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OTP Generation Process

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Highlights

Recursive Quantum Network

Effective Authentication Scheme

Discovering Thoughts, Inventing Future

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An Effective Authentication Scheme for Distributed Mobile Cloud Computing Services using a Single Private Key

By Mrs. Kavitha K K & Avinash B
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Abstract- Mobile cloud computing comprises of cloud computing, mobile computing and wireless network. Providing secure and convenience for the mobile users to access multiple cloud computing services is essential. This paper furnish an effective way of providing the authentication for the mobile users to access multiple cloud computing services. The proposed scheme outfit a secure and expediency for mobile users to access several cloud computing services from multiple service providers using a single private key. Our proposed scheme is based on bilinear pairing cryptosystem. In addition, the scheme also supports mutual authentication, key exchange, user anonymity. To overcome the vulnerabilities of traditional methods, from system implementation point of view, the proposed scheme eliminates the usage of verification tables that are required to store the user credentials(user ID and password) which are the part of smart card generator service and cloud computing service provider.

Keywords: smart card generator (SCG), mutual authentication, ID based cryptosystem, bilinear pairing cryptosystem, identity provider (Idp).

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I. Introduction

Due to abundant benefits and possibilities that are provided by Cloud computing there is a rapid growth of users in the recent years. As the report from Juniper Research estimates that the number of unique consumers accessing cloud-based services will exceed 3.6bn by 2018, rising from an estimated 2.4bn in 2013 [1]. This expeditious development has been revolutionized in number of areas. In early days of computing, huge scale machine and mainframe computers were used to implement various task and applications. Now a days, we are doing the same tasks, but in flexible, much cheaper, and are in portable manner, either by desktop computers or mobile devices(such as, smart phones, tablets, etc.), with several type of services tied, so called Cloud Computing System(CCS). The user can use services and application on the cloud through internet.

However, In the recent years, there is a rapid growth in the mobile application due to increase in the popularity of smart phones. Mobile devices have started becoming abundant with application in various categories such as entertainment, health, games, business, social networking, travel and news [2]. The reason for this is that mobile computing is able to provide a tool to use the user when and where is needed, irrespective of user movements, hence supporting location independence. So the development mobile cloud computing become an important research in this mobile oriented world. The general purpose[3] of mobile cloud computing is, a public system is built need uses the cloud infrastructure, to contribute in improving mobile device performance efficiency.

In this paper, an effective authentication schema for the distributed mobile cloud computing is proposed. This schema uses a single private key for the authentication of multiple service providers [4]. Earlier, in one mobile user authentication only the target cloud service provider need to interact with the requestor (user). As the mobile user generally access different mobile cloud computing services, it is very tedious for user to register different user accounts on each service provider and to maintain them. The proposed schema is built upon bilinear pairing[5]. And therefore, requires less computation resources on both mobile devices and service provider. Through this, a user can get access to multiple service providers using a single private key, provided both mobile user and service provider should know the identities of each other.

II. Related Work

Today, providing access to right user is the major concern. There should be a right mechanism that prevent the illegal access from unauthorized user. Authorization schema is the security mechanism for the network based services. Traditionally, authorization schema's user traditional public key cryptosystem such as RSA, which requires lengthy key size and utilizes the maximum of computational resources on the mobile devices. Since mobile devices be short of resources, traditional authentication schema are inappropriate to use. Therefore an efficient schema is required, which is beneficial for the mobile device.

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In the recent years, many ID based cryptosystem [6] have been proposed. An ID based cryptosystem is the public key cryptosystem that resolve the issues with the traditional public key cryptosystem. In the proposed system, an ID based cryptosystem is based on bilinear pairing in an elliptic curve.

III. Proposed System

In this paper, an user authentication schema is based on bilinear pairing for distributed mobile cloud computing. The proposed system supports mutual authentication, key exchange, and user untraceability.

The following are the benefits that are preserved by using this authentication scheme.

i. The key size provided by ECC is much smaller compared to the size provided by the traditional public key cryptosystem.
ii. Since the public key is used as a identity of the user, the computational cost to verify other public keys are eliminated and the storing space of other public key is not required.
iii. The user must access multiple service provider, it is important for the user to manage multiple keys provided by each service provider. This problem is resolved by sharing the same private key by all the service provider.

The trusted smart card generator (SCG) is used in the proposed system as the third party, that eliminates the use of identity provider (IdP), which is used by other system for the user authentication. There are three characters in the scheme: mobile user, mobile cloud service provider and trusted SCG service. In our scheme, the user is assigned a smart card, which is being modified by some parameters during the user registration phase. The usage of this smart card makes the system make more protected by avoiding the user from distributing their login credentials. By this the scheme effectively prevents the situation of many logged in users with same login ID. Typically the registered user share his credentials so that other who know the login-ID and password can login successfully. In this scheme, the login request is created by the smart card using its stored secret component without any human intervention. It is extremely difficult to extract the secret component from the smart card, and thus the user cannot share it with others. Even if the legitimate user's password is shared with others, the other person cannot login to the system without the smart card. Once a valid user logs into the remote system, his smart card will be inside the terminal until the user logs out. If the user pulls out the card from the terminal after login the remote system, the login session will be immediately expired. Thus, the scheme can successfully prevent the scenario of many logged in users with the same loginID.

The scheme consist of three phases: set up phase, registration phase, and authentication phase. In the rest of the paper, we give preliminaries of these three phases based on bilinear pairing cryptosystem [7].

Preliminaries

a) Bilinear pairing

Let G_1 the cyclic additive group generated by P, whose order is Q. G_2 be the multiplicative group of same order. A map $e : G_1 \times G_1 \rightarrow G_2$ is called bilinear mapping if it satisfies the following properties.

a) Bilinear: $e(aP, bQ)=e(P,Q)^{ab}$ for all $P,Q \in G_1$ and $a,b \in Zq^*$.
b) Non degenerate: there exist $P,Q \in G_1$ such that $e(P,Q) \neq 1$.
c) Computable: there exist an efficient algorithm to compute $e(P,Q)$ for all $P,Q \in G_1$.

In reality, G_1 is the group of points on an elliptic curve Zq^* and G_2 is the subgroup of multiplicative group of finite field $Z^*_q{}^k$ for some $k \in Z_q^*$.

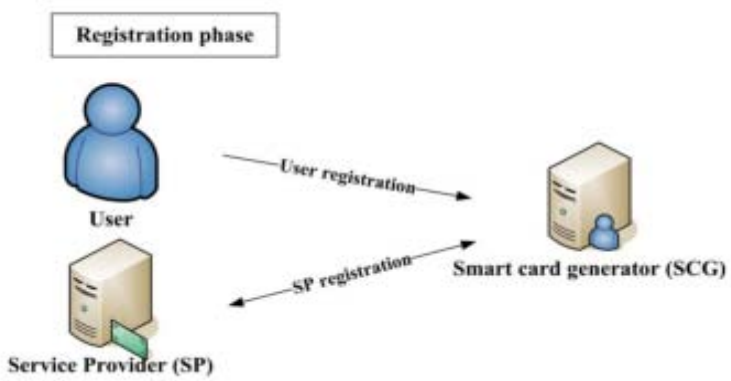
b) Set up Phase

During set up phase, the smart card generator select the random number and computes its master private key (s). With this master private key it also generates public key and public parameters.

Suppose G_1 is an additive group and G_2 is the multiplicative group of order q and suppose P is the generator of G_1, then $e : G_1 \times G_1 \rightarrow G_2$ is called bilinear mapping, $H: \{0,1\}^* \rightarrow G_1$ is the cryptographic hash function. Selects a master private key s and computes public key as $Pub=sP$. Then publishes the public parameters $(G_1, G_2, e, q, P, Pub, H)$ and keeps s secret.

c) Registration Phase

The registration phase is executed between the SCG and the mobile users. The mobile who wishes to join the network and utilize the service can join the network by sending the identities to the SCG. Even the SP's also requested to register with SCG in this phase. With the identities provided, the SCG generates the public key for each mobile user and SP, then dispatches it to corresponding user or SP securely.

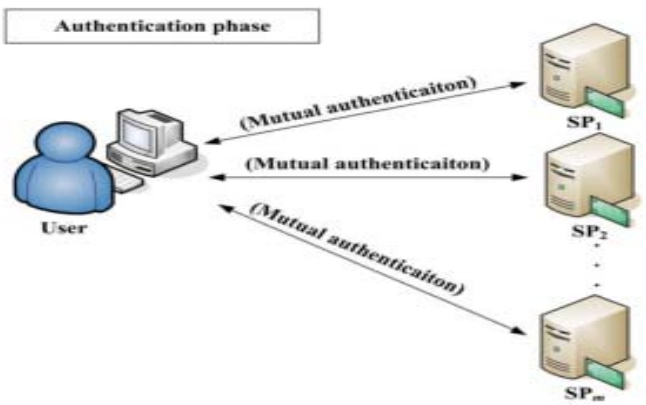


This phase is executed by following steps when user wants to register.

i. Suppose a new user U_i wants to register with SCG.
ii. U_i submits the identity ID_i and password PW_i.
iii. On receiving the request, the SCG computes $Reg_{id} = s.H(ID_i) \mid H(PW_i)$.
iv. The SCG initializes the smart card with the parameter IDi, Regid, H(.) and send the smart card to the U_i over a secure channel.
v. The SCG initializes the smart card with the parameter ID_i, Reg_{id}, $H(.)$ and send the smart card to the U_i over a secure channel.

d) Authentication Phase

This is executed when the user logs into the system. This phase is further divided into login phase and verification phase.



i. *Login Phase*

The user U_i insert the smart card in a terminal and enter ID_i and PW_i. The ID_i is identitical to one that is stored in smart card. If the credentials are same then sends the login request to the corresponding SP.

i. Computes $DID_i = T.Reg_{id}$, where T is the user system's timestamp.
ii. Computes $Vi = T.H(PW_i)$.
iii. Sends the login request $(ID_i, DIDi, V_i, T)$ to the SP over a public channel.

e) verification Phase

The SP receives the login message (ID_i, DID_i, V_i, T) at time $T^* (\geq T)$. Over receiving the login request the SP does the following operations.

i. Computes the time interval between T and T^*. If $(T^* - T) \leq \Delta T$ then SP proceeds to step ii. Otherwise rejects the login request. ΔT is the expected time interval between transmission delay.
ii. Checks whether $e(DID_i - V_i, P) = e(H(ID_i), Pub)$. If it is valid, the SP accept the request , else rejects it.

During this phase, the mobile user and service provider are able to authenticate without the intervention of SCG. And therefore reduces the time required by the trusted third party to verify the user. The session key is also generated during this phase to encrypt/decrypt the messages sent between user and service provider.

f) Password Change Phase

This phase is executed when the user wants to change the password. The proposed scheme allow this step to execute without the intervention of the SCG. The user insert the smart card into the terminal and keys ID_i and PW_i. If ID_i is matching with the value stored in smart card then allows the user to change or it terminates the operation. The phase works like this.

i. U_i enters the new password PW_i.
ii. The smart card calculates $Reg_{id}^{*} = Reg_{id} - H(PW_i) + H(PW_i^{*}) = s.H(ID_i) + H(PW_i^{*})$.
iii. The password has been changed to the new password PW_i^{*} and the smart card restore the value of Reg_{id} with Reg_{id}^{*} value.

IV. Resilience of Proposed System

a) Security

The proposed scheme can resist to the following attacks:

i. *Replay Attack*

Suppose an adversary tap the login request from the valid user, the SP receive the request at time T_{new} . The SP calculates the time interval (T_{new}-T) and compares with expected time interval delay (ΔT) which exceed the value. And therefore the attack fails.

ii. *Forgery Attack*

From the valid login message, an adversary can get only get ID_i, DID_i, V_i and T. from these values an adversary can't find any use full information. Though $DID_i = T. Reg_{id}$, this does not reveal any information needed since the Reg_{id} kept secret.

iii. *Insider Attack*

In password based user request, the trusted third party maintains a separate table called verifier table for storing the user credentials. Since in our proposed scheme, the login request is based on user's password as well as the secret key *s*, and thus it eliminates the usage of verifier table.

V. Conclusion

The scheme prevents the adversary from forgery attacks by employing a dynamic login request in every login session. The use of smart card not only makes the scheme secure but also prevents the users from distribution of their login-IDs, which effectively prohibits the scenario of many logged in users with the same login-ID.

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Cloud Computing Distilled: What the Practitioner Needs to Know

By Harvey Hyman
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Abstract- While cloud computing has moved to the forefront of strategic IT initiatives in recent years, only a few articles have focused on the basic fundamentals, and none have been written with the practitioner in mind. This article presents a basic, yet comprehensive discussion on what cloud computing is, and how it works.

The article identifies and describes the core concepts that an IT manager should know about cloud computing, and provides simple explanations for how the fundamental methods of cloud are used and their impacts upon business processes. This article divides the technology of cloud computing into four distinct categories: service models, delivery architecture models, virtualization and performance.

We describe three service models of SaaS, PaaS and IaaS, three architecture models of public, private and hybrid cloud, explain how virtualization technology works, and discuss the current trends in performance factors of HA, FT, scalability, optimization, control and management.

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I. Introduction: Defining Cloud Computing

What is Cloud Computing? There are three general ways to define it. An operational definition of cloud computing is "utility computing." A descriptive definition for cloud computing is service-based, or resource-based computing. A practical definition is simply "pay as you go" computing [1]. All of these descriptions of cloud are correct, and they reflect the two main impacts of cloud computing upon business: scalability and leverage [2], [3]. We discuss these impacts later in the paper, as well as the business and individual advantages to using cloud computing.

In this article we treat the use of cloud computing in terms of "leveraging third party resources, communicated across a network" to support one's individual or organizational computing needs. The goal here is to divide the use of cloud computing into four simple groupings: service models, delivery architecture models, virtualization, and performance. We describe and explain each grouping in the sections that follow. We begin with the three main models of cloud computing services: SaaS, PaaS, and IaaS [2].

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II. Cloud Delivery Models: SAAS, PAAS, IAAS

The general consensus starting point for a framework for discussing concepts in cloud computing is the 2009 article by Armbrust et al., entitled "Above the Clouds" [1], [4]. While there were a few earlier articles [5], [6], theirs marked the first significant attempt to comprehensively define the emerging landscape coined as *cloud computing* by identifying developing categories in the technology, models, and services evolving as the core constructs that make up the "cloud." Over last six years since the release of Armbrust et al., several studies have been working toward a consolidation of the domain constructs into a paradigm to guide academic research and industry practice [4].

The first area of consolidation is in regard to service delivery models. For the past several years there has been an overabundance of descriptive service models. This has not been very helpful. Instead of providing a clear path for guiding researchers and practitioners alike, toward the most productive resources to focus upon, a plethora of service delivery models had led to a murky field of definitions and a glorified "thinking out loud" about the next would-be "potential of the day" in cloud computing services. This overabundance has culminated in the catch-all phrase XaaS or "everything as a service" – not very informative or focused. One might as well use the term AaaS – for "*anything* as a service."

The general consensus, both in academic and practitioner circles is that cloud service delivery models have been consolidated into three distinct categories: SaaS, PaaS, and IaaS.

SaaS, stands for Software as a Service. This delivery model is most commonly associated with the term *thin client* and software accessed via a web browser. Think of this model as *user-facing*. This is the choice of delivery for end-users who wish to access a hosted application such as common business applications. The operative description here is *software applications that are subscription based and internet hosted*.

The main significant factor with SaaS as a service delivery model is the centrality and control in distribution. Instead of deploying multiple copies of a software application, SaaS allows for a single copy to be

accessed by the end-user. The specific advantages here are versioning and policy – both of which can be controlled almost instantly by updating the application host. In technical terms, SaaS supports a *multi-tenant architecture*. This means that all customers of the service use the same single version of the software application with the same single configuration of hardware, OS, and communication network. If we want to support more than one version of an application, another means of SaaS distribution would be the use of individual virtual machines (VMs), each supporting a different configuration or version of the application. This is explained in greater detail later.

PaaS, stands for Platform as a Service. Think of this model as *developer-facing*. In practical terms it is really just a more robust variety of SaaS. This model is most commonly associated with providing development, deployment and maintenance support for a web-based application. You might also think of this model as a lifecycle approach – beginning with developing the application and ending with hosting and maintaining the application. This is the type of solution a business would use to deploy an application to be used as a SaaS by its customers.

Some technical analysts might distinguish SaaS from PaaS in terms of where the user's data lives. For example, SaaS is sometimes viewed as merely providing processing, and the data itself begins and ends on the user's local machine, whereas the "platform" in PaaS is viewed as providing the container for everything, including the residence of the user's data.

This distinction highlights a significant concern when relying on cloud computing for a business solution – when the connection is down, so is the service, there are no local copies as with the traditional client deployment model. There is also the potential for "data lock," not discussed in this article.

IaaS, stands for Infrastructure as a Service. This model is the most aligned with the cloud definition of "utility computing." In this service delivery model, we are no longer focused on the individual end-user. In this model the customer is defined as an organization, and the service is defined as computing resources. Think of this model as the configuration of a computing backbone that supports an entire enterprise. An IaaS provider supplies a pool of resources for the three computing components of CPUs, memory, and storage. The technologies most closely associated with IaaS are virtualization, provisioning, and instances. These are discussed in the sections that follow.

In the interest of providing complete information on the subject of service delivery models, we need to acknowledge that over the past several years there have been numerous variations of service oriented computing such as IDaaS (Identification), BaaS (backend), STaaS (storage), EaaS (email), (enterprise), (everything). However, the industry has consolidated service models into the main three described above, with all other variations of service deliveries over the cloud having been merged into the main catch term XaaS – everything as a service, also eponymously written as *aaS or EaaS.

III. How Does Cloud Computing Work? Virtual Machines and Hypervisors

What the IT manager needs to know is that there are three main components to a Cloud Computing solution: Virtual Machines (VMs), Hypervisors (VMM), and Hosts (servers). The remainder of this section will explain what these components are, the purpose they serve, and how they work.

A quick note to the reader here: Virtualization does not make the cloud work, but it allows for the best features of cloud to be provided. Specifically, virtualization allows for scalability, high availability, fault tolerance, optimization, management, and control. These features will be explained later in the article.

Remember, cloud computing is a construct, meaning it is not a technique, in and of, itself. Instead, one should think of cloud computing as a *collection of computing technologies* that support the goal of resource-based, service-based, utility computing.

Remember also that, cloud computing is the ability to access computing services over a network. Cloud computing provides these services by making use of the core technology of virtualization.

The definition of virtualization is "software acting like hardware" or "software taking the place of hardware" or "software emulating hardware" or "software functioning as hardware" [7], [8]. Take your pick, but the concept remains the same. The purpose of virtualization is to increase the capacity of physical hardware by creating multiple virtual environments (VMs) on top of them [8].

The modern virtualization model focuses primarily on the virtual machine (VM) and the hypervisor (VMM), but, like cloud computing, virtualization is more akin to a collection of technologies than a specific technique itself. Meaning, the significance of virtualization is not limited to its application of the VM and the VMM. There are also vLANs to take the place of physical LANs, and vSwitches to take the place of physical switches. Both of which are examples of using software to take the place of hardware with the goal of supporting easier configuration, greater control, scalability, and increased capacity. For an excellent discussion on virtualization techniques applied across the enter enterprise resource pool see reference [9].

Now, for a little history on the origins of the concept of virtualization, early work on virtualization and the use of virtual machines (VMs). The concept of virtualization and the virtual machine dates back to, at

least, the 1950s and the use of mainframes, followed by work in the 1970s on "Grid Computing." [7], [8]. See the referenced Popek and Goldberg article for a good discussion of the 1970s view on virtualization and the VM.

A VM is an "isolated duplicate" [7] of a physical machine. In the practical sense, think of a VM as a separate, isolated container that provides an entire computing environment – this is also known as *provisioning* an *instance*, explained in more detail later.

The hypervisor, which has historically also been called the VMM or virtual machine monitor, [7] also sometimes referred to as the "controller program," [7] is the software application that supports the VM environment. The hypervisor is what allows a single server (also called the host) to support multiple guests (VMs) [7]. The number of VMs is only limited by the total number of physical resources available from the host [8]. So, for example, if there are 20 CPUs available on the host, then up to 20 CPUs can be allocated to the various VMs to be created. An important thing to remember here is that there must always be some reserve for the host itself and for the hypervisor itself, as well as the VMs they are supporting [8].

There are two models for running a hypervisor: Type I and Type II. In a Type I installation, the host is the bare metal server. In this case, the hypervisor "presents" the environment to the VM and serves all resource requests from the OS residing in the VM container [9].

In a Type II installation, the hypervisor sits on top of the existing OS and relates resource requests to the underlying OS, which then fulfills the requests. A common example of this use case is an individual user who downloads an application as an appliance, and runs that appliance in a free virtual machine (typical examples are MS Hyper-V or Oracle Virtual Box) on their laptop or desktop. An application as an appliance is a complete package version of an application that includes everything it needs to run on a bare minimum OS environment – hence why it is a very popular choice for individuals who prefer an application that comes preconfigured for a virtual environment (think a VM wizard). A type II hypervisor model is also handy for presenting a testing environment for a development team that may wish to install specific versions of an OS or a legacy application without impacting the native host or larger resource pool.

IV. Types of Clouds: Public, Private, Hybrid.

Public, private, and hybrid clouds are three leading types of cloud architectures that have emerged as the main conceptual descriptions for the deployment of cloud computing configurations.

In the past several years there have been other variations of cloud architecture offered to explain ad hoc configurations such as *community cloud, distributed cloud, inter-cloud,* and *multi-cloud*. However, for the most part, the industry has consolidated cloud provider models to the main three described here.

The public cloud describes a computing architecture whereby the user's instance is drawn from a shared pool of resources. This is also called multi-tenancy. The main advantage here is for the small business user who wants to "spin up" or "tear down" a web based computing application or service, and does not require specific hardware or software configurations or have particular security concerns. The public cloud is most closely associated with the "pay as you go" business model for cloud computing. The security aspect is particularly important to note here given that the user's instance is based on the shared pool of resources and not dedicated to the user as would be in a single tenant model. This model is associated with managed solutions common supplied by AWS and Azure.

The private cloud describes a computing architecture whereby the hardware, storage and communication network is dedicated to the organization. This is called single tenant. This model is associated with users whom require custom configurations, have specific hardware, software or network requirements, have higher level security concerns such as HIPAA or other compliance issues, and desire greater control and management of their computing resources. This model is not a "pay as you go" model due to the dedicated nature of the hardware and software pool.

The hybrid cloud is more of a scalability solution than an architectural model. Hybrid cloud covers situations whereby an organization requires the flexibility to temporarily expand their computing needs such as increased CPU for processing power, added storage, or additional memory allocation.

In this use case, an organization may have a custom configuration of dedicated hardware, software and network communication, but requires additional resources to temporarily scale up a service or process. The organization can achieve this temporary increase in scale by extending into the public cloud. This allows the organization to take advantage of the "pay as you go" approach for the additional scale up, and release those resources when no longer needed, all the while maintaining their custom configuration to meet their unique business needs.

V. Provisioning and Instances

What is Provisioning? Simply put, provisioning is the allocation of computing resources. The resources are configured as an **instance**, which is the specific operational deployment of computing resources to support a particular business process [10], [11]. A good

use case example is an organization that wants to run a Hadoop application. The cloud provider will "provision" an "instance" of a Hadoop cluster, or "spin up a VM" configured for this purpose. This allows the organization to horizontally scale the Hadoop application, using as much compute, memory and storage as needed.

When we think of provisioning an instance from a pool of resources, we begin to think of this implementation as a computing cluster [12]. A cluster is comprised of nodes. Think of nodes as individually configured CPU, memory and storage elements combined in a manner to support the required business process. This is an example of optimization, whereby a provisioned instance is matched to a specific performance requirement. This is discussed in more detail in a later section.

The cluster approach differs from the Grid model in that each node of a cluster is running its own instance. It is this simple distinction that allows for the support of features known as HA and FT, also associated with functionalities called load balancing and fail over.

VI. High Availability (HA)

High Availability (HA) is a design method for system continuity by switching services over to alternative hosts in the case of server or hardware failure, generating a new VM in the case of software or OS failure, or generating a new node in the case of a node failure [13].

The main thing to understand when discussing HA is that services are restored quickly, but not instantaneously [14]. However, the vast majority of applications and services will appear to be seamless to the end user. HA is often associated with minimizing downtime due to maintenance, upgrades, and software application failures (the most common source of failure). In the use cases of maintenance and upgrades, HA is used to migrate the VM to another available host during the planned down period.

Two additional things to know here. One, in order for HA to work, there needs to be enough resources available to host the VMs needing to migrate. Two, in the case of an application failure, there is a moment of unavailability (however short), until the VM is restarted (this is reboot time).

If services are so critical that the end user cannot accept even a momentary lapse, then FT offers an added level of robustness.

VII. Fault Tolerance (FT)

Fault Tolerance (FT) is a design method intended to achieve no interruption in service [14]. This topic is currently still ripe for continued system testing and bench marking.

The main thing to understand here is the tradeoff between robustness and cost. FT is achieved through redundancy. In the case of HA, as long as resources are available a VM can be restarted (the delay is in the required boot time). FT by comparison not only reserves a redundant amount of resources to absorb the failure, but also sustains a shadow copy of the VM, thereby maintaining a primary and secondary VM [15].

An example of this is the feature known as vLockstep offered by VMware [15]. This feature maintains simultaneous writes to a primary and a secondary VM. When the primary VM fails, the secondary continues on. As far as the customer is concerned, nothing has happened. The main technical difference here is the service continuity occurs without the need for a reboot [14].

The main tradeoff when it comes to HA and FT is the increased cost for the additional resources, just sitting there, waiting to be used. This becomes a significant economic as well as architectural issue that must be considered by the stakeholders of the service in terms of how much risk they are willing to accept, the level of service they are committed to provide, and the cost they are willing to absorb.

VIII. Performance: Scalability, Optimization, Management and Control

Current trends in cloud computing are exploring performance factors in scalability, optimization, management, and control. These factors are used to assist organizations when choosing the type of cloud service model (SaaS, PaaS, IaaS), architecture model (Public, Private, Hybrid), and continuity model (HA, FT) best suited for their business processes.

When we discuss scalability in the cloud, we are referring to the ability to scale up as well as scale down dynamically and elastically [16]. Scaling up refers to the ability to add resources to handle additional workloads without reducing performance. Scaling down refers to the ability to release or eliminate resources when workloads are reduced.

Under the physical model for computing, increased scalability is achieved through the time consuming acquisition, installation and configuration of hard assets. When workloads are reduced, idle computing assets sit unused, waiting to be tasked – costing money.

The cloud model (applying virtualization) allows for dynamic scaling of resources. The advantage here is the ability to instantly respond to increased workload demands and yet, only pay for what is needed, when it is needed. Unused assets are released. In this use case, "elasticity rules" are applied to establish the optimal use of computing resources for an organization's needs [17].

The practical definition of optimization is the ability to match resources to workload needs as closely as possible. In the realm of cloud computing this refers to the dynamic adjustment of provisioned resources to meet the exact needs of the business process at any given moment. Optimization is a constant exercise in the avoidance of two problems: overprovisioning and underprovisioning [18].

Overprovisioning refers to the problem of having more computing resources than needed, resulting in idle assets.

Underprovisioning refers to the problem of having too few computing resources available for the current workload, and may result in reduced performance below service level agreements (SLAs), outages, or even complete system failures due to lack of compute, memory or storage.

Cloud Management refers to the "fundamental support of users of cloud services" [19]. From the practical IT management point of view, this issue refers to how much direct control the organization wants to exert on its cloud solution. This is a strategic IT decision that will impact the organization's choice of service model (SaaS, PaaS, IaaS) and delivery architecture (Public, Private, Hybrid).

The degree of control to which the organization wishes to maintain over its computing resources is largely a factor of balancing the preference of having portions of computing resources, or even the entire computing infrastructure, managed by a provider versus maintaining those resources by internal personnel.

Issues effecting this strategic calculation normally include: the level of expertise on hand, whether the organization's IT solution is starting from scratch or is migrating an existing solution, ability to control policy and protocols, specific regulatory requirements, unique security concerns, and the organization's culture and comfort with risk and third party provided services.

IX. Conclusion

This article set out to present a discussion on the underlying concepts of cloud computing, and point out the most common factors and issues that an IT manager will be confronted with, based on current trends.

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Big Data using Cloud Technologies

By Sushma Talluri
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Abstract- Cloud technology is playing a vital role in presentera to store and process massive amount of data, which leads to the convergence of cloud and big data. Cloud computing holds a tremendous promise of unlimited, on demand, elastic, computing and data storage resources. It has the potential to enhance business agility and productivity while enabling greater efficiencies and reducing costs. Big data environments require clusters of servers to support the tools that process the large volumes, high velocity, and varied formats of big data. It offers the promise of providing valuable insights that can create competitive advantage and also to explode new innovations. In this paper, I discussed how cloud and big data technologies are converged to improve quantitative decision making with minimal risk and to offer cost-effective delivery model for cloud-based big data analytics.

Keywords: *cloud, big data, technology, analytics.*

GJCST-B Classification : *H.2.8 C.2.1 C.2.3*

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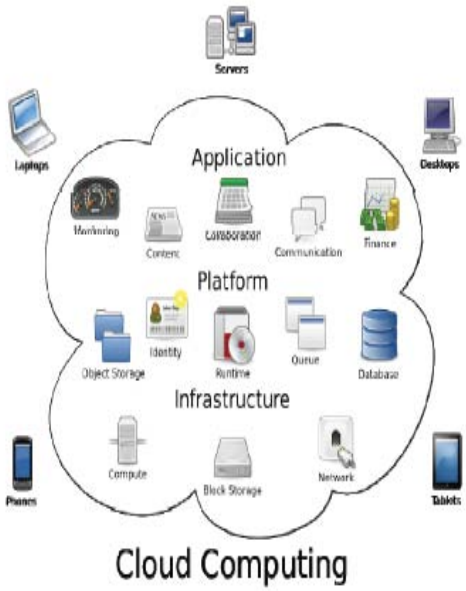
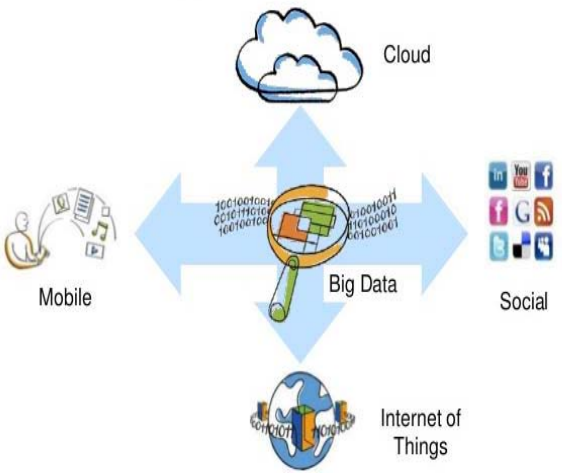
I. Introduction

a) Cloud Computing

Cloud Computing technology depends on sharing of resources than having local servers or personal devices to handle the applications. In Cloud Computing, the word "Cloud" means "The Internet", so cloud computing means which performs operations or services through the Internet.

The main objective of Cloud Computing is to make use of increasing computing power to execute millions of instructions per second. [1] It uses large group of servers with specialized connections to allocate data processing among the servers. By using this technology just there is a need to install single software in each computer that allows users to log into a Web-based service and which also hosts all the programs required by the user. In this system there will be a considerable workload shift and therefore, local computers no longer have to take the entire burden in running applications. Thus minimize the usage cost of computing resources [4]. The only thing that must be done at the user's part is to connect to the cloud. Cloud Computing consists of a front end and back end. The frontend includes the user's computer and software required to access the cloud network. Back end consists of various computers, servers and database systems that create the cloud. The user can access applications in the cloud network from anywhere by connecting to the cloud using the Internet. Some of the real time applications which use Cloud Computing are Gmail, Google Calendar, Google Docs, etc.





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a) Big Data

The term "Big Data" is used to describe massive volumes of structured and unstructured data that are difficult to process using traditional databases and software technologies.

The following are the properties of Big data:

a) *Volume:* Various aspects contribute towards increasing quantity flow of data.
b) *Variety:* In the present days data come up in all types of formats emails, video, audio, transactions etc.
c) *Velocity:* This means how fast the data is being produced and how fast the data needs to be processedto meet the demand.[5].
d) *Variability:* Along with the Velocity, the data flows can be highly incoherent with regular peaks.
e) *Complexity:* Complexity of the data also needs to be considered when the data is coming from multiple sources. The data must be linked, matched, cleansed and transformed into required formats before actual processing.

II. Converging Technologies of Cloud and Big Data

Data is becoming more valuable. Now-a-days the discussion is shifting from "What data should we store?" to "What can we do with the data?" to boost the competitiveness companies must find new approaches to processing, managing, and analyzing their data whether its structured data or more varied, unstructured formats.

Cloud computing is becoming a reality for many businesses. Among different types of deployment models private cloud deployment model often leading the way in business.[2] Cloud technology is maturing and addressing barriers to adoption with improvements in security and data integration, while IT organizations are evolving to support cloud services delivery. As a result, businesses are demonstrating growing trust in cloud delivery models. Organizations continue to store more and more data in cloud environments, which represent an immense, valuable source of information to extract by offering business users scalable resources on demand.

a) Scope of big data analytics

In the beginning day's interest in big data analytics focused first and foremost on business and social data sources, such as e-mail, videos, tweets, Facebook posts, reviews, and Web behavior. [3] But now the scope of big data analytics is growing to include data from intelligent systems, smart devices and device sensors at the boundary of networks because everywhere connectivity and the growth of sensors and intelligent systems have opened up a whole new storehouse of valuable information. By applying big data analytics to these increases richer insight to enhance machine-based decision making more cost effectively than in the past and to personalize customer experiences.

b) Cloud and big data

Cloud delivery models offer incomparable flexibility, enabling IT to evaluate the best approach to each business user's request. For example, if organizations that already support an internal private cloud environment can add big data analytics to their in-house using a cloud services provider or by building a hybrid cloud to protect certain sensitive data in a private cloud. Private clouds can offer a more efficient, cost-effective model to implement analysis of big data in-house, while enhancing internal resources with public cloud services. This hybrid cloud option enables companies to use on-demand storage space and computing power via public cloud services for certain analytics initiatives like short-term projects and provide added capacity and scale as needed. While enterprises often keep their most sensitive data in-house, huge volumes of big data owned by the organization or generated by third party and public providers may be located externally some of it already in a cloud environment. Moving relevant data sources behind the firewall can be a significant commitment of resources. Analyzing the data where it resides either in internal or public cloud data centers or in edge systems and client devices often makes more sense. Thus, cloud and big data technologies are converging to offer a cost-effective delivery model for cloud-based big data analytics.

III. Conclusion

Cloud and big data technologies continue to evolve. Big data provided through Cloud is an absolutely necessary trait for today's businesses to make proactive, knowledge driven decisions, as it helps them have future trends and behaviors predicted. As data is growing every day, the ability of integrating big data in cloud has potential for elasticity, scalability, deployment time, and reliability by offering a cost-effective delivery model.

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To Enhance the OTP Generation Process for Cloud data Security using Diffie-Hellman and HMAC

By Gagandeep Kaur Sandhu & Er. Gurjit Singh
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Abstract- Cloud computing is an innovation or distributed network where user can move their data and any application programming on it. In any case, there is a few issues in cloud computing, the main one is security on the grounds that each user store their helpful data on the network so they need their data ought to be protected from any unapproved access, any progressions that is not done for user's benefit. There are diverse encryption methods utilized for security reason like FDE and FHE. To tackle the issue of Key management, Key Sharing different plans have been proposed. The outsider auditing plan will be fizzled, if the outsider's security is bargained or of the outsider will be malicious. To tackle this issue, we will chip away at to design new modular for key sharing and key management in completely Homomorphic Encryption plan. In this paper, we have utilized the symmetric key understanding algorithm named Diffie Hellman, it is key trade algorithm with make session key between two gatherings who need to speak with each other and HMAC for the data integrity OTP(One Time Password) is made which gives more security. Because of this the issue of managing the key is expelled and data is more secured.

Keywords: *OTP, HMAC, diffie-hellman, cloud security, FHE, FDE.*

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I. Introduction

Cloud computing is the earth which gives on-demand and helpful access of the network to a computing resources like storage, servers, applications, networks and the other services which can be discharged minimum effectiveness way. The five key characteristics made by cloud design. Cloud design likewise advances the accessibility [5]. User retrieved data and changed data which is stored by client or an association in centralized data called cloud. Cloud is a design, where cloud service provider gives services to user on demand and it is otherwise called CSP stands for "Cloud Service Provider" [3]. It implies that the user or the client who is using the service needs to pay for whatever he/she is using or being utilized and served. There are three deployment models and three services models defined by NIST, theses are:

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a) Service Models: There are three service models of cloud-

i. *Software as a Service (SaaS)*

This is the ability of using applications which are running on cloud infrastructure. The users access these applications through internet associations. These kinds of clouds offer the usage of some particular business strings that gives particular cloud abilities. For E.g. GMAIL, Facebook [2].

ii. *Platform as a Service (PaaS)*

It gives the computational resources on which services and applications can be host and create. For E.g. Online Photo Editing, Google Docs, YouTube [12]

iii. *Infrastructure as a Service (Iaa* S)

This is the ability of doing processing, storing and run software which is given to the buyer. It's additionally alluded as the "Resource Code" which gives resources as the services to a user. This work is finished by the service provider. For E.g. Host Firewalls [6].

b) Deployment Models

Cloud services are mainly available in the three types of cloud. These clouds are as follows-

i. *Public Cloud*

In this cloud, resources dispensed are publically. Applications in this cloud are on pay-per-use premise. Public clouds can be managed by government organizations or business. For E. g. Sky Drive and Google Drive [2].

ii. *Private Cloud*

In this cloud, resources are constrained and used within an association. It is more secure as representatives in an association can access the specific data as it were. For E. g. Banks [12].

iii. *Hybrid Cloud*

In this cloud, there is a combination of both Public and Private cloud. The services within the association are control by the client and resources which should be conveyed remotely are controlled by the service provider [12].

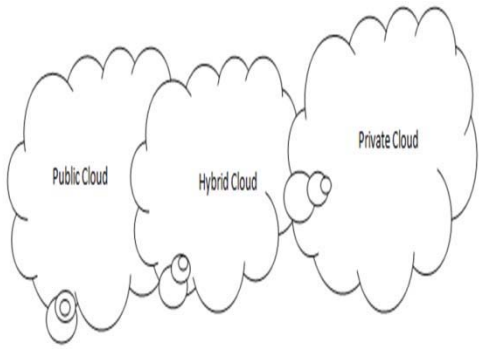

Fig. 1.1 : Deployment model of Cloud

c) Cloud Computing Security

Network security, information security and many other security sorts like the PC security together make the expression "Cloud Security" because it comprise the greater part of the security system as given above. It gives the expansive set of innovations, policies and controls that are used to secure the data and applications exist with the cloud computing environment [8]. It is not the result of PC security like hostile to viruses and against spam's. Security is the most concerning point to any service. Outer security or internal security required to every field. Just security guarantees the privacy and integrity the cloud data. There are many security loopholes exist in the service. There are many sorts of security issues exist like DDOS, Man in the middle and so on. Some security sorts include:

i. *Outages*

This term alludes to the issue of the user where he/she is not ready to access services because of the provider being down. Assume there is some imperative business meeting and user require a document for the presentation and provider's site is down. This may happen part of times [8].

ii. *Data Loss*

Due to lack of security data may be lost during uploading on cloud because of nearness of malicious hub [11].

iii. *Phishing*

It is an email misrepresentation trick which is directed with the assistance of network investigation stream tool to concentrate information from the server.

II. Review of Literature

In this paper [1] they proposed distinctive systems and their benefits and bad marks like Message Authentication Code (MAC) which protect the data from integrity. The proprietor of any information checked the data integrity by recalculating the message authentication code of data got by others however recalculation is conceivable if the measure of data is huge. A hash tree is used for extensive files. Outsider auditor is used to alleviate the substantial data into little parts of maintenance and security. The proposed algorithm depicts data integrity and dynamic data operations. They use encryption to ensuring the data integrity. Public key is likewise defined which is based on homomorphic authenticator. A hash function is used for evidence of retriveability. The proposed algorithm has a main drawback that it require usage of the higher resources cost. In this paper [2] Dynamic versatile token application is introduced. This is the application in cellular telephones which is used to produce a code with the assistance of OTP (One Time Password). This OTP code is used just for one an opportunity to login session. In this paper, they depict one of the techniques for OTP. There are two phases in it Registration phase and Login phase. User first enlists itself by fill credentials in the structure and then enters to the Login phase. In login phase, OTP will produce for the login session. OTP is produced by three parameters: The present time, 4-digiti PIN code and Init-mystery. This code is legitimate for three minutes as it were. This guarantees protection against eavsdroppers attack and man-in-middle attack. Henceforth, they demonstrate OTP is extremely secure. In this paper [3] a design and engineering is recommended that can scramble and unscramble the file at the user side which gives data security in both cases while user is very still or is transferring data. In this paper they used the Rijndael Encryption Algorithm alongside EAP-CHAP. This algorithm has five stages which should be take after for the data security. The users are dependably worry about the privacy protection and security issues before storing their data on cloud. So in this the attention is on client side security in which just the approved user can access the data. Regardless of the possibility that some intruder (Unauthorized user) gets access of the data then the data won't be unscramble. Encryption must be finished by the user to give better security Algorithm. For this, Rijndael Encryption algorithm is used. In this paper [4], two strategies are talked about: Virtualization and Multi-tenancy which gives security about cloud computing. Data is sorted out by outsider organizations that offer Saas and PaaS which is critical for the security. In this way, Virtualization and Multi-tenancy strategies are used for the security purposes. Virtualization is a method for making a physical PC function as though it were two or more PCs where each non-physical or virtualized. There are two sorts of virtualization: Full virtualization and Para virtualization and two designs of virtualization: Hosted and Hypervisor engineering. Multi-tenancy is the capacity to give computing services to different clients by using a typical infrastructure and code base. Multi-tenancy can be connected to various levels i.e. application level, middleware level, operating system, equipment level. Then security of virtualization and multi-tenancy has been talked about. In this paper [5] they talked about various issues identified with cloud

computing security. To protect cloud computing system and to counteract different attacks many security instruments have been created. To enhance the security of cloud computing new innovations has been created by the analysts. Distinctive sorts of attacks like SYN flood, malware injection, account hijacking are examined in this paper. The main center of this paper is on detecting and preventing SYN flood in cloud computing. The creator created two algorithm one detecting algorithm and one preventing algorithm. They will actualize and test these algorithms on cloud computing.

III. Diffie-Hellman and OTP

Diffie Hellman was the primary public key algorithm or we can say that it is symmetric key agreement ever invented, in 1976. Diffie Hellman key agreement protocol is [6]:

1. It allows exchanging a secret key between two parties.
2. Exponential key agreement
3. Requires no prior secrets

a) Definition of Diffie Hellman

Before establishing a symmetric key, the both the two parties need to pick two numbers n and p. Give n a chance to be a prime number and p be an integer. The Diffie Hellman Problem (DHP) is the issue of computing the estimation of p^{ab}(mod n) from the known estimations of p^a (mod n) and p^b (mod n).The setup of Diffie Hellman algorithm

Assume that we have two parties Alice (Master) and Bob (Slave), they need to convey to each other.

They don't need the eavesdropper to know their message.

Alice and Bob concur upon and make public two numbers n and p, where n is a prime number and p is a primitive root mod n. Anybody has admittance to these numbers.

Table 1 : Private computations

Alice	Bob
Choose a secret number a. Compute M≡ p^a (mod n)	Choose a secret number b Compute S≡ p^b(mod n).

Generated public values are exchanged.

- Alice sends M to Bob ==M
- S= Bob sends S to Alice
- Alice calculate the number K≡ S^a ≡(P^a)^b (modn).
- Bob calculate the number K≡M^b≡(p^b)^a (mod n).

Here Alice and Bob have the same key that is K=p^{ab} (mod n).

In the Diffie-Hellman algorithm if two parties, say, Master and Slave wishes to trade data, both concur on a symmetric key. For encryption or decryption of the messages symmetric key is used. We realizes that Diffie Hellman algorithm is used for just key agreement or key trade, however it doesn't used for encryption or decryption. Before starting the correspondence, secure channel is set up between both the parties [5]. Both parties select their own particular random number. On the premise of the chose random numbers, secure channel and shared key is built up.

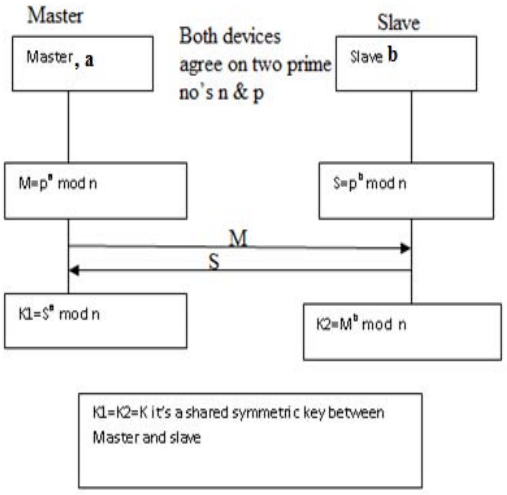

Fig.1.2 : Diffie-Hellman Key exchange

Figure1.2 demonstrates that Master and Slave needs to speak with each other. To begin correspondence both parties need to build up secure channel. To set up secure channel, two random prime number p and n are chosen, both gadgets are concurred on these two numbers. Chosen p and n are the public numbers. Both parties, say gadget 1 get to be master and gadget 2 get to be slave; both master and slave select their private numbers "an" and "b" individually. Master and slave use their public and private number and computed their private keys [15].

Master computes:

M= p^a mod n

Slave computes:

S= p^b mod n

Now both master and slave exchange their private keys such as 'M' and 'S'. After getting 'M' and 'S', master and slave calculates the secret keys such as K1, K2.

From S, master computes:

K1= S^a mod n

From M, slave computes:

K2= M^b mod n

If both master and slave calculate same values of K1 and K2, then secure channel is established between them. The combination of K1 and K2 becomes the shared symmetric key between master and slave.

To encrypt the messages, they used the public key or shared key (K) of both parties. For decryption of

messages private key of both parties which is randomly chosen by the users i.e. 'a' and 'b' are used [16].

a) One Time Password

Password is used for authentication by all the business and association. In addition Static passwords have many impediments. Password can be get hacked. Lackadaisical representative may note down passwords some place, system with spared passwords might be used by different users or a malicious user may reset all passwords just to make destruction. So it is exceptionally useful to use dynamic password i.e. one time password [10]. Dynamic passwords are more secure when contrasted with static. There is no compelling reason to record these passwords and recollect these passwords. For each login session every time another password is produced. One time passwords are more reliable and user friendly also for authentication. OTP generation should be possible by different OTP generation algorithms for generating strings of passwords. OTP guarantees security. This prompts authenticating them again and again over the period of time for each login session. To maintain a strategic distance from the overhead we can use OTP for multi cloud environment.

IV. Proposed Methodology

There are many encryption algorithms to give security to the cloud. "Fully Homomorphic" is more reliable. It gives more privacy and security as contrast with plan of "Full Disk Encryption". The main issue which is there in Fully Homomorphic Encryption is a key storage, key management, Access control and Data Aggregation list maintaining. To tackle issue of Key management, Key Sharing different plans have been proposed in a years ago. The different security attacks are conceivable in these plans. The outsider auditor is the plan for key management and key sharing. The outsider auditing plan will be fizzled, if the outsider's security is bargained or of the outsider will be malicious. To take care of this issue, In this thesis we will take a shot at to design new model for key sharing and key management in fully Homomorphic Encryption plan. In this work, we find that fully homomorphic encryption system is more effective than full disk encryption. Yet, the main issue exists in fully homomorphic encryption is of key management and key sharing which decreases the reliability of the plan. For key management and key sharing, improvement has been proposed in the encryption plan and upgrade is based on Diffie-hellman algorithm and HMAC and OTP is created on the premise of mystery key produced from Diffie-hellman algorithm. This algorithm makes session key amongst user and cloud. Every time new key is produced between two preceding correspondence selected node suppose user1

1. Login
2. Key generation
   2.1 Enter prime numbers
   2.2 Enter random numbers by client and cloud service provider
   2.3Secret key generation and secure channel establishment
3. OTP (One Time Password) generation
   3.1 cloud server will set count1=0, count2=0...count5=0 for respective user at its side.
   3.2 Cloud Server will request for the OTP from user 1
   3.3 user1 enter (secret key+count) as OTP
   3.3 server match it because server knows both secret key and count of each user.
   3.3.1: count1++; // so for user 1 it will be count1=1; for remainig user their count will be still 0;
   3.3.2 if (secret_key+count(x) == secret_key+count(y))
   { Access granted;
   display message by server : print ("please enter the operation");}
   else{ display message by server: print(" wrong password, your login number is count1);}
4.4 clinet will enter the operation using HMAC digest
   4.4.1 : hmac(already generated secret key || v, file1,ver1 || sha1)
   { if(ope==v)
   { server will check the file name and version;
   if (file1,ver1== file1,ver1)
   {
   printf("file is valid"); }
   else {
   print (file is invalid, please replace the file)
   }}
if(ope==I) { insert new file file2 }
5. encryption/decryiton
6.data operation
7.logout;

note: // 1.at client side, user will enter prime number, random number for generating secret keys, once generating secret key user will enter otp , after inserting otp, user will enter operation(Insertion) with corresponding file name(file1 or file2).

V. Exprimental Results

The whole scenario has been implemented on MATLAB tool.

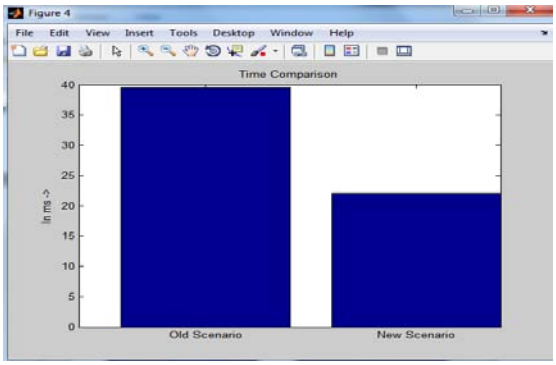

Fig. 1.3 : Comparison Graph

As appeared in figure 1.3, the comparison amongst previous and proposed methodology is appeared as far as delay. The delay in previous system is increasing, when numbers of trade messages are increased. In the proposed approach the delay is less because of increasing the number of message.

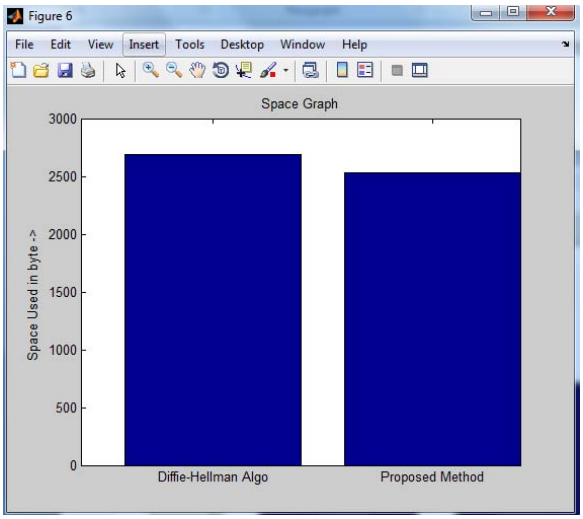

Fig.1.4 : Comparison with Diffie Hellman in terms of used bytes

As appeared in figure 1.4, the comparison amongst previous and proposed methodology is appeared as far as used bytes. The used byte in previous method is increasing, when numbers of trade messages are increased. In the proposed approach the data utilization is less when contrasted with existing strategy.

VI. Conclusion

Cloud computing is the environment which gives on-demand and helpful access of the network to a computing resources like storage, servers, applications, networks and the other services which can be discharged minimum productivity way. In this user can store their data and use diverse services and pay according to those services. The main component is security that how we can store our data while storing into the cloud. In this thesis, we audited two most prevalent procedures for cloud data encryption. These systems are full disk encryption and fully homomorphic encryption. In this work, we find that fully homomorphic encryption method is more proficient than full disk encryption. Yet, the main issue exists in fully homomorphic encryption is of key management and key sharing which lessens the reliability of the plan. For key management and key sharing, improvement has been proposed in the encryption plan and upgrade is based on Diffie-hellman algorithm and HMAC and OTP is produced on the premise of secret key created from diffie-hellman algorithm. This algorithm makes session key amongst user and cloud. Every time new key is produced between two preceding correspondence. This decreases the time happens in management and sharing of keys and secure channel is set up between both i.e. user and the cloud service provider. The simulation demonstrates that proposed improvement is more proficient and reliable than the existing one.

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A Review on Integration of Quantum Processor Services with Recursive Quantum Network in Cloud System

By M. M. Fazle Rabbi, Md. Masudul Islam & Mijanur Rahaman
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Abstract- Cloud computing system is based on a vast network. They provide different services, transmit valuable data and store them in remote storage. Making the network security system stronger and faster is one of the greatest challenges to secure the cloud. Since recent trends are going on quantum technological research, there is a way to secure cloud system using quantum internet. However, recently developed recursive quantum repeater networkfor large-scale internetwith cloud system could bring revolutionary change in cloud computing services. Our paper's main view is to show recent progress of quantum internet and recursive quantum network. In addition, we will review a simple model to integrate quantum processor services in cloud with recursive quantum network architecture for reliable, secure and faster cloud computing services.

Keywords: quantum chip, recursive network, quantum repeater, cloud, network layer, entanglement, QCaaS, QRNA.

GJCST-B Classification : C.2.1 C.2.3

Strictly as per the compliance and regulations of:

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M.M. Fazle Rabbi [α], Md. Masudul Islam [σ] & Mijanur Rahaman [ρ]

Abstract- Cloud computing system is based on a vast network. They provide different services, transmit valuable data and store them in remote storage. Making thenetwork security system stronger and faster is one of the greatest challenges to secure the cloud. Since recent trends are going on quantum technological research, there is a way to secure cloud system using quantum internet.However, recently developed recursive quantum repeater networkfor large-scale internetwith cloud system could bring revolutionary change in cloud computing services. Our paper's main view is to show recent progress of quantum internet and recursive quantum network. In addition, we will review a simple model to integrate quantum processorservices in cloud with recursive quantum network architecture for reliable, secure and faster cloud computing services.

Keywords: quantum chip, recursive network, quantum repeater, cloud, network layer, entanglement, QCaaS, QRNA.

I. Introduction

Cloud computing is globalization for internet computing. It is a revolutionary system but still faces some vulnerability in many cases. Many threats such as, data loss, privacy issue, data theft, vendor security, data locality etc. has shown up. Using most powerful encryption system or secured medium to transfer data over cloud is not properly safe yet.

Because intruders have a chance to eavesdrop client's information at any time in this classical system. Cloud computing is 50 year old business model, which still needs to expand and overcome limitations that prevent the full use of its potential.[1]Clouds must be able to define computational risk management tactics to identify, assess, and manage risks involved in the execution of applications with regards to service requirements and customer needs.[2]

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Secure cloud computing concerns some issues like secure cryptographic key distributions, strong network system, fast processing etc.

All these system are based on classical method, they are electronically and virtually safe. However, they are not safe enough to rely because advancement of technology and method is a hint of upcoming problem. However, new concept of quantum physics for information technology is making a way to make safe and faster cloud system. All we need to integrate the quantum network system with cloud system. In order to established Quantum internet networks using classical optical technology it needs storage to store quantum information and quantum repeater as amplifier for long distribution of entanglement.

As we know, there is a possibility of QCaaS (Quantum Computing as a Service) in cloud system.[17]In here our paper is reviewing the model of integration cloud with recursive quantum internet for further more secured and faster cloud computing.

At first, we will know about some facts aboutcloud, classical networks and quantum networks, entanglements as well as recursive quantum repeater network for our further review on integrating quantum internet with cloud.

a) Cloud System

Understanding basic system of how cloud-computing works in network is important. It consist two layers; user interface layer and backend layer consist of hardware and software services. This cloud uses a network layer to connect users' endpoint devices. Present network architecture of cloud system consist router, firewall, Ethernet switch, fiber channel switch, Server Load balancing etc. Fig. 1[3] shows present architecture of cloud computing network. However, these architecture cloud change based on different service module. This complex structure is costly and has different vulnerabilities. As we see, each part is connected to the internet at a time so making the network system more secure and faster is one of the challenges. This why we will review a new model of cloud system integrated with recursive quantum internet.

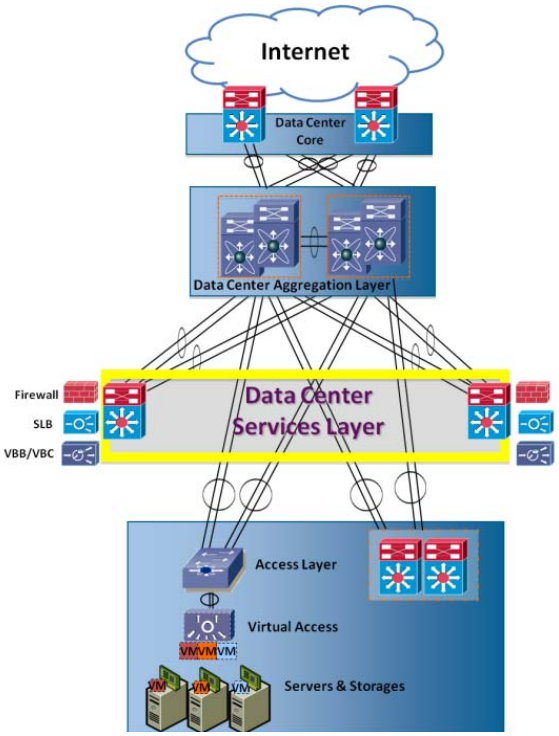

Fig. 1: Cloud Network Architecture

b) Superposition & Entanglement

Superposition and Entanglement are two vital point for our quantum network system to secured QKD and faster information travel. If a Qubit is $|0\rangle \pm |1\rangle$then the equal superposition state of the Qubit is $(|0\rangle \pm |1\rangle)/\sqrt{2}$ which represent 45° linear polarization. This means there are immense possibilities of information bits within a single photon. This single Qubit representation is simpler to see but in the case of two Qubit, they show a new behavior called entanglement. Entanglement happens when a pair of particles interacts physically. Entangled photon particles spin vice-versa even if we observe it from a far distance. Fig. 2 shows a simple view of entanglement for a pair of photon particle. It shows if we observe one of the photon from the pair then we can assume easily the other one's spin status not matter how far they are. This is a key technique for instant data teleportation in Quantum networks system.

c) Recursive Networking

In classical network system can be used or add all over the network topology so that the complex subnet structure stay hidden and it can reuse single protocol for different layers in a protocol stack. In Fig 3. A simple recursive network is presenting where each node in the fig can actually represents a complete network itself. Here the black dot represents simple repeater, red dot represents router and blue dot represents nodes in request states.[4]

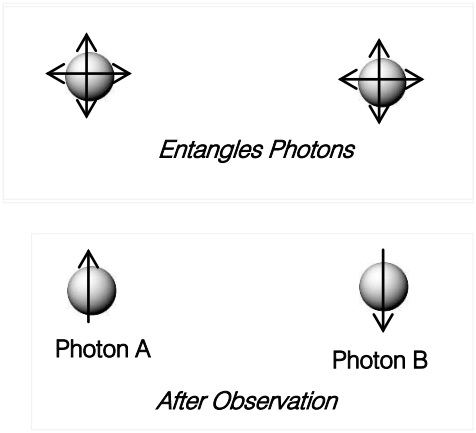

Fig. 2 : Entangled Photons

A recursive network architecture reuses single flexible protocol for the different layer of protocol stack to avoid recapitulation of implementation and dynamic composition of services.[5] Before we introduce recursive quantum network with cloud system it's essential to know why new network architecture like RNA is needed. Current classical internet architecture has been remodeled by adding different extension layer, protocol and facilities such as, SHIM6, HIP, SCTP, TLS, BEEP etc.[6]But in many cases these extensions affects the nature of conventional protocol stack and sometimes it repeats services which are available at existing layer. That is why recursive network model unifies basic properties of protocols and reuses components services to avoid these shortcomings. Another similar classical network recursion is shown in Fig. 4, a simple recursive classical network where the embedded subnet works as router at the higher level, this embedding could happen in many times, on top of its existing embedding and that's how it works like a recursive network.[7]

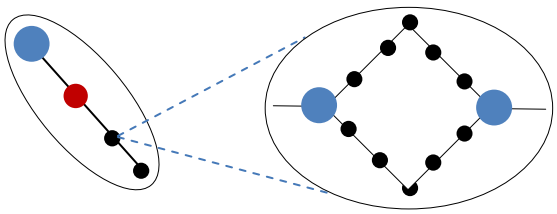

Fig. 3 : A simple view of classical recursive network system

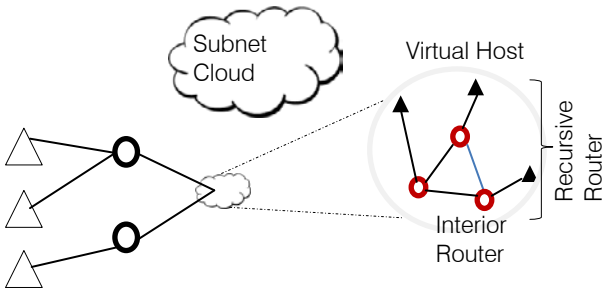

Fig. 4 : Classical recursive networking

II. Quantum Internet & Quantum Repeater

The Quantum Internet is a concept of information travels to the end users in a quantum state through an optical fiber link using entanglement. The main thing to create a quantum internet is the capability to encrypt information on single photons of light that can be produced on demand. There is no quantum communication scheme so that is why we use a classical communication scheme to transmit quantum information using infrared photon through optical fiber. However, photons decay exponentially as they propagate so a quantum repeater is used to amplify the transmission as long as possible. Simple quantum network structure using entanglement is shown in Fig. 5. Just like in classical perspective amplifiers is used to extend the data communication we use here quantum repeater to pass data through one fiber links to another fiber links. Our main concern for Quantum repeater is to ensure that the whole system is compatible with standard fiber optical communication system for long distance transmission.

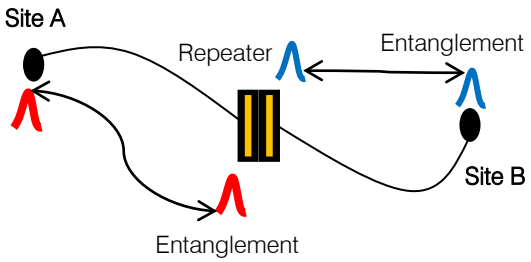

Fig. 5 : Quantum repeater internet using photon entanglement

III. Recursive Quantum Repeater Network

In 2011, a team of Van Meter, Joe Touch and Clare Horseman presented a better quantum internet system by adopting classical recursive network. As we know classical network forward the data packet on towards its destinations but quantum internet does not sends the data rather than it recreate quantum states by requesting for the execution of operation. In the(QRNA) Quantum Recursive Network Architecture system the developer team contributes a solution for 4 major scaling problem such as: ensuring interoperability among technologies that are heterogeneous (at both the physical and logical levels), reconciling the competing needs and policies of independent organizations (including the desire to keep information about the network internals private), choosing a technical approach for the routing, naming, and resource discovery problems that is robust in the face of this heterogeneity and federated operation and managing communication requests using incomplete, out-of-date information about the dynamic state of the network, including availability of resources and topological change occurring as nodes join and leave, and network links go up and down.[8]This model gives quantum internetwork system a possibility in large-scale deployment which is essential for world-wide cloud computing services.

IV. Recursive Quantum Repeater Network and Quantum Processor Services in Cloud

In 2015, the Cloud Security Alliance formed a new working group called the Quantum-Safe Security Working Group (QSSWG).[9] So secured cloud computing is a provocative question at present. Judging this facts unify present fiber network technology with Quantum physics features we could build a strong repetitive and large network system, so that cloud data passing and storing will more secured and reliable. Our approach is to unify different progress in Quantum internetwork system in recent years and propose a minimum view of model to integrate cloud with Quantum internet.

One of the greatest challenges for implementing a globally distributed quantum computer or a quantum internet is entangling nodes across the network.[10]

Building peer-to-peer small quantum network system is not so hard. However, in the case of large quantum network there are difficulties to deal with de-coherence and photon decay. Therefore, there is a method to build large quantum network using photon entanglement by distributing quantum state. In this system, the network nodes are Quantum repeaters, which are equivalent to classical internet routers. In entanglement, behavior pair of entangled particle is called Bell pair. This entanglement increases the photon transmission distance through networks. Research on the physical mechanisms for transmitting quantum states typically assumes transmission through a fiber, but free-space optical links and even satellite links can also be used, with repeater nodes at each end of the link.[11]Since our present technology is not fully quantum specialized and the quantum computer still not available so we have to take help from classical network control system to design a unified Quantum Repeater. A unified architecture proposed by Van Meter, Joe and Horsman team to build classical recursive network concepts to extend data distribution. This system claimed to be very useful to build arbitrary distributed states such as Bell pairs and GHZ, W and Cluster state.[12]In order to safely long-distance Distribute Quantum Key through a large network system there must be an error proof request-response protocol. The request naturally produced in the nodes and processed through a set of protocol

software modules.[13]In their proposed system, the building block for distributed algorithm is a core group of entangled states, which supports direct distributed execution of any quantum algorithm. In quantum repeater, network recursion is natural model because of purification, entanglement, swapping and Calderbank-Shor-Steane (CSS)[14]

Fig.6shows a simple structure of Quantum repeater network, which can distribute QKD over approximately 50km to 3000km where each Quantum Repeater node contains Error correction purification, Entanglement distribution, initialization and measurements.

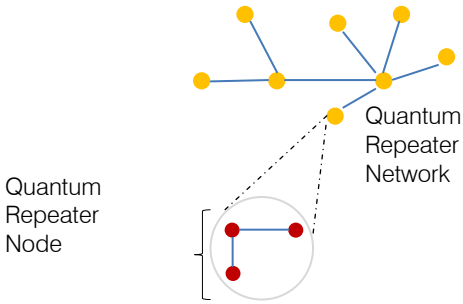

Fig. 6 : Simple structure of Quantum repeater network & nodes

Another progress in Quantum internet system is to add a quantum SIM chip in cloud architecture so that anyone can process any quantum algorithm application in web browser using internet. A group of scientist in University of Bristol, UK has already done this part experimentally. According to their claim a small quantum chip connected to the internet will works by guiding two photons through a series of optical channels. As the photons pass through the 2-Qubit chip, they become entangled, meaning that a measurement on one influences the outcome when measuring the other. Programming the computer involves tweaking the extent of this entanglement to produce different computations.[15]However, this is a limited version of Quantum processor service; we need to implement it in large scale for public. And that's why we propose to unite recursive quantum repeater network system for large-scale communication with the quantum cloud chip services.

Because of QKD is vulnerable to distance and loss factor so we could use recursive quantum repeater network model with an extra layer of Quantum chip service so that anyone can process Quantum algorithm over the internet using existing fiber optical technology.

In our proposed approach, we could add the Quantum chip service in our physical layer of present network architecture thatprovides users a secured and faster quantum processing over internet. The quantum SIM chip we are using is actually open web interface simulator. This high-level application interface helps us to do experiments on various quantum application theory. This API could integrate in Application layer of QRNA.We merge the recursive quantum repeater system in physical layer so that processed Quantum encrypted key could travel through internet to the end user in cloud system in large-scale. This integrated approach will increase the performance the Quantum internet over cloud system.Fig. 7 is a simple structure for our proposed model how the end user cloud use Quantum processor which is interconnected with recursive Quantuminternet system over cloud.

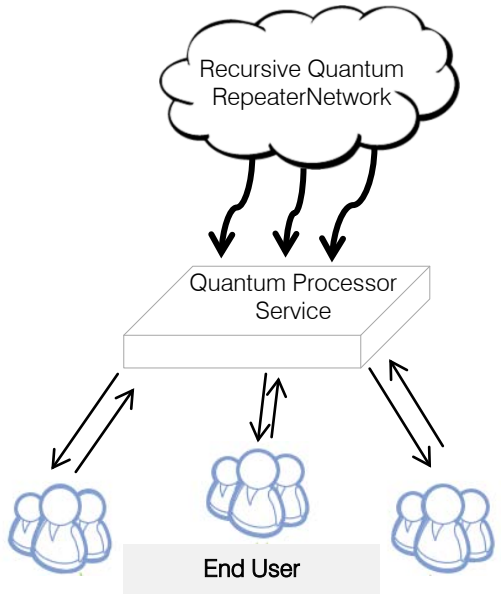

Fig. 7 : Tentative model view of integration recursive quantum network with Quantum Processor service

V. Conclusion

A cloud system is all over the world is truly a large-scale system. In classical networking approaches data moves through network using source applications, but in normal quantum networking system it creates distributed entangled quantum states as well as transport the data one to another places. In advance, Quantum recursive Network system it asks a node or network to contribute vigorously in the view of large state network. Therefore, the major issue of large-scale distributed computing could be solved using QRNA. We hope within next few years, hybrid technology of quantum internet will deploy. So that Quantum processor with quantum storage system in cloud system will add with microwave–optical transducers for long-distance optical communication.[16]In our paper we have showed a simple view and recent progress of integrated quantum network system with quantum processor chip in cloud, but there could be more of it. Not only a single quantum chip but also all the major cloud application could be attached with recursive quantum network so

that distributed quantum computing gets availability all over the internetwork system. We hope QCaaS (Quantum Computing as a Service) would be more efficient with the integration with recursive quantum repeater networks.

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	A-B	**C-D**	**E-F**
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Introduction	Containing all background details with clear goal and appropriate details, flow specification, no grammar and spelling mistake, well organized sentence and paragraph, reference cited	Unclear and confusing data, appropriate format, grammar and spelling errors with unorganized matter	Out of place depth and content, hazy format
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Result	Well organized, Clear and specific, Correct units with precision, correct data, well structuring of paragraph, no grammar and spelling mistake	Complete and embarrassed text, difficult to comprehend	Irregular format with wrong facts and figures
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