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SeSPHR: A Methodology for Sharing Personal Health Records Securely in the Cloud

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ABSTRACT

The widespread use of cloud-based healthcare services has made it possible for many eHealth system participants to share Personal Health Records (PHRs) at a low cost and with simplicity. However, storing personal health information on clouds servers leaves it open to theft or exposure, prompting the creation of PHR privacy protection techniques. As a result, We provide SeSPHR, a method for safely transferring PHRs via the cloud. The SeSPHR method enables patient-centric PHR administration while protecting patients' privacy. Patients store their encrypted PHRs on untrustworthy data centres and provide access to various PHR parts to various categories of persons. Server Installation and Re-encryption (SRS), a semi-trustworthy proxy,used to create the pairs of authentication tokens and create re- encryption keys. Furthermore,system implements restriction of access in both the forward and backward directions while preventing risks from insiders. Using High Level Petri Nets, we explicitly assess evaluate the performance of the SeSPHR technique (HLPN). The SeSPHR approach should be used to safely exchange PHRs in the cloud,according the time consumption study.

Keywords: Cloud, Re Encrypted Server, SeSPHR

I. INTRODUCTION

Conveyed figuring [1], [2] has arisen as a critical handling perspective for inevitable and on-request admittance to different resources like gear, programming, system, and limit. Accordingly, the disseminated registering perspective advantages associations by letting them free from the tedious assignment of framework improvement and empowering them to depend on outsider Information Technology (IT) organizations [3]. Moreover, the disseminated processing worldview has shown enormous commitment in expanding coordinated effort among a couple of clinical consideration suppliers, as well as guaranteeing steady admittance to wellbeing information and flexibility [4]. [5]. Moreover, distributed computing incorporates an assortment of basic clinical consideration elements, for example,patients, center staff, including specialists, medical caretakers, drug stores, and clinical lab workers, protection suppliers, and specialist co-ops. [6]. Thus, the mix of the recently expressed substances prompts the development of a brilliant and helpful wellbeing organic framework in which patients may with certainty make [7]. PHRs normally contain information, for example, (a) section details, (b) patients' clinical past, considering investigation, responsive qualities,operations, as well as therapies, (c) research facility news, (d) information concerning health care coverage cases,(e) secret regarding health unambiguous huge took note. Hardships [8]. PHRs are all the more officially regulatedutilizing Internet-based instruments that permit patients to make and deal with their wellbeinginformation as long haul documents that might be given access to any individual whoever must have access [9]. Subsequently, PHRs empower individuals to discuss straightforwardly with specialists and other medical care suppliers to dive deeper into secondary effects, look for counsel, and stay up with the latest for exact determination and therapy.

In spite of the benefits of the cloud's versatile, agile, shrewd, and broad organizations, different worries about the security of wellbeing information create. Sharing and putting away PHRs in the cloud [10] is a significant reasoning for patients' interests about PHR secrecy. Putting individual wellbeing data on cloud servers that are managed by outsiders makes it helpless against unapproved access. PHRs put away in open fogs under the management of business master centers, specifically, are under grave danger [11]. The security PHRs are capable of risked invarious methods, including robbery, adversity, and spillage [12]. Because of the noxious way ofworking of PHRs in scattered capacity or on their excursion as from hospital to the internet or from the from one cloud to the other client, they might be powerless to unapproved entry. componentsoutwardly Furthermore, there are a couple of dangers to the information from huge insiders [13]. Because of the horrendous manners by which outside components act, PHRs indispersed capacity or on their excursion from the patient to the cloud or from the cloud to another client might be defenseless to undesirable access [10]. Individuals who work at the cloud expert center can possibly be accursed. A notable model is an occurrence where a Department of Veterans Affairs worker in the United States brought back touchy individual wellbeing information for over 26.5 million individuals with practically no endorsement [14The Affordable Care Act orders that the respectability and security of electronic wellbeing information put away by clinical benefit suppliers be safeguarded by conditions of direction and divulgence, as well as tolerant assent[15]. Taking into account everything, just substances or people with the 'right-to-know' honor ought to approach the PHRs. Moreover, the apparatus for giving admittance to PHRs ought to be managed by genuine patients to keep away from any unapproved alterations or abuse of information when it is shipped off to various accomplices in the wellbeing cloud climate. To ensure the security of PHRs stored on cloud servers, various systems have been utilized. Secrecy, uprightness, validness, obligation, and a starter assessment are completely ensured by the security saving strategies. Secrecy guarantees that wellbeing information is completely safeguarded from unapproved social events [14], while trustworthiness guarantees that data is kept new, whether on the way or in scattered capacity[16]. Authenticity guarantees that main allowed substances approach wellbeing data, while obligation alludes to how data access game plans ought to stick to laid out frameworks. Survey starter [6] is the most common way The framework views cloud servers as deceitful and, subsequently, gives a semi-believed server known as the Setup and Encryption Server(SRS) as a middle. Go-between The SRS utilizes a encryption-based method to produce encryption keys for secure PHR dividing between clients. PHRs are encoded by patients orPHR proprietors, and just endorsed clients with the keys given by the SRS can interpret the PHRs. Likewise, clients approach the exact pieces of PHRs that the PHR owner considers significant. When contrasted with different developments, the recommended procedure is secure in light of the fact that the PHR data is never shared. sent in the SRS in the proposed structure.Generally, the SRS's liability is to keep track of the keys, while encryption exercises dealt with because of the PHR proprietors, and the unraveling is taken care of by the referenced clients, who have legitimate unscrambling keys. The proposed technique likewise carries out forwardand in reverse access control. The keys are given to the people who have recently joined a particular client bunch by the SRS. The owner's keys, it could be said, tangle the common sense. After the PHR owner's endorsement, admittance to the data for recently joining individuals is conceded. Fundamentally, a leaving client is eliminated from the ACL, and theclient's looking at key erased. The repudiation of the client keys and ejection according to the ACL brings about the PHR denying any misguided confirmation endeavors after the client has left. We likewise utilized the Petri Nets at High Levels and the Z language to directa customary examination concerning the proposed connivance. The HLPN is utilized to reflect the structure, yet in addition to give mathematical properties that can be utilized to concentrate on how the system acts. The Library of Uses And gratification Theories and the Z3 solver are utilized to confirm the outcomes. The undertaking of check with the SMT is achieved by first deciphering the incorporates the petri net model alongside the particular assets, as well as afterward utilizing Z3 solve to decide whether the attributes are valid. Coming up next are the basic responsibilities of the arranged work: We present SeSPHR, a framework that permits people to control the cloud sharing of their wellbeing records. To guarantee PHR classification, the SeSPHR procedure utilizes El-Gamal encryption and mediator re-encryption. The strategy empowers PHR proprietors to give clients admittance to explicit PHR bits in light of the ACL's predetermined section level for particular client gatherings. RS, a semi-confided in halfway, is dispatched to guarantee entrance control and make encryption keys for unmistakable gatherings of clients, after which the vital organization above at the PHR owner's end is killed. In the recommended method, access control is executed both forward and in reverse. The proposed approach is exposed to formal assessment and confirmation to guarantee that it is working as per the determinations. Coming up next is a breakdown of the paper's construction. Area 2 presents the El-Gamal encryption and intermediary re-encryption thoughts. Area 3 presents the recommended procedure, SeSPHR, while Section 4 presents the conversation ofthe proposed strategy. Area 5 presents the conventional examination and check of the proposed strategy. The trial results are definite in Section 6, and the paper is closed in Section

II. PRELIMINARIES

Patients or PHR proprietors can oversee admittance to their wellbeing data utilizing the SeSPHR procedure, which guarantees fine-grained admittance control. Patients transfer encoded PHRs utilizing the proposed approach by scrambling the segments of PHRs autonomously, like I individual data, (ii) clinical data, (iii) protection related data, and (iv) remedy data. Moreover, the PHR client program produces the re-encryption settings, which are then moved to the SRS. To get to any piece of the PHR, they should initially confirm andafterward download it from the cloud. It's actually important that the client can't decode the

PHRs as of now since the client needs to get the significant unscrambling settings from the SRS. The SRS analyzes the requesting that client's ACL check whether the PHR proprietor has approved the client admittance to the parcel for which the decoding boundaries have beenmentioned. The SRS will create the pertinent boundaries and communicate them to the mentioning client in view of the entrance freedoms characterized in the ACL. It's significantthat the extent of this exploration is confined to getting the PHR. Moreover, normal conventions like as IPSec or SSL are thought to be utilized to get correspondence between the client and the SRS. The conventions referenced above are regularly utilized on the Internet and are fit for defending correspondence. Correspondence security, then again, is outside the extent of this review. SRS is accountable for the arrangement, key creation, and re-encryption processes. Therefore, said stages are examined exhaustively inSection3.3. We portray a few critical primer ideas prior to diving into the recommended system enabling the safe exchange of PHRs between various parties classes of clients. The thought of Personal Medical Records is presented in Section 2.1, and ElGamal encryption is momentarily talked about in Section 2.2. In Section2.3, the starter standards connecting with the proxyre-encryption are highlighted.

2.1 Personal Health Records are characterized an dynamical rendition of a patient's clinical data that is overseen by the patient. Patients can oversee datalike socioeconomics, analysis, medicines, observing, and taking care of oneself utilizing PHRs. PHRs contrast from Computerized Health Records constrained by wellbeing associations and contain data input by specialists and clinic staff as opposed topatients [8].

2.2 Encryption utilizing El-Gamal the El-Gamal cryptography framework is a cryptosystem that uses public keys in light of Diffie-Hellman key trade [18] T. El-Gamal suggested [17]. The El-Gamal encryption framework's security depends on the trouble of processing discrete logarithms. Instatement, encryption, and unscrambling are the fundamental cycles in the El-Gamal encryption philosophy [19]. Coming up next are a few early insights concerning the El-Gamal encryption: Implementation. Given a large prime p and the multiplicative function gathering Zp's generator g. Work out b 14 gx modp utilizing an irregular mystery key x. Moreover, p; b; g indicates the made The shared key. Cryptography. The source scrambles the letter m from getting the collector's public keyp; b; g: g 14 gx modp; (1) and d 14 m gx k: (2) The recipientgets the encoded message Em14 g;d. Decoding. After the collector gets the encoded message Em, it is unscrambled utilizing the confidential key x as well as the unscrambling consider the following:14 gp 1 x modp: d 14 gp 1 x modp: (3) The scrambled The letter m is decoded as follows: DEm 14 d dmodp: (4)

2.3 The s new of intermediary The intermediary reencryption technique utilizes an outsider with the capacity to re-encode the encoded text that was scrambled in just one of theimparting parties so it very well might be decoded by the other client or party. Arrangement,key creation, encryption, and unscrambling are the significant activities of intermediary re- encryption [4].

2.4 Encryption utilizing El-Gamal The El-Gamal scrambling framework is a shared key cryptography in light of Diffie-Hellman key trade [18] by T. El-Gamal [17]. The El-Gamal encryption framework's security depends on the trouble of processing discrete logarithms. Instatement, encryption, and unscrambling are the fundamental cycles in the El-Gamal encryption philosophy [19]. Coming up next are a few early insights concerning the El-Gamal encryption: Configuration. When given a huge fundamental p as well as the exponential gathering Zp's generator g. Work out b 14 gx modp utilizing an irregular mystery key x. Moreover, p; b; g indicates the made public key. Encryption. The source scrambles m's message by getting the collector's public keyp; b; g: g 14 gx modp; (1) and d 14 m gx k: (2) The recipientgets the encoded message Em14 g;d. Decoding. After the collector gets the encoded messageEm, it is unscrambled utilizing the confidential key x unscrambling consider the following:14 gp 1 x modp: d 14 gp 1 x modp: (3) The scrambled m' message is decoded follows: DEm 14 d dmodp: (4)

III. THE PROPOSED SESPHR METHODOLOGY

For ensuring security and opacity trade PHR across the public cloud proposed approachutilizes intermediary re-encryption. Figure 1 portrays the design of the proposed SeSPHR method. 3.1 Entities Three elements are engaged with the proposed strategy for sharing PHRsin the cloud climate: (a) the cloud, (b) the Setup and Re-encryption Server(SRS), and (c) the clients. The following is a concise synopsis of every one of the substances. The Cloud is an illustration for the Internet. The strategy suggests that PHR proprietors store their records inthe cloud and afterward safely share them with different clients. Customers move or downloadPHRs from or to internet systems, which are believed to be a dishonest substance. Since the cloud assets are exclusively used PHRs may be sent and downloaded by both types of clients in the proposed proc Architecture of the proposed SeSPHR Architecture.

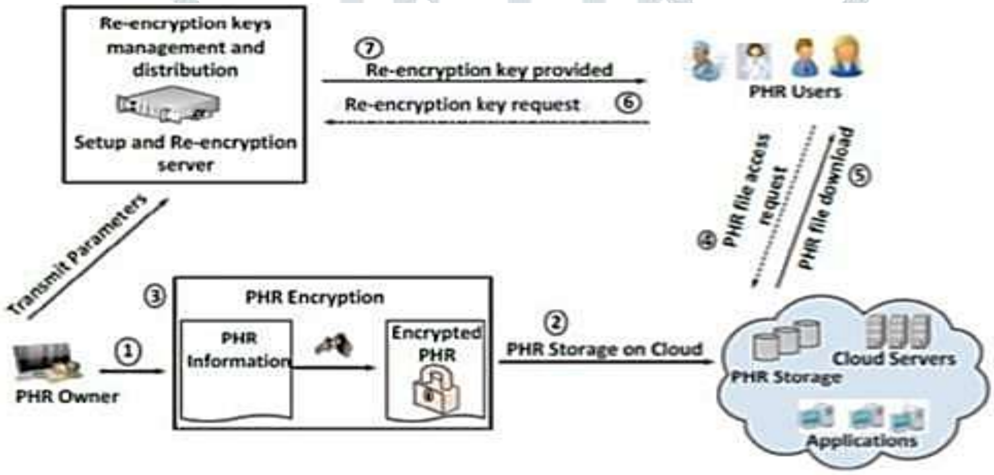


Fig. 01. The suggested SeSPHR methodology's architecture

Server for Arrangement as well as re-encryption (SRS). The SRS is a semi-trusted server in charge of laying out open/classified key counterparts for the structure's clients. The SRSadditionally produces re-encryption keys to guarantee PHR security appropriation different customer get-togethers In the proposed way of thinking, the SRS is viewed as semi-sure about substance. Subsequently, we expect it honestly and exploratory in nature, however forthe most part sticking to custom. The SRS monitors the keys, yet PHR data is never shared.imparted to the SRS. At the client's end, encryption and it are completed to unscramble activities. Beside key administration, the SRS likewise controls admittance to normal statistics. The SRS stands for a free that connection can't be send as opposed to a public cloud because of the deceitfulness of the cloudy. A trusted third-party can maintain the SRS.organization or with a care center for the benefit of patients. It really can likewise be overseen by a gathering of patients who are associated SRS kept up with by clinical facilities or a gathering patients,then again, will create more trust because of the investment of wellbeing experts or potentially tolerant poise over SRS. Clients. Patients and family members or buddies in terms of patients, trained professionals and specialists, medical care associations' representatives, drug subject matter experts, and researchers are the two primary kinds of clients for the structure. Buddies or family members are named secret space clients in the SeSPHR framework, though many clients are delegated public space clients. The PHR owners might give clients of both the private and public spaces fluctuating levels of admittance to the PHRs. For instance, clients who have a confidential space might be conceded finished admittance to the PHR, though open space clients like specialists, subject matter experts, and medication experts may just beconceded admittance to specific pieces of the PHR. Furthermore, when the PHR proprietor considers it significant, the recently portrayed clients might be allowed full admittance to the PHRs. Generally speaking, the SeSPHR method permits patients to rehearse fine-grained confirmation command over PHRs. To utilize the SRS's organizations, the clients in the structure should be all enlisted with the SRS. The enlistment depends on the clients'occupations, like subject matter expert, researcher, and prescription trained professional. PHR Partitioning (3.2) The PHR is separated into four pieces in a sensible way: Personal data; clinical data; protection related data; remedy data; However, it is important that the previously mentioned separating isn't unbending. The client has the choice of dividing the PHR into a more modest or bigger number parts. The PHRs are easily accessible circulated and tended to in plans, like XML. Besides,PHRproprietor might appoint a similar degree of access control to a few bundles. A particular client is probably not going to be conceded full admittance to their wellbeing records, and some PHR highlights might be limited to the client. A drug specialist, for instance, might beconceded admittance to arrangement and security related information, though individual andclinical information might be confined for a medication trained professional. Likewise, a relative or buddy might be conceded finished admittance to the PHR. A researcher could request admittance to clinical records while de-recognizing the singular subtleties that aren'tcompletely firmly established by PHR proprietor and are shipped off the SRS at the hourof information transferring in the cloud 3.3 Methodology Proposal in real life The SeSPHR procedure proposed incorporates theaccompanying components: (a) game plan, (b) key age, (c) encryption (d) unscrambling.Coming up next is a rundown of the strategies in general: Setup. With the heavenlysolicitation q, the proposed strategy snack away at G1 and G2 gatherings. G1 and G2's bilinear arranging is G1 G1! G2. A limit g is a generator that is sporadic to the place where g 2 G1. The variable Z is additionally an unpredictable generator, to the place where Z 14 eg;g2 G2 means "Key Generation." For the course of action of permitted clients, the SRS makes general society/private key matches. The keys are made in the accompanying manner: (5) where xi 2 Z q;SKi 14 xi;PK I 14 gxi; Client I's private and public keys are tended to exclusively by the SKi and PKi. The keys are safely conveyed to the clients in question. Encryption. Accept P knows that the individual in question necessities to move their PHR to the The patient client application is hosted in the cloud produces an unpredictable number(s) that compare to the PHR fragments entered by the client in the particular access level get-togethers. For our motivations, we think about every one of the four sections showed in Section 3.2 to be atan alternate degree of openness. Along these lines, four sporadic elements r1;r2;r3;r4 2 Z q are framed for our case. The variable ri is utilized to scramble the PHR's I-th bundle. The client application encodes each bundle independently. The application might execute encryption/unraveling on savvy parts of the PHR because of the XML plan. Coming up next is the way the recently portrayed parts of the PHR are encoded.

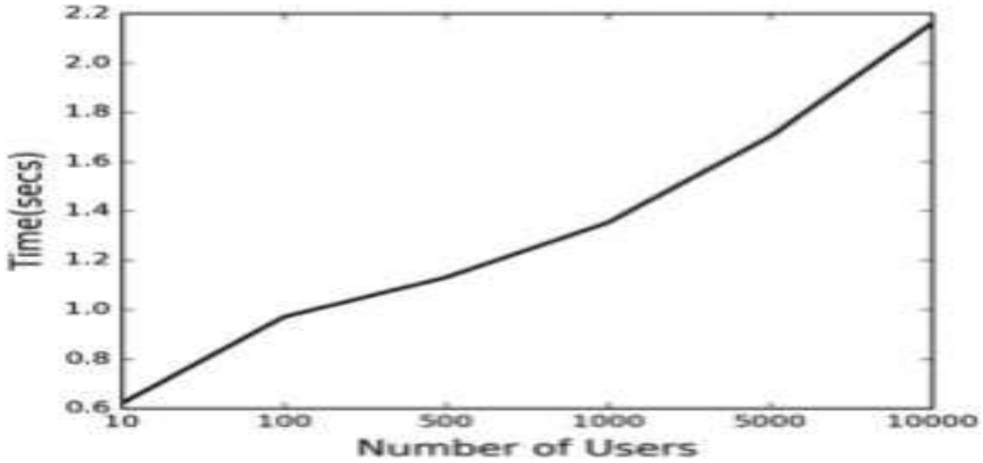
IV. DISCUSSION ON THE SESPHR METHODOLOGY

For PHRs shared through the public cloud, the recommended procedure gives the accompanying types of help. Secrecy secure PHR isolating between allowed client social occasions Guarding PHRs from undesirable access by critical insiders Control of access in the two bearings;

The cloud isn't viewed as a safe part in the proposed framework. The advantages of a conveyed processing viewpoint, like a common pool of resources, multi-inhabitance, and virtualization, could uncover PHRs in the cloud to insider and outcast dangers. Accordingly,the PHRs should be encoded prior to being put away on an outside cloud server. The PHR isfirst encoded on the PHR proprietor's end prior to being shipped off the cloud. In the recommended method, the cloud simply fills in as a stockpiling organization. The encryptionkeys, as well as other control information, are never put away in the cloud. Subsequently, the data's classification is significantly improved at the cloud's end. Despite how the unapprovedclient at the cloud acquires the encoded PHR document, the record can't be unscrambled on the grounds that the control data doesn't dwell The PHR's confidentiality is protected on the cloud. The proprietor scrambles the sent PHRs, while different clients get the plain information by using the encryption key took care of by the SRS. In contrast with the referenced client, the SRS just creates re-encryption limits for the endorsed fragments. Thus, a hacked continuousassembling part doesn't imperil the entire system's security. The PHR owner characterizes the ACL, which determines every one of the honors applicable to every one of the clients. The honors are characterized as far as client classes and are expanded/limited by the PHR owner's endorsement.

Considering the predefined opportunities on the parts, the SRS decides and imparts the re- encryption limits. Thus, even authentic clients can't get to the precluded package. The keys are acquired from the SRS by the recently joined segment.

The owner's keys, as it were, scramble the common data. The SRS's endorsement awards admittance to data for as of late joined parts. Moreover, providing another key in the system doesn't necessitate re-encryption of the information. Essentially, a leaving client is taken out from the ACL, similar to the contrasting keys. The renouncement of client keys and removal from the ACL brings about quick refusal of admission to the PHR for any misguidedaffirmation endeavors. In this design, the proposed framework is



very protected since it confines leaving clients' entrance (forward access control) while permitting approaching clients admittance to authentic information. (on account of opposite access control) The SRS is viewed as a semi-accepted, plain, and curious power. By and large, the SRS is expected tostick to the show. Notwithstanding the way that the SRS creates and stores the significant pair for every client, the data is never moved to the SRS, whether mixed or plain. The SRS just liable key administration as well as s new limits. Also, the SRS guarantees that the entry control is kept up with. Regardless, the proposed way of thinking's cutoff and challenge is support for the SRS.

V. PERFORMANCE EVALUATION

We assessed the SeSPHR framework's show from various viewpoints, including key maturing times, encryption and translating times, and the time important to return again. Welikewise viewed as the intricacy of the SeSPHR framework according to numerous viewpoints. Ensuing segments cover the subtleties of the trial arrangement and results. 6.1 Setup for Experiments The SeSPHR cycle for securely splitting PHRs between differentkinds of clients was assessed by fostering a Java client application. The cloud, SRS, and clients are parts of the proposed SeSPHR approach. As our conveyed stockpiling, we utilized

Simple Storage Services by Amazon [25]. The Java APIs for AWS organizationswere gotten by means of the Amazon Web Services SDK (AWS) for Java. As a pariah serverThe SRS is in charge of creating everybody/secret key matches and the encryption keys.The PHR information was encoded utilizing the Java Pairing Based Cryptography (JPBC) library [26]. We utilized Type A matching from the JPBC library, which depends on the twisty2 14 x3 x the great field Fq. The unified numbers q has been set to 64 bytes (512 pieces).The encryption and unscrambling system were finished in 64-byte lumps because of the unified number's decent size. The tests were led on a PC with an Intel Key Creation As demonstrated already in Article 3: Mission of the SRS is to lay out private/public key matching for clients who are essential for the endorsed client course of action.

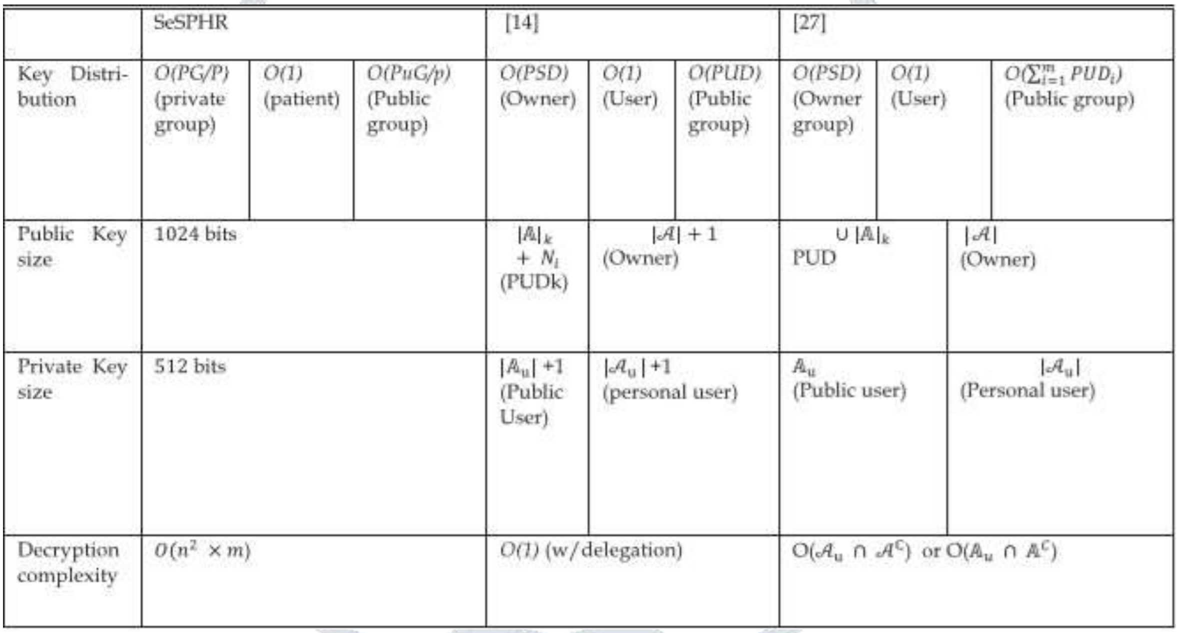
VI. TIME CONSUMPTION FOR KEY GENERATION

The age of the systems with a large number of customers might affect in common show of the structure. Thus, we evaluated the SeSPHR's show in terms of time spent on the crucial age adventure for different clients. In Figure 3, the time spent assembling keys for 10, 100, 500,1000, 5000, and 10,000 clients is shown. Rather than the commonplace example of expandedkey age time as the quantity of clients develops, it tends to be found in Fig. 3 that when the quantity of clients develops, the comparing expansion in The crucial age time is not consistent. For example, consider the time it takes to deliver key for ten client is 0.6 seconds, when the clock is ticking it takesto make keys for 100 clients is 0.97 seconds. Essentially, the critical age for 10,000 clientsis 2.16 second, which is somewhat sensible given the huge number of customers The critical age for newly entering people is likewise low, as such people join consistently, and makingkeys for a solitary client guarantees a proficient cycle. Encryption and decoding The time it takes for the SeSPHR scatter method and unscramble data records of different size is likewise estimated.

VII. RELATED WORK

The currently available works are associated are associated with the planned work presented in this section. The creators of [28] utilized a public key.

Comparison of SeSPHR with Other Approaches



	SeSPHR			[14]			[27]		
Key Distribution	$O(PG/P)$ (private group)	$O(1)$ (patient)	$O(PuG/p)$ (Public group)	$O(PSD)$ (Owner)	$O(1)$ (User)	$O(PUD)$ (Public group)	$O(PSD)$ (Owner group)	$O(1)$ (User)	$O(\sum_{i=1}^{m} PUD_i)$ (Public group)
Public Key size	1024 bits			$\lvert\mathbb{A}\rvert_k + N_1$ (PUDk)	$\lvert\mathcal{A}\rvert + 1$ (Owner)		$\cup \lvert\mathbb{A}\rvert_k$ PUD	$\lvert\mathcal{A}\rvert$ (Owner)	
Private Key size	512 bits			$\lvert\mathbb{A}_u\rvert +1$ (Public User)	$\lvert\mathcal{A}_u\rvert +1$ (personal user)		$\mathbb{A}_u$ (Public user)	$\lvert\mathcal{A}_u\rvert$ (Personal user)	
Decryption complexity	$O(n^2 \times m)$			$O(1)$ (w/delegation)			$O(\mathcal{A}_u \cap \mathcal{A}^C)$ or $O(\mathbb{A}_u \cap \mathbb{A}^C)$		

By freely introducing the Personally Identifiable Information, an encryption-based way to deal with managing keeping up with the haziness and unlikability of wellbeing informationin a semi-believed cloud can be utilized (PII). Patients encode PHRs utilizing the Operators of Cloud Services public key, and the CSP decrypts the data using the secretkey, store patient's the document's healthiness record and region (rundown), and afterward jumbles the utilizing symmetric cryptography of keys. The patient's administrative on The PHRs are maintained up to date. with by matching the region and the master important. In any event, one impediment The approach enables the CSP to decode the PHRs, which could prompt vindictive way of behaving. Then again, We developed a sub-finalist The SRS is a confided in power that re-encodes the decryption created by the PHR owner and the keys issued toclients who solicitation admittance to the PHRs. Chen et al.

VIII. CONCLUSIONS

We introduced an idea for safely putting away and sending PHRs to ensured cloud components. The method safeguards PHRs' secrecy and keeps a customer admittancecontrol over different pieces PHRs in light of the consents conceded because of the patients. We utilized a perfectly alright admittance management methodology as a result of which significant structure Customers are unable to access parts of the PHR that they aren't approved to see. Just permitted clients with credible keys for re-encryption given by a semi-trusted source moderate can unravel the PHRs, which are put away by the PHR owners on the cloud. The semi-accepted middle person'sresponsibility is to deliver and store general/privatekey matches for clients in the structure. .The framework keeps up with forward and turn around access control for leaving and recentlyjoining clients independently, as well as keeping up with secrecy and guaranteeing patient-driven permission control over PHRs. We likewise utilized the HLPN, SMT-Lib, and the Z3solver to authoritatively separate and confirm the SeSPHR approach's activity. The show assessment was finished utilizing the accompanying measures: time spent making encryption, and keys deciphering difficulties, and fruition time. The testing discoveries display theSeSPHR strategy's relevance for safely sharing PHRs in a cloud setting.

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