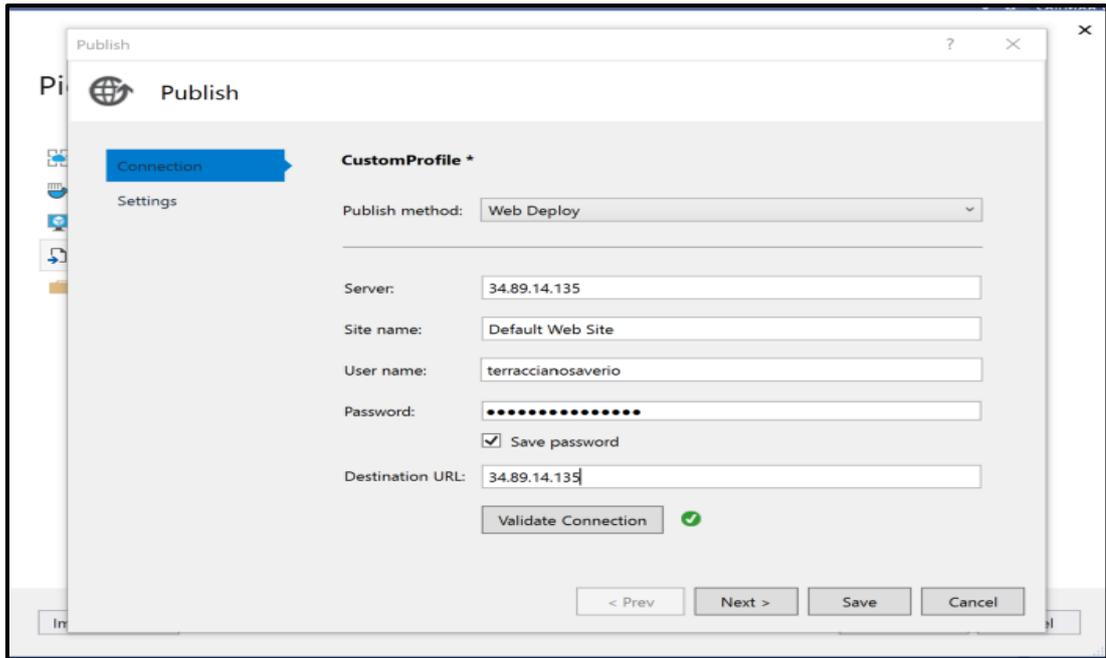


Figure 4.16 Publish Website

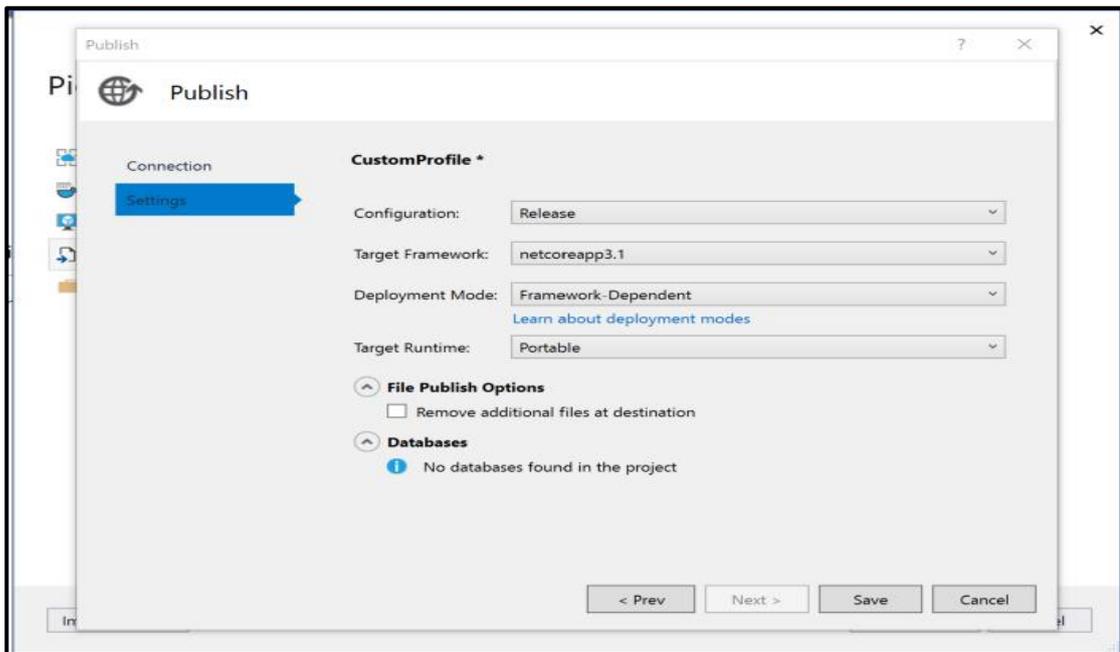


Figure 4.17 Ready to Deploy

Then the user must press “Next”, and the user shouldn’t be required to change anything for the Settings and can then press “Save” as shown in figure 4.17.

The user should now be ready to deploy, so just press “Publish”. If the user wants to use the Preview action, he/she will need to allow untrusted certificates (like our self-signed one). There are various ways to do this; the quickest one will be to manually edit the profile file and adding comment as shown in figure 4.18 and save it. So the user can finally use the Preview Option in figure 4.19.

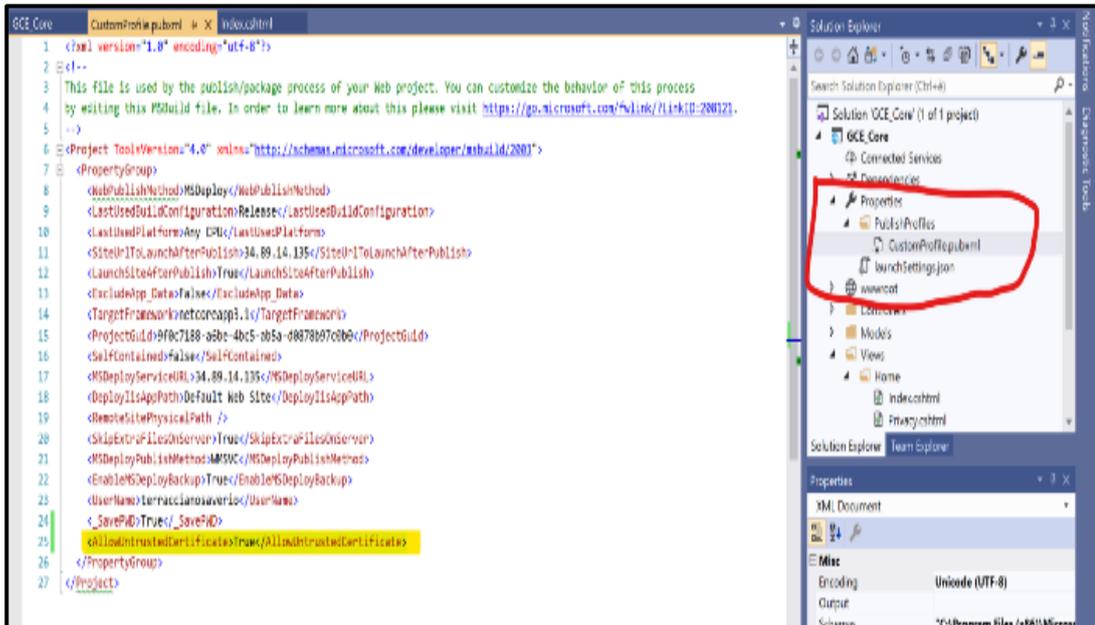


Figure 4.18 Edit the Profile File

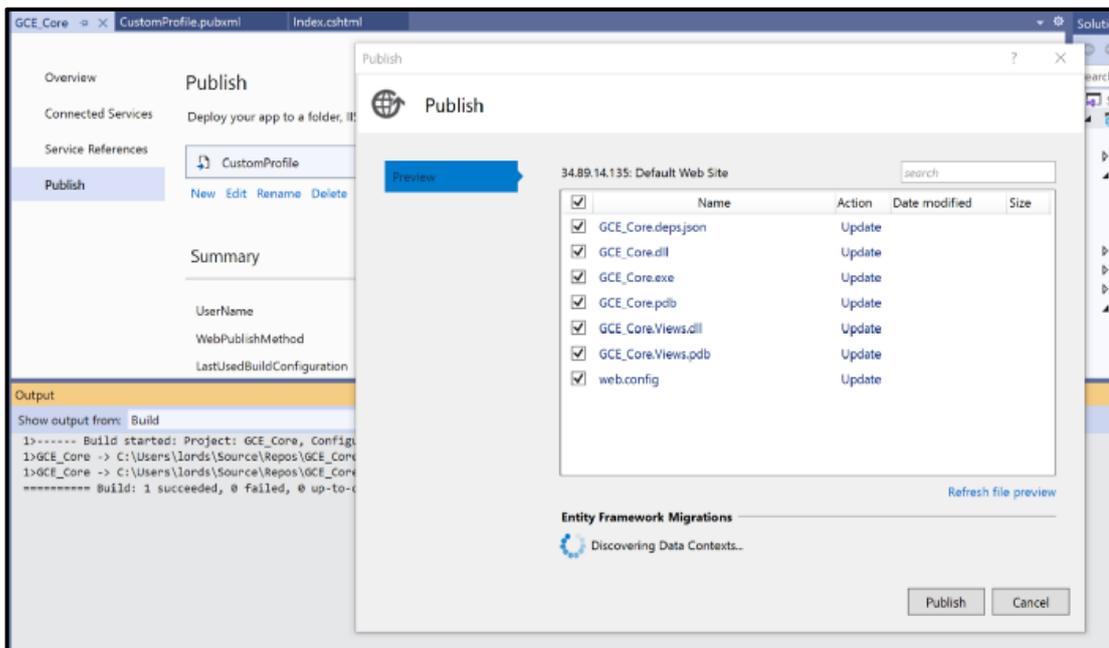


Figure 4.19 Preview Option

### 4.3 Experimental Result

The proposed system is simulated using C# (asp.net) language in window 10 PC. This system uses Google Cloud with four backup servers. And then this system simulate by using ASP.NET version 4.5.2 and Microsoft SQL version 10.0.2573.0. This system can use in all operation system (Linux, Window, Max). The files are stored in our servers until you delete it and this system make uploading and recovering your files quick and easy. You can store in our servers for many different file types and sizes. The investigation is directed by taking various kinds of documents and their sizes as displayed in table 4.1.

**Table 4.1 Various Kinds of Documents and Their Sizes**

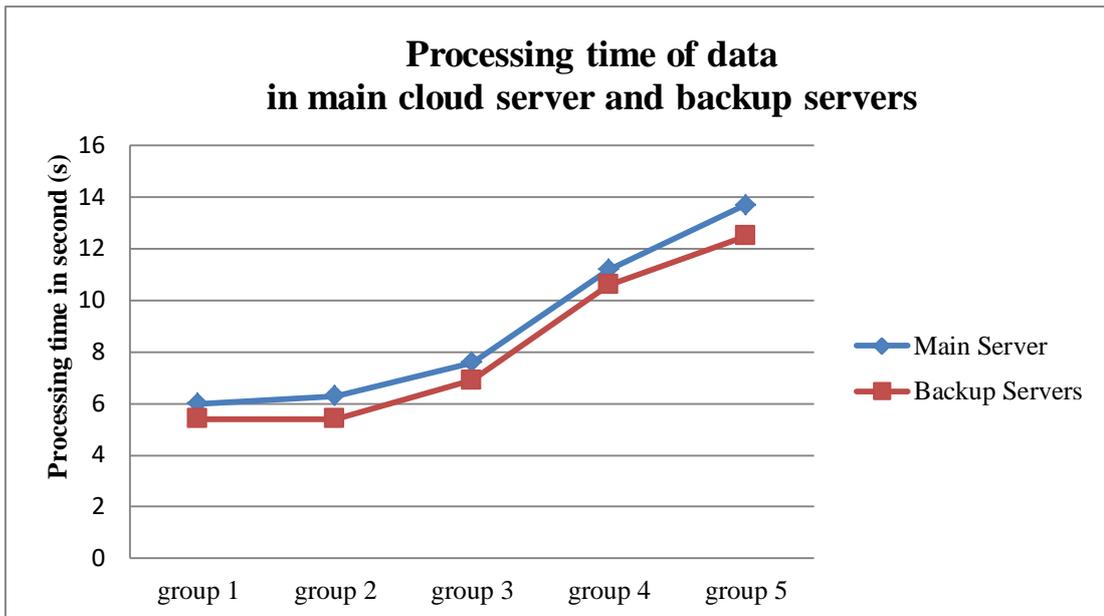
<b>Type</b>	<b>File Size</b>	<b>File size in remote servers</b>	<b>File size of recovered file</b>
<b>.txt</b>	<b>250KB</b>	<b>250KB</b>	<b>250KB</b>
<b>.pdf</b>	<b>580KB</b>	<b>580KB</b>	<b>580KB</b>
<b>.jpg</b>	<b>30KB</b>	<b>30KB</b>	<b>30KB</b>
<b>.png</b>	<b>40KB</b>	<b>40KB</b>	<b>40KB</b>

**Table 4.2 The Percentage of the Originality of Recovered Files with the Different Numbers of Files and that are Different Sizes**

<b>No.</b>	<b>Size Range (KB)</b>	<b>Number of Recovery Testing Files</b>	<b>Percentage of recovered file size with respect to original file size</b>	<b>Recovery Time (Time consuming)</b>
Testing Group 1	10 – 50 (KB)	100 files	100%	5s
Testing Group 2	100 – 1000 (KB)	100 files	100%	5s
Testing Group 3	1001–10000 (KB)	100 files	100%	6s
Testing Group 4	10001– 100000 (KB)	100 files	100%	10s
Testing Group 5	100001-1000000 (KB)	100 files	100%	12s

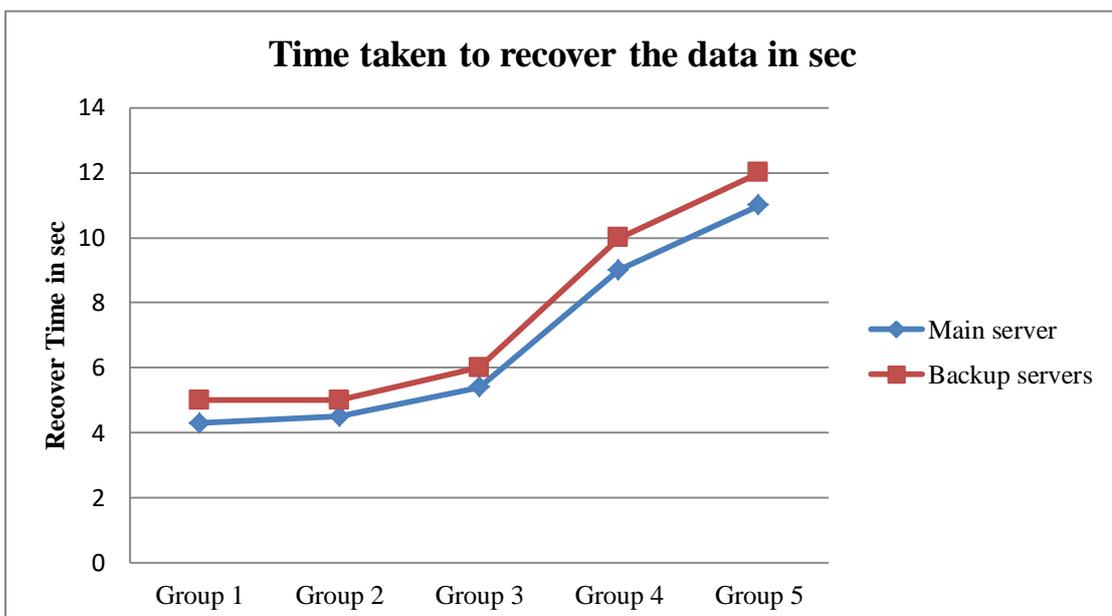
In these experiments, there are five groups of files according to the data volume ranges. This system mainly emphasized on data recovery for zero data loss. So, this system can prove zero data loss according to the experiment results of table 4.2. The recovery time in delay point of view is an acceptable minimum time as shown in the above table.

Figure 4.20 shows processing time of data in main cloud and backup server. The processing time is not significantly change between data size in 10 KB to 1000000 KB. The cloud backup server processing time has less than main server processing time.



**Figure 4.20 Processing Time of Data in Main Cloud and Backup Servers**

The next figure 4.21 shows the data recovery time in seconds. The files have been deleted from the main servers; it is time to recover the files from the backup server. On the off chance that the file is erased or not found on the main cloud server, it will be retrieved from the backup server. There is the four-cloud servers strategy when information is erased or not found in the main cloud, the information stays on one backup server and afterward recovers the information from another backup.



**Figure 4.21 Time Taken to Recover the Data**

The benefits and burdens of all the above-examined procedures from related works are depicted in table 4.3. Also, because of the great applicability and need of backup processes in many organizations and undertakings,

**Table 4.3 The Advantages and Disadvantages of Techniques from Related Works and Proposed Technique**

No.	Approach	Advantages	Disadvantages
1	DR-Cloud version	<ul style="list-style-type: none"> <li>- less cost</li> <li>- provides privacy</li> <li>-high accuracy in repair and retrieval of data</li> </ul>	- Different file formats not supported
2	Advanced Encryption Standard (AES) and Seed Block algorithm (SBA) technique	<ul style="list-style-type: none"> <li>- Reliable</li> <li>- Privacy</li> <li>- Less amount of time</li> <li>- Integrity</li> <li>- Confidentiality of user data</li> </ul>	- High complexity
3	Cloud mirroring method	Cost to recuperate the information is additionally less.	High data transfer capacity, Complete server backup at a time
4	Parity Cloud Service (PCS)	- Reliable, Privacy and Low cost	- High complexity
5	HSDRT	- Used for movable clients	- Costly - Increased redundancy
6	Cold/Hot Backup Strategy	-Triggered only when failure detected	- Cost increases as data increases
7	Proposed Technique (Enriched Genetic Algorithm)	<ul style="list-style-type: none"> <li>-Exact match retrieval, privacy.</li> <li>-Recovery time is not enormously increases as data increases</li> </ul>	-Increased complexity

## **CHAPTER 5**

### **CONCLUSION**

Cloud computing is recently new technological development that has the potential to have a great impact on the world. It has many benefits that it provides to its users and businesses. For example, some of the benefits that it provides to businesses are that it reduces operating cost by spending less on maintenance and software upgrades and focus more on the businesses itself. But there are other challenges the cloud computing must overcome. People are very skeptical about whether their data is secure and private. There are no standards or regulations worldwide provided data through cloud computing. Europe has data protection laws but the US, being one of the most technological advance nation, does not have any data protection laws. Users also worry about who can disclose their data and have ownership of their data. But once, there are standards and regulation worldwide, cloud computing will revolutionize the future.

Now a day's large amount of data is stored in the cloud and becoming very important to all the organization. The four backup server's concept is used to recover the deleted data. The experimental result section show the proposed method has reliable and efficient. Because user files can recovery from any back server among four backup servers in the case of data loss and although the data size increases, the recovery time does not increase.

#### **5.1 Advantages of the System**

By using this system, the users would not be worry to loss data in cloud servers. The proposed system consists of the cloud recovery section which will precede the failure file request transaction to become a successfully completed transaction. So, this system is reliable for the data loss recovery during file request transaction processing because of the original database and cloud data backup are parallel stored. The system can also prove zero data loss according to the experiment results and the data can be retrieved when extract match of hash code. So this system has privacy and recovery time is not enormously increases as data increases.

## **5.2 Limitations of the System**

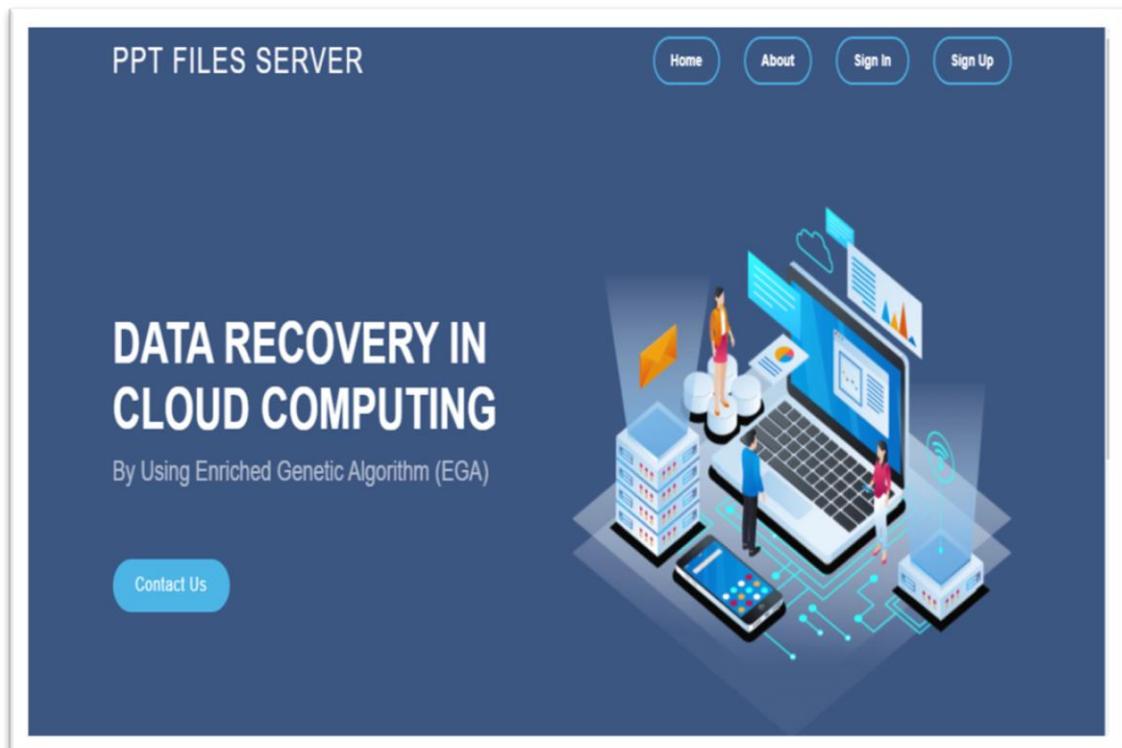
There are some limitations in this system. This system based on cloud storage. So, it is dependent on having an internet connection. If you are on a slow network you may have issues accessing your storage. In the event you won't be able to access your file. This system can upload and recovery files with the following extensions: pdf, doc, docx, txt, jpg, jpeg, png, xlsx, xls, pptx, and log. This system is not possible to restore files residing on network drives or on rewritable CD/DVD discs.

## **5.3 Further Extensions**

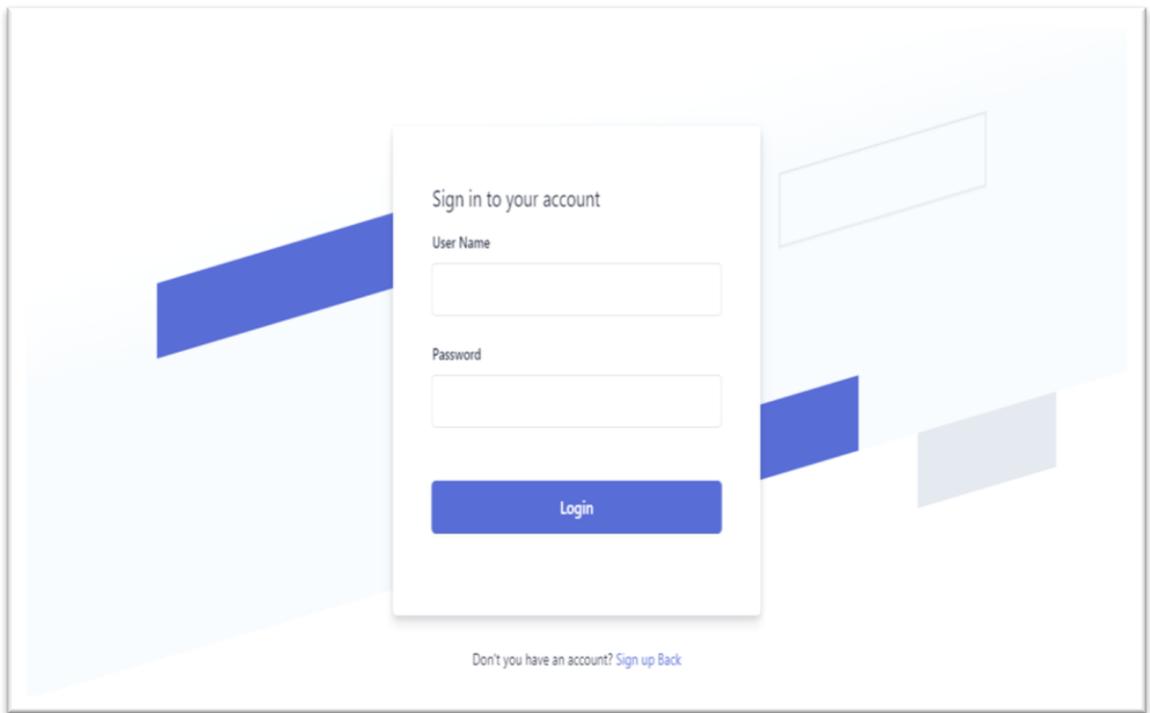
The software discussed above is a great effort to bring more effectiveness to the whole system of recovery of files on cloud. There is a scope for modification an upgradation in the future. The author tend to add additional functionality of assigning a specific amount of free space for a user on the drive and ask the user to pay for additional space, if required. The owner of the file will have read, write and execute permissions, by default and he/she can assign privilege permissions to a specific number of users as desired.

## APPENDIX A

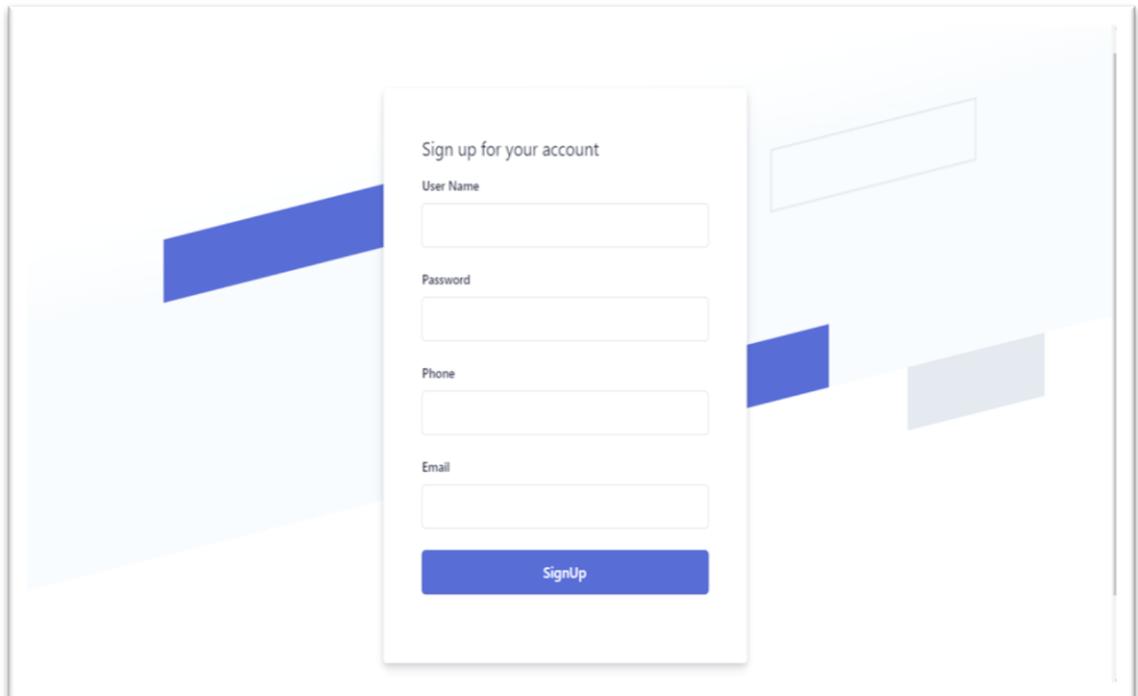
This system will start with the main page as shown in figure A-1. But this system can only be used by registered user to maintain the data security and privacy. So, the new user must be registered / sign up first. Then, the registered user can be entered the system via log in page. The sign up page and log in page of the system are shown in figure A-3 and figure A-2.



**Figure A-1 Main Page of the system**



**Figure A-2 Sign in page of the system**

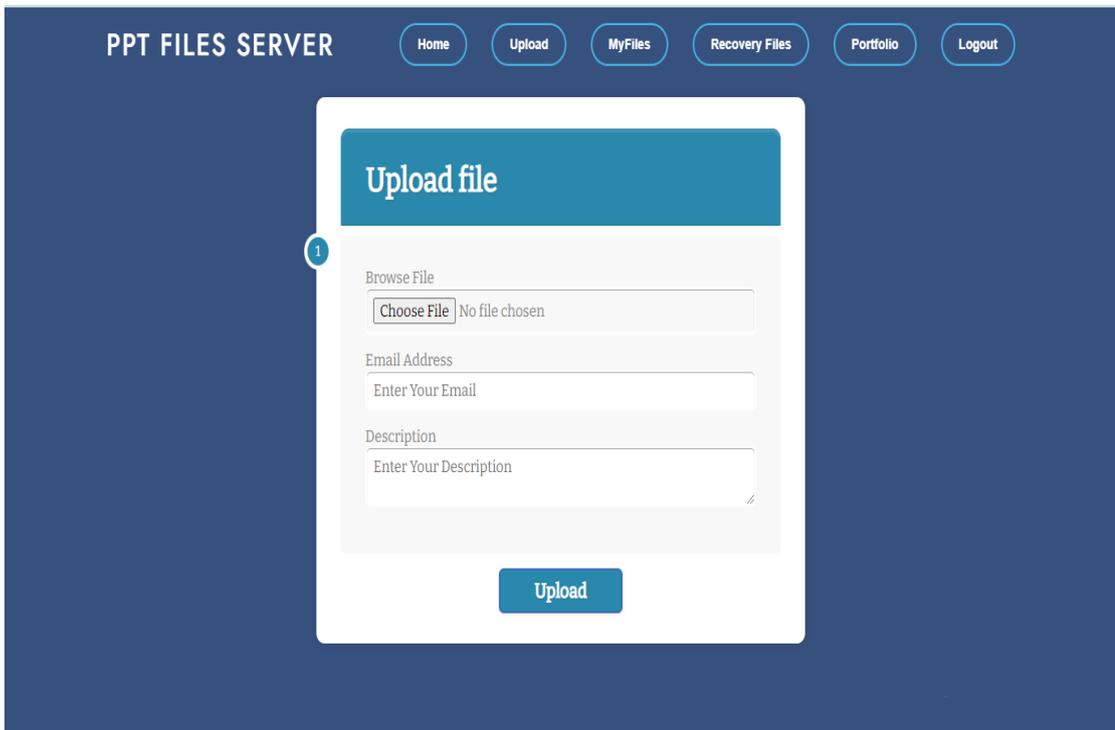


**Figure A-3 Sign up page of the system**



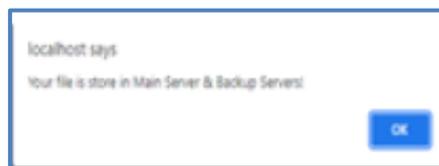
**Figure A-4 'My-File' Page**

Authentication is the act of establishing or confirming something (or someone) as authentic, that is that claims made by or about the subject are true. This might involve confirming the identity of a person, tracing the origins of an artifact, ensuring that a product is what it's packaging and label claims to be, or assuring that a computer program is a trusted one. The system will permit the system users if their login name and password is correct. And then the system user can access the data by their respective privacy control. This is called authorization. After login success the system will be taken to 'My Files' Page as figure A-4.



**Figure A-5 Upload page of the system**

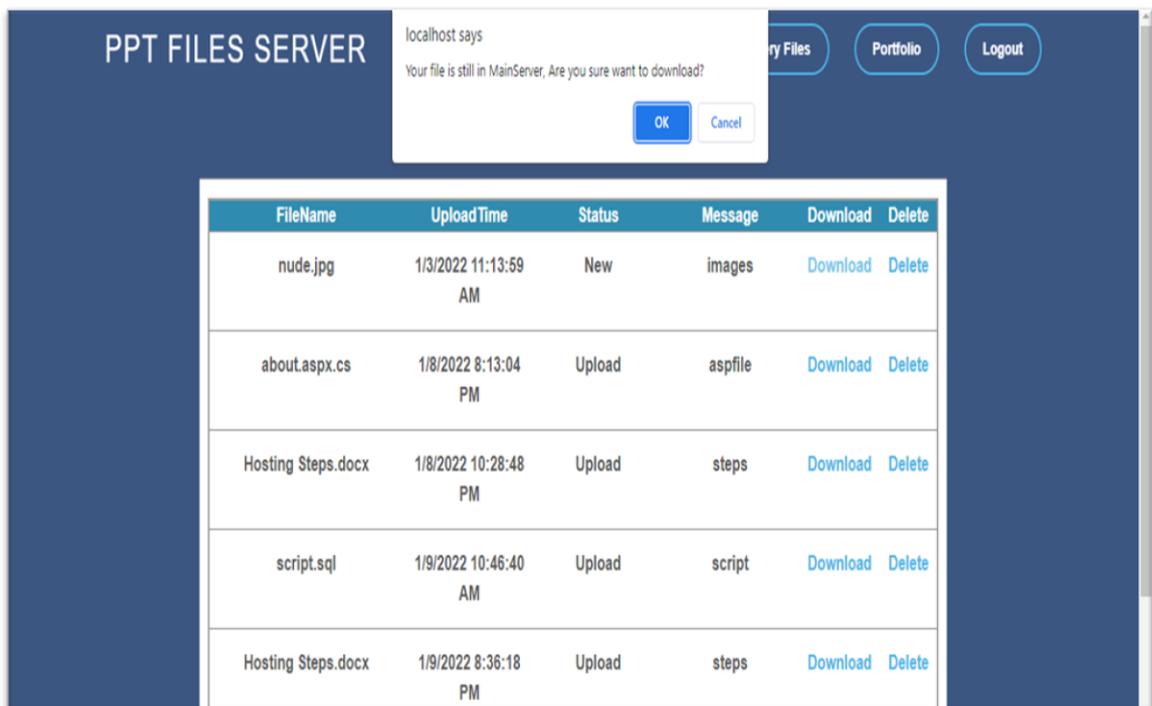
The next step after the login is uploading the file in figure A-5. After user uploads the file, the system generates the hash code H1 automatically for particular file using the MD5 algorithm and stores that file in the system's server. If user wants to retrieve the file from cloud then the system is searches in main cloud server firstly and downloads from the main server. After file upload successful 'acknowledge message' will be show as figure A-6.



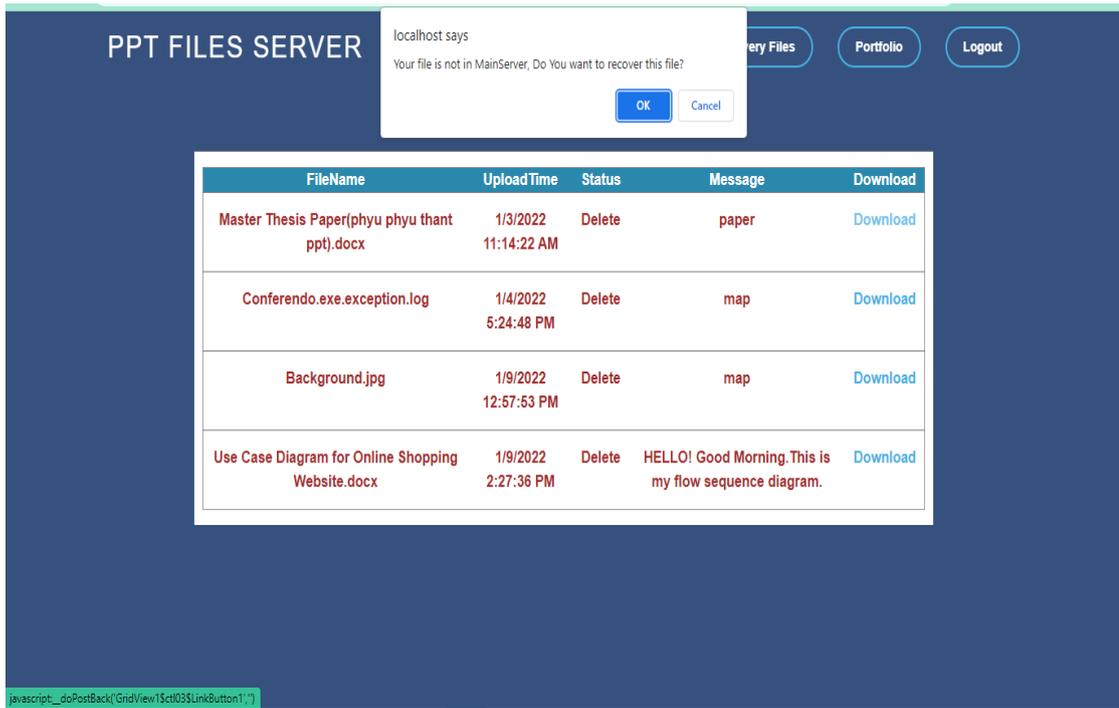
**Figure A-6 Acknowledgement Message of File Uploading Complete**

In File uploading module, client needs to choose the document to upload to cloud by choosing the quantity of duplicates of replication expected to store. While transferring charm application will select the document size in kb. Then, at that point, it will choose the best cloud storage server in view of the capacity accessibility, estimating cost, indicator, size and so on for honesty Verification process it will create the Hash Key (HK1) utilizing MD5 calculation and it will keep it in the client DB. At long last in view of the Replication subtleties the File will be put away in the Cloud Storage Server.

If the user want to download document that exist in ‘My Files’ page (exist in Main server), the acknowledge message will be show as figure A-7.

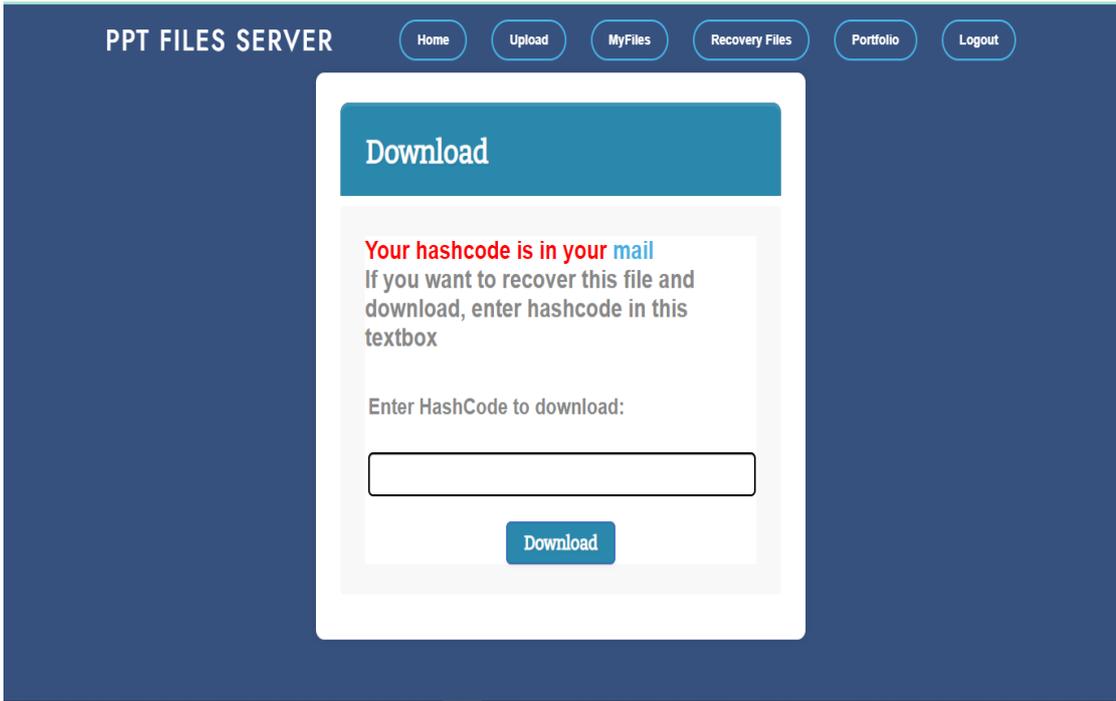


**Figure A-7 Downloading File from Main Server**



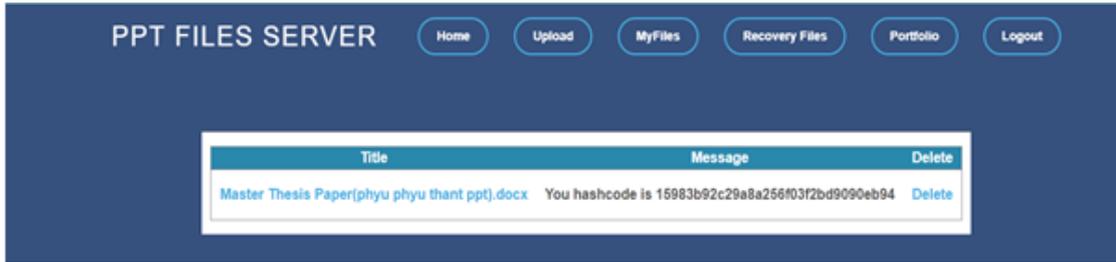
**Figure A-8 Acknowledgement of File Lost in Main Server**

In the case of data loss due to any reason such as natural calamity, man-made attacks, and server crash, file on main cloud server which gets deleted or crashed. If the data is not present in main server then the system searches the file from any backup server and generates hash code H2. The system will generate the acknowledgement for the lost file as shown in figure A-8. To download the deleted file, the user must type hash code H2 in the text box firstly as figure A-9.



**Figure A-9 Hash Code Submitting Page for Recovery**

The user can find hash code H2 from the mail box as figure A-10. After typing the hash code H2, the system fetches the hash code H1 from the database. If the hash code H1 and H2 are match, the user can retrieve the original file and the system restores the original file in the main server.



**Figure A-10 Mail Box of System**

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