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Multi-Level Privacy-Preserving Patient Self-Controllable algorithm Healthcare in Cloud

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***Abstract*— Secure patients' confidentiality and privacy preserving healthcare system is well proposed which makes access control of the vital healthcare information of the personals using it in this case it is the patients. In order to solve this problem a scheme as PSMPA was proposed to take care about the data and information of the personnel. Patients can consent to physicians by setting an access tree sustaining flexible threshold predicates. This scheme will be using DVS and ABE algorithms in order to realize security and privacy. This is supposed to be realized in a distributed environment. The basic aim of the scheme is to provide the access rights control in the hand of patients so that they can manage their personnel healthcare information which can otherwise if seized by intruders can be used for breach of privacy of the patient.**

I INTRODUCTION

Cloud computing is a new and emerging paradigm for distributed computing, which allows to provide storage, computing powers as well as software and platform for development of software on an on demand basis or else by reserving resources on the cloud. This is fulfilled by some SLA agreements between the service providers and the users of the setup[11]. The concept is to commodity the computing functionalities and make it available as a commodity to the users whenever wherever required. Conceptually similar to power or electricity supply quite much. The services provided by cloud computing can be largely categorised as 'Infrastructure as a Service' (IaaS), in which infrastructure is provided as a service by the cloud service provider 'Platform as a Service (PaaS)' e.g. aneka which provides platform as a service for the developers or 'Software as a Service' (SaaS)[3]. Clients can right to use web-based tools or applications in the course of a web browser or using a cloud-based resource like storage or computer power like installed locally, eliminating the requirement to install as well as run the application on the customer's personal computer and this well also help in making the maintenance easier.

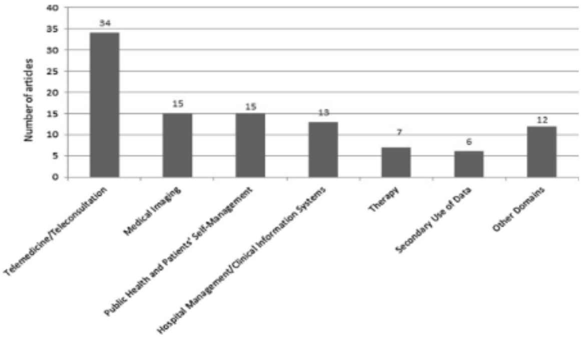
The cloud can be developed as any of the following

1. Private cloud: This contained within the organization.

2. Public cloud: can be assessed by people outside the organization also.[5]

3. Hybrid cloud: this is amalgamation of the above two.

Healthcare industry has as compared to other industries, has not utilized emerging technology in order to increase its operational abilities [8]. Many healthcare organizations still rely on paper medical account, report. Data information that is digitized is characteristically not transportable, which restricts knowledge sharing between the different healthcare providers. Utilization of technology to smooth the progress of association and to synchronize heed between patients and medical practitioners, and amongst the medical society is inadequate.



Graph 1. Cloud computing in healthcare–main domains.

There is a need for modernization of healthcare information technology (HIT) which can be facilitated with the utilization of the computing powers of cloud computing giving ease of deployment of applications and significantly very less initialization cost[10]. Cloud computing is capable enough to bring about revolutionary change in the way data is handled in healthcare organizations. The healthcare organizations are changing in the direction of an information-centric model, by open principles that sustain collaboration, shared workflows and information distribution. Cloud computing fulfils the foremost technology necessities of the healthcare industry: by providing on-demand admittance to computing and large storage conveniences which otherwise was not facilitated in legacy healthcare software. Maintenance of huge amount of data sets for electronic health records (EHR), radiology images and genomic data offloading, is also possible in cloud platform which otherwise would be a big aggravate[4].

The main concern is the integrity and privacy of personnel heath care information of the patients, the intent of the proposed system is to provide the control of information to the patients they themselves, the benefit of the proposed system will be as follows

1. Sharing of EHRs among authorized medical practitioners and research centers in various geographically distributed areas,
2. Providing access to practitioners for second opinion and reference
3. Provide authorization rights in the hands of the patients improves the reliability of information passage in the EHRs (with the proper information governance).

Table 1.The basic comparisons between Paper-based and Electronic-based PHR

PHR class Property	Paper-based PHR	Electronic based PHR
Availability	Hardcopy	softcopy
accessibility	locally	globally
protection	open	secure
Update	difficult	easy
storability	On paper	On electronic storage

The biggest hindrances in using a cloud based system for the PHR in that the control of information goes into the hands of the third party cloud service providers; this holds back the clients to trust such kind of systems in terms of data storage and management. Personnel Healthcare data has stern requirements for confidentiality, security, availability to authorized patients [6]. Clouds vendors need to note this accordingly develop some SLA agreements with the users, while also taking into consideration legal issues pertaining to the government and industry regulations.

Challenges in Healthcare for migrating into Cloud Computing Information technology can be explored in order to get the benefits of the ever evolving technological advancements in information communication systems (ITC)[5]. New and improved facilities can be provided to the users or the patients. The basic concern remains the same as of privacy, reliability security, incorporation and data portability.

Privacy and Security Challenges:

Data managed in a cloud contain private and confidential, personnel information such as regarding a particular ailment the person might be suffering from, this information if goes into the hands of say Health Insurance Company; it might adversely affect the chances of that person being able to get the health insurance.

Cloud Computing for Healthcare:

Keeping the patient in-charge of his personnel health care data is the main motive in the current cloud offerings. This gives the user the control over his confidential data by not compromising on the clinical support by the peers.

II SYSTEM ARCHITECTURE

Cloud solutions can help us address certain societal challenges more efficiently and address the current lack of sustainability in healthcare systems.

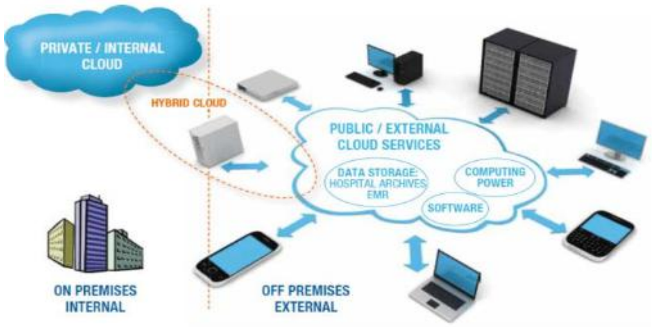


Figure 1: Cloud Computing In Healthcare

In the proposed distributed system members or actors are divided into three levels depending on their access rights over the health care information

1. Directly access rights
2. Indirect access rights
3. No rights

The first type of actors can access both the personnel health care information as well as the patient profile, the second set of actors can see the healthcare information but cannot access the patient profile, these are the physicians who can read only the medical condition and respond on the same. The third type of actors cannot view any the health data or the patient profile.

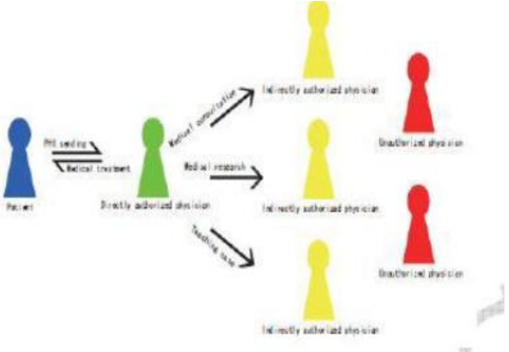


Figure 2. Multiple Security and Privacy Levels in m-Healthcare

In the above figure the red icons belong to the third category, the yellow icons belong to the second category and the green icons belong to the first category.

The information access for the first type of actor is provided by the patient. The access for the second type of actor is provided by the type one actor.

The basic scheme in order to realize the same is. An authorized accessible privacy model for the multi-level access approach to be realized with different kind of access rights to the physicians in distributed framework is is incorporated for the generation of the (PSMPA) scheme known as the patient self-controllable multilevel privacy-preserving cooperative authentication scheme for the confidentiality, privacy, security of the data.

More so ever we use the combination of (ABE) technique and designated verifier signature (DVS). Attribute-based encryption is a category of public-key encryption. In ABE secret key of a patient and the ciphertext relative to the query are reliant upon attributes (e.g. the kind of subscription). The decryption of a ciphertext is accomplished only if the set of attributes of the user key matches the attributes of the ciphertext. Designated verifier signature (DVS) is a cryptographic methodology in which there is a provision of the signer to induce a verifier the legitimacy of a testimonial such that the verifier is incapable to reassign the confidence to a third person[16]. In DVS, signatures are visibly confirmable. If it is from the signer or the verifier then only it is considered as valid.

III PRELIMINARIES

(1) Bilinear Pairing. Let G0, G1 be two cyclic multiplicative groups generated by g with the same prime order p. Let e : $G0 \times G0 \rightarrow G1$ be a bilinear mapping with the following properties.

(2) Bilinearity: for all $u, v \in G_0$ and $a, b \in z_p$, we have $e(u^a, v^b) = e(u, v)^{ab}$.

(3) Non-degeneracy:$e(g, g) \neq 1$.

We say G_0 is a bilinear group if the group operations in G0 and the bilinear map$e: G_0 \times G_{0 \rightarrow} G_1$ are both efficiently computable. Notice that the map *e* is symmetric since $e(g^a, g^b) = e(g, g)^{ab} = e(g^b, g^a)$

The related complexity assumptions are as follows.

(4) Bilinear Diffie-Hellman Problem (BDHP). Given g as a generator of $G0$as well asg^a, g^b, g^c for unknown randomly chosen *a, b, c* $\in z_p$

Attribute Based Designated Verifier Signature

We propose a patient self-controllable and multi-level privacy- preserving cooperative authentication scheme based on ADVS to realize three levels of security and privacy requirement in distributed m-healthcare cloud computing system which mainly consists of the following five algorithms: Setup, Key Extraction, Sign, Verify and Transcript Simulation Generation. Denote the universe of attributes as U.

We say an attribute set v satisfies a specific access structure A if and only if A$(\omega) = 1$ 1 where v is chosen from U. The algorithms are defined as follows.

1.Setup**.** On input 1^l, where l is the security parameter, this algorithm outputs public parameters and y as the master key for the central attribute authority.

2. Key Extract. Assume that a physician requests the attribute keys for an attribute set $w_d = U$. If he is qualied to be issued with skD for these attributes, the attribute authority produces skD for him.

3. Sign. The patient takes as input his private key skP , the uniform public key pkD of the healthcare provider which the physicians work in and a personal health- care information m to generate a signature σ. Namely, $\sigma \leftarrow$ Sign(skP , pkD,m).

4. Verify. Suppose that a physician wants to validate the correction of a signature σ which contains an access structure A and owns a subset of attributes $w_j \in w_d$!satisfying A$(\omega j) = 1$, a deterministic verication algorithm can be executed. Once receiving a signature_, he uses his attribute private key skD and the patient's public key pkP , then returns the message m and True if the signature is correct, or false otherwise.

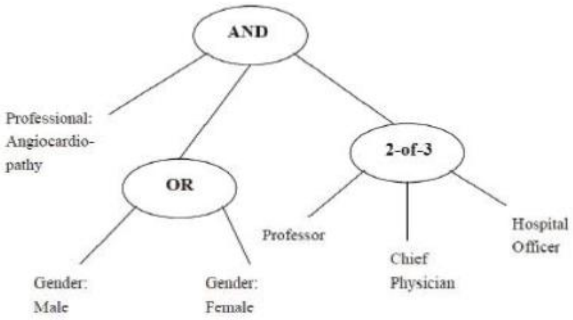


Figure 3: An Example Access Structure in Our Distributed m-Healthcare System

Figure 3 explains Access Structure in Our Distributed m-Healthcare System. Figure 4, shows a instance of the health care system. As illustrated in the figure actors are divided into 3 levels of security based on their access rights. Patient is meeting the physician bob, whom we call as the local health care provider he given the direct access right by the patient.

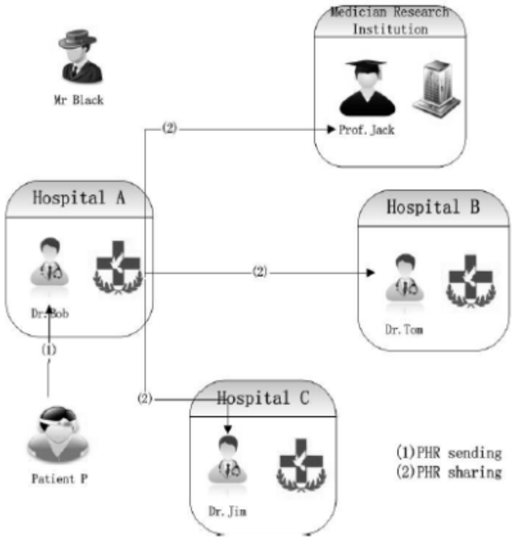


Figure 4: An Overview of Our Distributed m-Healthcare System

Tom, jack and jim are at a geographically remote location and are not having direct access to the patient heath care information, bob can give access to the indirect access physicians. If bob does not give access right to jack then jack will not be able to see the personnel profile of patient neither the health related data.

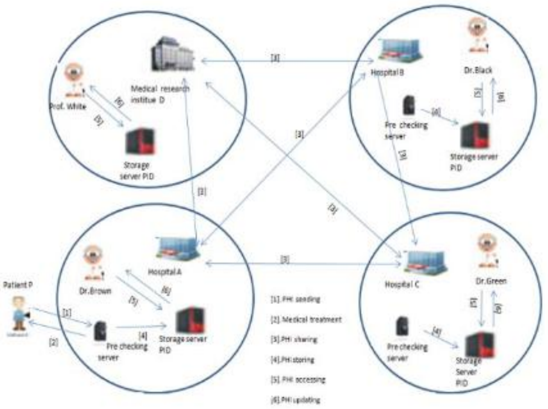


Figure 5: An overview of our distributed m-healthcare cloud computing system.

IV PERFORMANCE ANALYSIS

The performance of the new system was evaluated from both qualitative and quantitative perspectives before and after the implementation in order to improve user satisfaction and justify the investment on the system. The qualitative evaluation dealt with factors related to user satisfaction and improvement in the business process based on the performance reference model (PRM) . PRM is a standardized framework to measure the performance of major information systems (IS) investments and their contribution to program performance. PRM has been widely used in evaluating IS performance for government projects in the United States. Chung et al. [2] applied PRM to evaluate IS performance for several e-government projects in Korea. Since PRM evaluates IS based on the key performance indicators (KPIs) for each of three system layers, input, process, and business, it provides a comprehensive view of the overall IS performance. Chung et al. [2] also developed PRM version 2.0 as a standard performance evaluation tool and identified 138 KPIs for evaluating the performance of government IS projects. However, many of these KPIs are not applicable in healthcare settings because they were primarily developed for IS's for government projects unrelated to healthcare. Moreover, there are not many studies that compared the changes in KPIs before and after the introduction of IS. Therefore, there is a need to analyze KPIs for evaluating such performance of IS projects in a healthcare setting based on the PRM framework.

A. Numerical analysis.

We now consider the efficiency of PSMPA in terms of storage overhead, computational complexity and communication cost. As to the storage overhead, the size of public parameters in our scheme is linear to the number of attributes in w_x^* and ψ_x' . The private key consists of two group elements in G_0. for every leaf node in the key's corresponding access tree T . That is the number of group elements in private keys equals to the number of attributes in the union of w_d and a default set of attributes ψ_x' . Assuming w_x^* is one of the public parameters, the signature almost consists of one group element in G_0 corresponding to each attribute in w_x^* and ψ_x' . Therefore, the communication cost is independent of the number of attributes in w_D possessed by each physician. As to the computational overhead, compared to the hash functions (e.g., SHA-1) and private key encryption (e.g., AES), the most resource-consuming operations in PSMPA are parings and exponentiations which we will focus on for evaluating the computational complexity. In the signing procedure, the number of modular exponentiations is almost linear to the number of attributes in the union of the requiring attribute set in w_x^* and a default subset of attribute and ψ_x' . The verification procedure is by far the hardest to define performance for. The number of parings and exponentiations might always be linear to the number of nodes in the access tree. However, it can be reduced to $O(|S_R|(n+d-k))$ where S_R denotes the first k_R sets of the smallest size corresponding to the leaf nodes. To achieve the same security, our construction performs more efficiently than the traditional designated verifier signature for all the directly authorized physicians, where the overheads are linear to the number of directly authorized physicians. On the other hand, our construction also essentially distinguishes from the combination of a fine-grained attribute based encryption and a traditional DVS supporting flexible predicates, since in our construction the partial verifying key $e(g_1,g_2)^b$ is utilized for the secret key for encrypting *m*. m. It prevents the patient and the physicians from negotiating another symmetric encryption key in advance and saves almost half of the computational complexity, the signature size as well as the communication cost. Assume that *n*, n_D *d, k* represent the size of the required set of attributes w_x^* the physician's attribute set w_D the default attribute set ψ_x' and the flexible threshold respectively. P and E represent pairing and modular exponentiation operations. The storage and computational overhead of our construction PSMPA are illustrated in Tables 2 and 3 respectively.

Table 2: Storage Overhead Of PSMPA

Items	Storage Overhead
Public Key	$O(n+d-k)$
Private Key	$O(n_D+d)$
Signature	$O(n+d-k)$

Table 3: Computational Overhead of PSMPA

Items	Computational Overhead
Sign	$O(n+d-k)E$
Verify	to $O(\lvert S_R\rvert(n+d-k))(P+E)$

V CONCLUSION

There is a void of technological advancement in the field of medical science in India. Technology can ensure easy and fast access to the information, rapid sharing of data is also possible especially for the medical research purpose. Healthcare organization have a bright future in Cloud computing. The initialization cost is minimized in clouds. There is provision of scalability, elasticity which promote such advancements. Any time sharing of data to geographically diverse location is possible in such a distributed environment. The data being patient self controllable gives him the reliance that there will not be any misuse of his personnel health record.

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