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Investigations on Remote Virtual Machine to Secure Lifetime PHR in Cloud

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ABSTRACT: This paper reviews methods to protect medical data in distributed cloud for the past 15 years. Methods developed to protect data in distributed environment evolved over the past 30 years are enumerated. Developing strategies to securely store data across cloud is a much focused topic of research in recent days. Cloud computing focuses on maximizing the effectiveness of the shared resources. Cloud storage provides a convenient means of storing and retrieval of huge amount of data. Personal Health Records (PHRs) should remain the lifelong property of patients and should be displayable conveniently and securely to selected caregivers. MyPHRMachines a patient centric system that takes a radically new architectural solution to health record interoperability. Patients Can Upload their Medical data then they access and share through remote Virtual machine. We have made a literature survey on techniques to protect PHRs and find open prototype of MyPHRMachines supports the use case of a real world patient scenario.

KEYWORDS: Cloud Computing, Personal Health Records (PHRs), MyPHRMachines, Medical data, Virtual Machine.

I. INTRODUCTION

Cloud computing offers unique opportunities for supporting long-term record preservation. MyPHRMachines [1], a patient owned health record system prototype based on remote virtual machines hosted in the cloud. MyPHRMachines is particularly promising for countries with a very heterogeneous architecture of systems across hospitals and other care institutions. In the view of developer PHRs should be portable. PHR systems typically offer functionality to share, visualize and analyze PHR data. Secure lifelong management of patient medical records since data are stored in the cloud and do not have to be carried around by patients.

The remainder of the paper is organized as follows. Literature review of several techniques prevailing in literature aimed to secure the electronic methods over past 15 years are discussed in Section 2. Section 3 gives the architectural representation of cloud based PHR storage systems. Section 4 gives a broad overview of discussion of experimental results carried out. Section 5 concludes the paper and outlines the future work.

II. LITERARY REVIEW

Jeffrey J. Clawson (2000 b) [20] projected "Method and system for giving remote emergency medical counsel to choking patients" defined that Medical system provided for emergency medical counsel to choking patients remotely. Gather emergency medical information including medical dispatch services to choking victims and providing qualified emergency medical information to callers thereby permitting "zero time" response. Advantage of using this technique is a choking victim injuries can be treated with appropriate guidance. It is mostly useful for the remote emergency sufferers they provide a "zero time" response at the case of emergency.

Marc Edward Chicorel (2001) [21] proposes medical progress note a doctor can utilize the base of about 350,000 bytes of medical descriptive to paradigm particular medical progress note. During completion of the patient meeting, the doctor proceeds to write a short "code" should have at least two letters in the suitable box on a predesigned form. Basically this process uses approximately 15 to 90 seconds of the doctor's time. The code is then entered into the

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programmed processor and information corresponding to the code is printed, analyzed and signed by the doctor. The printed and signed text is then entered into the patient's medical chart.

Charlyn Jordan (2002) [22] proposed "Health analysis and forecast of abnormal conditions" said Health record signals are been stored and processed for the predetermined health function or parameter to define value in the abnormal range. Also future health signal record is to trend the predetermined function and assume a value in abnormal range and condition. Jeffrey J. Clawson (2003) [23] defined Standard process is involved in gathering and processing emergency medical information, categorizing such information into various basis levels for correct response and for providing qualified emergency medical information to callers thereby permitting "zero-time" response. Important function of this system is dispatcher is guided through the examination of callers, meeting the critical information dispatching the mobile care when needed and giving the appropriate guidance to the caller. It has universal entry protocol for accessing medical complaints

PekkaRuotsalainen (2004) [24] in "A cross-platform model for secure Electronic Health Record communication" defined an Enhanced cross security platform is proposed which support a platform for communication through the adhoc network to access the distributed electronic health records. Roger J. Quy (2005) [25] in "Method and apparatus for health and disease management combining patient data monitoring with wireless internet connectivity" said the health related data is communicated from the WWD to a server using standard internet protocols. Server calculates the response time and further it reviewed by a physician or health care provider. User and server interaction takes place the server transmits a response to the WWD and the user may answer the response.

Avner Amir, Avner Man (2006) [26] in "System and method for administration of on-line healthcare" defined the end-unit device is guided by the CMIP so that anamnesis, diagnosis treatment is provided, monitored, recorded and clinically investigated. This system is useful for the management of medical records. Christopher Alban, KhiangSeow (2007) [27] defines a single electronic database it stores clinical patient notes, provides multiple points of read/write access through user interface operating on single or more client computers that are in real time communication with the repository. Brian A. Rosenfeld, Michael Breslow (2008) [28] in "System and method for accounting and billing patients in a hospital environment" explored if the billable service is provided by a specialist, a specialist identifier is also associated with the billable service. The hospitalized patient is counted and a current procedural terminology (CPT) manager assigns CPT codes to the billable service. A bill generator receives all the details of the patient data, insurance information and CPT codes which generate a bill for the billable services provided to the hospitalized patient.

Jacquelyn Suzanne Hunt, Joseph Siemienczuk (2009) [29] in "Process and system for enhancing medical patient care" explored the fact that a data warehouse receives the extracted information and reformats that information. Information's are analyzed by a health care provider having that medical condition. It further collects the data of the selected patients for multiple health care providers and enables comparisons of health care provider's success for such patients to promote advance of the treatment by less successful providers.

Richard J. Schuman (2010) [30] defines "Health care computer system" which define the A hospital bed, patient and nurse call system. A hospital network is provided. Communication is provided over a packet based communication network. Kanagaraj, G.Sumathi, A.C. (2011) [31] in "Proposal of an open-source Cloud computing system for exchanging medical images of a Hospital Information System" proposed clinical information system through the cloud can provide the essential details to the health care and the patient can seek the treatment in different hospital, reduce computational resource maintenance in the hospital also existing medical equipment's can be reconstructed to be more efficient and low-cost.

J. Vidhyalakshmi, J. Prassanna (2012 b) [33] proposed "Providing a trustable healthcare cloud using an enhanced accountability framework" explored that Security and accountability of patient's personal health record maintenance it handle the Privacy protection problem. They define Distributed accountability framework to control and monitor user data in cloud. It also handle the object centric which automatically trigger an object to create a log record and access over distributed data. Log file corruptions are handled, log manager maintenance and verify corrupted log records. With the introduction of cloud computing in medical data capital expenditure is converted to operational expenditure.

Carmelo Pino and Roberto Di Salvo (2013) [37] in "A Survey of Cloud Computing Architecture and Applications in Health" explained Cloud computing provide resource management and computation capabilities, hybrid cloud can increase the development of the health sector. Abhishek Kumar Gupta, Kulvinder Singh Mann (2014 b) [41] defined "Sharing of Medical Information on Cloud Platform" explored that basically hospitals store the patient details in paper format now in the migration to next level medical information are stored in cloud computing which provide a secure way to share. It results in the setting the platform for the exchange and collaboration of medical information.

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Table 1 Analysis of Various Problems and Proposed Solution Methodology in Literature

S.No.	Year	Authors	Problem Addressed	Proposed Solution
1	1984 a	Lichtenstein Eric Stefan	Monitors the status of the patient modular vessel structure	Modular vessel structures are keyed to exact programs
2	1984 b	Robert S. Behl, Falrport, Sybron Corporation, Rochester	Electronic portable for storing medical details and store bills	Electronic Medication Dispensing System
3	1985	Ralph R.Frerichs, Dr. PH.Robert A. Miller	To provide effective health report of a patient	Introduction of a Microcomputer for Health Research
4	1986	Steven P.Brown	Electro cardiogram based medical data analysis	Combinational Medical Data, Identification and health Insurance card
5	1987	ERobert J. Schwartz, Kenneth M. Weis, Anne V. Buchanan Dr. P.H(	Error Control in Medical Data	Automated record management
6	1989	Peter P. Gombrich, Richard J. Beard, Richard A. Griffee, Thomas R. Wilson, Ronald E. Zook, Max S. Hendrickson	Identification of patient	Bar code reading device, and LCD display Remote terminals
7	1990	Neil Bodick, Andre L. Marquis	Medical data identification of each individual patient.	Propose textual and pictorial information of medical information of patient
8	1991	Angela M. Garcia, Dr.,Boca Raton	Identifying patient health status frequently	Scheduling and Reporting Patient related services
9	1992	Robert W. Kukla	Transmission and receipt of the messages	Patient care communication system
10	1993	Mark C. Sorensen	Computer aided medical diagnostic problems	Disease are color coded, To aid a doctor or other user to diagnose disease.
11	1994 a	Edward J. Whalen, San Ramon, Olive Ave Piedmont	Managing medical records including narrative patent documents reports	Computerized file maintenance System
12	1994 b	Desmond D. Cummings	Interaction of patient and healthcare	Integrated interconnection within in a single system
13	1994 c	Woodrow B. Kesler Rex K Kesslerin	Tracking and evaluating medical treatment	Ambulatory patient care provide data for each analysis process
14	1995	Joseph P. Tallman, Elizabeth M. Snowden, Barry W. Wolcott	Guide and help patient through telephone.	Network management system (NMS)
15	1996	Peter S. Stutman, J. Mark Miller	Medical filtered information to a subscriber processing unit	Medical alert distribution system with selective filtering of medical information
16	1997	Edwin C. Iliff	Medical advice over a telephone network through voice response and speech recognition	Reenter function and sensitivity factors

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17	1998	Timothy Joseph Graettinger, Paul Alton DuBose	Diagnosis clarification of medical data	Computer-based neural network system
18	1999	Melanie Ann Clark, John Finley Gold, Michael Edward Huska, Geoffrey Harold Kabel, Marc Merrill Graham	Access to the patient data	Medical record management system
19	2000 a	Richard S. Surwit, Lyle M. Allen, III, Sandra E. Cummings	To monitor, diagnose medical conditions of remotely located patients	central data processing system to communicate and receive data
20	2000 b	Jeffrey J. Clawson	Remote emergency medical counsel	Choking victiminjuries can be treated
21	2001	Marc Edward Chicorel	A medical progress documentation	Computer keyboard-generated medical progress notes
22	2002	Charlyn Jordan	Tracking the health status of a patient and entering range of health record signals	Health analysis and forecast of abnormal conditions
23	2003	Jeffrey J. Clawson	Entry process of an emergency medical dispatch system	Processing, receiving and responding to emergency calls.
24	2004	PekkaRuotsalainen	Secure and sharing of distributed patient information	Enhanced cross security platform
25	2005	Roger J. Quy	Wireless health monitoring system	Patient data monitoring with connecting an internet enabled wireless device “WWD”
26	2006 a	Avner Amir, Avner Man	Method for administration of on-line healthcare	Common medical information protocol (CMIP)
27	2007	Christopher Alban, KhiangSeow	Storing, accessing and retrieving of data	Clinical documentation system
28	2008	Brian A. Rosenfeld, Michael Breslow	Accounting and billing patients in hospital environment	Current procedural terminology (CPT)
29	2009	Jacquelyn Suzanne Hunt, Joseph Siemienczuk	Enhancing medical patient care	Determined medical complaints shared by multiple patients
30	2010	Richard J. Schuman	Patient and health provider communication	Health care computer system
31	2011	Kanagaraj, G.Sumathi, A.C.	Processing and sharing medical information	Clinical information system
32	2012 a	AvulaTejaswi, NelaManoj Kumar, GudapatiRadhika, SreenivasVelagapudi	Authenticated doctors accessing.	Use Cloud Computing in Medical Science
33	2012 b	J.Vidhyalakshmi, J. Prassanna	Handling the Privacy protection problem	Healthcare cloud using an enhanced accountability framework
34	2013	Carmelo Pino and Roberto Di Salvo	Protecting patient sensitive information.	Design of Hybrid cloud
35	2014 a	K.S. Aswathy, G. Venifa Mini	Sharing the Personal Health Records in Cloud	Patient centric framework for sharing the personal health data
36	2014 b	Abhishek Kumar Gupta, Kulvinder Singh Mann	View and share the Medical Information	Setting the platform for the exchange and collaboration of medical information

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III. ARCHITECTURAL REPRESENTATION

The architectural representation of cloud based PHR storage is represented in Fig 1. The portal plays an important role in uploading copy of data, remote access maintenence, start/stop operation. PCAS access is used to provide and show copies. The cloud takes the responsibility of mounting the PHRs.

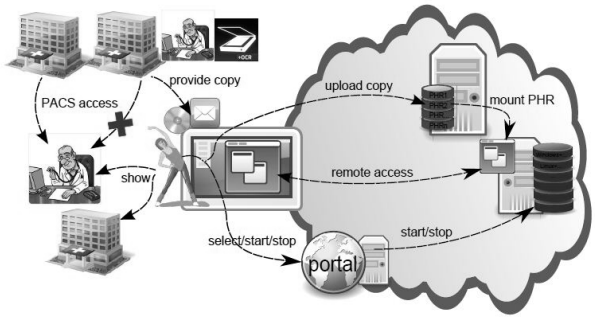

Fig. 1. Architectural example Cloud Based PHRs storage

Architectural representation of MyPHR Machine consists of two components evolution and storage with which client directly interacts with MyPHR Machine. The first component of MyPHR Machine consists of web portal which in turn interacts with Virtual Box Hypervisor. Virtual Machines are connected together with Virtual Box Hypervisor. The second component of MyPHR Machine, storage consists of VM Repository which houses VM Data and Private Network folders as indicated in Figure 2.

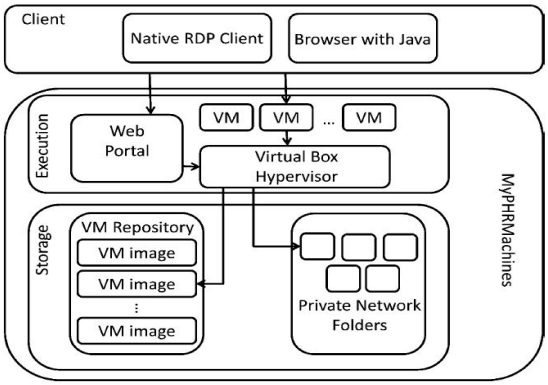

Fig. 2. Technical Architectural diagram of Cloud Based PHRs storage

IV. DISCUSSION AND RESULTS

MyPHRMachines allows patients to build PHRs which are robust across two dimensions namely:

i. Space Dimensions and ii. Time Dimensions

Two Use cases are also taken into consideration:

i. Spatial and Temporal pervasiveness and ii. Privacy related aspects.

The basic network model for the cloud data storage and four different network entities

1. User
2. Cloud Storage Server (CSS)
3. Cloud Service Provider (CSP)
4. Data owner

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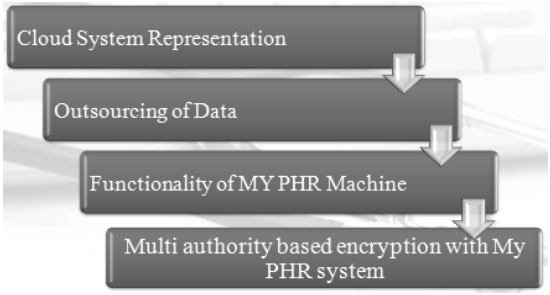

Fig. 3. Modular Workflow of Cloud Based PHRs storage

The process of multi authority based encryption with MyPHR system starts with a cloud system representation. After outsourcing of data the functionalities of MyPHR machine are carried out.

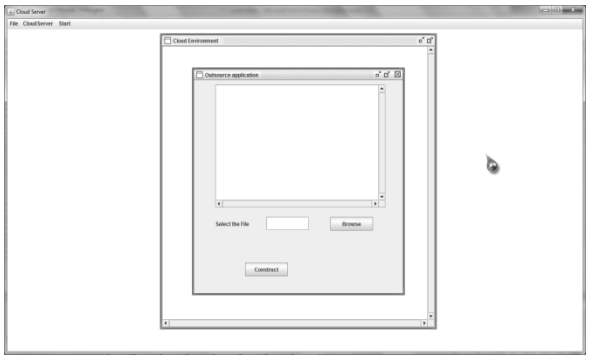

Fig. 4. A snapshot of outsourcing applications in Cloud Environment

The basic network model for the cloud data storage and three different network entities User: an entity, which has large data files to be stored in the cloud and relies on the cloud for data maintenance and computation, can be either individual consumers or organizations. Cloud Storage Server (CSS): an entity, which is managed by Cloud Service Provider (CSP), has significant storage space and computation resource to maintain the user data. The Data owner encrypted some keywords about his data, and service provider supported the owner to retrieve his data by keywords and not allow others to retrieve.

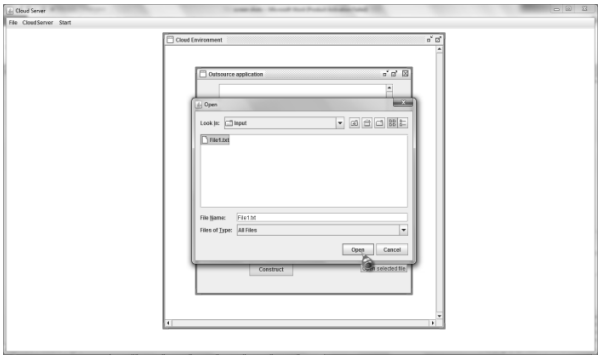

Fig. 4. B snapshot of outsourcing applications in Cloud Environment

Cloud storage services to users, where users can have access to very large volume of storage. Data kept on clouds can also be shared by users giving that the sharing is authorized by the data owners Alice has a piece of data that is kept on

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the cloud. Secure data sharing needs to be achieved via an un trusted cloud storage provider. It is necessary that the cloud storage provider helps to enforce the authorization policy for data access but the enforcement should not reveal any information to the cloud storage provider or enable the cloud storage provider have excessive privileges to allow unauthorized access.Cloud storage services provide, very large volume of storage to outsource user data. Data kept on clouds can also be shared to users that the sharing is authorized by the data owners. Cloud storage provider helps to enforce the authorization policy for data access.

V. CONCLUSION AND FUTURE WORK

In this paper, an extensive study is carried out on managing medical database in cloud for the past 15 years. Several approaches of cloud computing and high-performance computing models have been studied and the results were observed. Algorithms pertaining to ensuring security to electronic health records in cloud have been studied along with the computation overhead involved in implementing the algorithms for real and synthetic patient medical records. Also we have implemented the modular workflow based PHRs storage in Cloud Environment. .

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Prof.S.Balamurugan obtained his B.Tech degree in Information Technology from P.S.G. College of Technology, Coimbatore, Tamil Nadu, India and M.Tech degree in Information Technology from Anna University, Tamil Nadu, India respectively. He is currently working towards his PhD degree in Information Technology at P.S.G. College of Technology, Tamil Nadu, India. At present he holds to his credit **50 papers International Journals and IEEE/ Elsevier International Conferences.** He is currently working as Assistant Professor in the Department of Information Technology, Kalaignar Karunanidhi Institute of Technology, Coimbatore, Tamil Nadu, India affiliated to Anna University TamilNadu, India. He is **State Rank holder** in schooling. He was **University First Rank holder** M.Tech. Semester Examinations at Anna University, Tamilnadu, India. He served as a Joint Secretary of IT Association, Department of Information Technology, PSG College of Technology, Coimbatore, Tamilnadu, India. He is the **recipient of gold medal and certificate of merit** for best journal publication by his host institution **consecutively for 3 years**. Some of his professional activities include invited Session Chair Person for two Conferences. He has guided 12 B.Tech projects and 2 M.Tech. projects. He has won a best paper award in International Conference. His areas of research interest accumulate in the areas of Data Privacy, Database Security, Object Modeling Techniques, and Cloud Computing. He is a life member of ISTE,CSI. **He has authored a chapter in an International Book "Information Processing" published by I.K. International Publishing House Pvt. Ltd, New Delhi, India, 978-81-906942-4-7. He is the author of book titled "Principles of Social Network Data Security", ISBN: 978-3-659-61207-7.**

S.Charanyaa obtained her **B.Tech** degree in Information Technology and her **M.Tech** degree in Information Technology from Anna University Chennai, Tamil Nadu, India. She was **gold medalist** in her B.Tech. degree program. She has to her credit **12 publications in various International Journals and Conferences**. Some of her outstanding achievements at school level include **School First Rank holder** in **10th and 12th grade**. She was working as Software Engineer at Larsen & Turbo Infotech, Chennai for 3 years where she got promoted as Senior Software Engineer and worked for another 2 years. She worked at different verticals and worked at many places including Denmark, Amsterdam handling versatile clients. She is also the recipient of **best team player award for the year 2012 by L&T**. Her areas of research interest accumulate in the areas of Database Security, Privacy Preserving Database, Object Modeling Techniques, and Cloud Computing. **She is the author of book titled "Principles of Social Network Data Security", ISBN: 978-3-659-61207-7.**