International Journal of Recent Engineering Research and Development (IJRERD)
ISSN: 2455-8761
www.ijrerd.com || Volume 02 – Issue 09 || September 2017 || PP. 89-93

Security Enhancement of Health Information Exchange Based on Cloud Computing

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Abstract: Electronic Health Record helps us to improve the successful deployment of patient safety and quality of care, but it has the prerequisite of interoperability between Health Information Exchange at various different hospitals. The HL7 has developed a Clinical Document Architecture (CDA) is a core document standard to ensure such interoperability, and propagation of this document format is critical for interoperability. The hospitals are reluctant to adopt interoperable unfortunately by HIS due to its deployment cost except for in a handful countries. The data scattered in different documents are hard to manage because a problem arises even when more hospitals start using the CDA document format. Here, we described our CDA document generation and integration Open API service based on cloud computing, through which hospitals are enabled to conveniently generate CDA documents without having to purchase proprietary software. Our CDA document integration system integrates multiple CDA documents per patient into a single CDA document and physicians and patients can browse the clinical data in c1hronological order. In our system, the CDA document generation and integration is based on cloud computing and the service is offered in Open API. Developers using different platforms thus can use our system to enhance interoperability.

1. Introduction

Cloud computing is a type of Internet-based computing that provides shared computer processing resources, data to computers and other devices on demand. It is a model for enabling ubiquitous, on-demand access to a shared pool of configurable computing resources (e.g., computer networks, servers, storage, applications and services) they all can rapidly be provisioned and released with minimal management effort. Cloud computing and storage solutions provide users and enterprises with various capabilities to store and process the data either privately owned, or third-party centres that may be located far from the user ranging in distance across a city to the world. Cloud computing relies on sharing of resources to achieve coherence and economy of scale, similar to a utility (like the electricity grid) over an electricity network.

Cloud computing allowed to avoid up-front infrastructure costs in companies (e.g., purchasing servers). It enables organizations to focus on their core businesses instead of spending time and money on computer infrastructure. The cloud computing allows enterprises to get their applications up and running faster, with improved manageability and less maintenance, and enables Information technology (IT) teams to more rapidly adjust resources to meet fluctuating and unpredictable business demand. Cloud providers typically use a "pay as you go" model. This will lead to unexpectedly high charges if administrators do not adapt any of the cloud pricing model.

Cloud storage is the model for data storage in which the digital data is stored in logical pools, the physical storage spans multiple servers (and often locations), and the physical environment is typically owned and managed by a hosting company. These cloud storage providers a responsible for keeping the data available, accessible, the physical environment protected and running. People and organizations buy or lease storage capacity from the providers to store user, organization, or application data. Cloud storage services may be accessed through a co-located cloud computer service, a web service application programming interface (API) or by applications that utilize the API, such as cloud desktop storage, a cloud storage gateway or Web-based content management systems.

Electronic Health Record (EHR) is longitudinal collection of electronic health information for and about persons, where health information is defined as information pertaining to the health of an individual or health care provided to an individual and it can support of efficient processes for health care delivery. In order to ensure successful operation of EHR, a Health Information Exchange (HIE) system is needed in place. However, most of the HIS in service are different and incompatible. Hence, effective health information exchange needs to be standardized for interoperable health information exchange between hospitals. Especially, clinical document standardization lies at the core of guaranteeing interoperability. CDA (Clinical Document Architecture) by Health Level Seven is a major standard for clinical documents. CDA is a document markup standard that specifies the structure and semantics of ‘clinical documents’ for the purpose of exchange[4].

Objective of the Research Implementing CDA over cloud to maintain entire patient details and Integrating the Clinical Document over the cloud and making it to be readily available at all times. Integrated model of CDA can lead to the health care service quality improvement by strengthening the users' role in managing their own medical care. The use of integrated Medical record system will enable data sharing, analysis tools, and infrastructure that can speed up many research, especially in health care services, by enabling new insights and enhancing efficiency. This study had developed a design framework that uses cloud computing to host the CDA application in form of Software as a Service, which provide 3-way of access type and will be used by Government, Hospitals, Doctors, Patients, and Pharmacies through the Internet [4].

2. Related Works

The establishment of the Meaningful Use criteria has created a critical need for robust interoperability of health records. A universal definition of HIE has not been agreed upon. Standardized code sets have been built for specific entities, but integration between them has not been supported. The purpose of this research study was to explore the hindrance and promotion of interoperability standards in relationship to PHRs to describe interoperability progress in this area. Lagging interoperability has stemmed from slow adoption by patients, creation of disparate systems due to rapid development to meet requirements for the Meaningful Use stages, and rapid early development of PHRs prior to the mandate for integration among multiple systems. Findings of this study suggest that deadlines for implementation to capture Meaningful Use incentive payments are supporting the creation of PHR data silos, thereby hindering the goal of high-level interoperability[4].

If your patients lack trust in Electronic Health Records (EHRs) and Health Information Exchanges (HIEs), feeling that the confidentiality and accuracy of their electronic health information is at risk, they may not want to disclose health information to you. Withholding their health information could have life-threatening consequences. To reap the promise of digital health information to achieve better health outcomes, smarter spending, and healthier people, providers and individuals alike must trust that an individual's health information is private and secure. Your practice, not your EHR developer, is responsible for taking the steps needed to protect the confidentiality, integrity, and availability of health information in your EHR system[6].

Benefited from cloud computing, users can achieve an effective and economical approach for data sharing among group members in the cloud with the characters of low maintenance and little management cost. Meanwhile, we must provide security guarantees for the sharing data files since they are outsourced. Unfortunately, because of the frequent change of the membership, sharing data while providing privacy preserving is still a challenging issue, especially for an untrusted cloud due to the collusion attack. Moreover, for existing schemes, the security of key distribution is based on the secure communication channel, however, to have such channel is a strong assumption and is difficult for practice. In this paper, we propose a secure data sharing scheme for dynamic members. Firstly, we propose a secure way for key distribution without any secure communication channels, and the users can securely obtain their private keys from group manager. Secondly, our scheme can achieve fine-grained access control, any user in the group can use the source in the cloud and revoked users cannot access the cloud again after they are revoked. Thirdly, we can protect the scheme from collusion attack, which means that revoked users cannot get the original data file even if they conspire with the untrusted cloud. In our approach, by leveraging polynomial function, we can achieve a secure user revocation scheme. Finally, our scheme can achieve fine efficiency, which means previous users need not to update their private keys for the situation either a new user joins in the group or a user is revoked from the group [8].

Data sharing in the cloud is a technique that allows users to conveniently access data over the cloud. The data owner outsources their data in the cloud due to cost reduction and the great conveniences provided by cloud services. Data owner is not able to control over their data, because cloud service provider is a third party provider. The main crisis with data sharing in the cloud is the privacy and security issues. Various techniques are available to support user privacy and secure data sharing. This paper focus on various schemes to deal with secure data sharing such as Data sharing with forward security, secure data sharing for dynamic groups, Attribute based data sharing, encrypted data sharing and Shared Authority Based Privacy-Preserving Authentication Protocol for access control of outsourced data[11].

3. System Analysis

The CCR was created by health care practitioners based on their perceptions of the data they wish to share in a given circumstance. Unlike many other standards, clinician's been actively involved in the creation of the CCR and was integral to defining its form and content. It is patient focused andempha sizes the data directly related to a patient's current me dical problems. Ideally, the content for any instantiations defined by a provider who knows the patient well. The CCR document is then used to transmit timely and focuses information to other physicians involved in the patient's care. ASTM International defines the CCR as a summary of the patient's

health status (e.g., problems, medications, allergies) and basic information about insurance, advance directives, care documentation, and care plan recommendations [25].

The CCR has a header, footer, and 17 optional sections, which cover a wide range of functions including detailed insurance and payment-related administrative data that are highly specific to the USA. The CCR Header defines the document parameters, including its unique identifier, language, version, date/time, the patient whose data it contains, who or what has generated the CCR, to whom or what the CCR is directed, and the CCR's purpose [25]. The CCR Footer contains data defining all of the actors, as well as information about external references, all text comments, and signatures associated with any data within the CCR [25].

The CCR Body contains the core-patient-specific data, such as current and past medications, problems, and procedures. Data are aggregated into sections based on common clinical conventions. In a typical scenario, pulling in existing data from a variety of sources dynamically creates the body, and no new content is specifically created for the summary. In some cases, the source data will be narrative; in other cases there may be coded data supporting some aspects of the narrative; and in some cases the source data will be fully coded [25].

CCD (Continuity of Care Document) maps the CCR functionality into HL7 V3 CDA format, setting out a set of constraints on CDA, using templates. Although the stated purpose of CCD is to communicate clinical summaries, it is increasingly being used as a framework for developing other types of message. One way of looking at CCD is to consider it as a set of templates, because all parts are optional and it is practical to mix and match the ones you need. This is the direction of travel for future versions of CCD. A CCD is the semantic equivalent of a CCR – both are in XML and both adhere to ANSI-based specifications. Implementers must choose either one or the other standard as the primary data format. CCD has been endorsed by HIMSS and HITSP as the recommended standard for exchange of electronic exchange of components of health information [15].

Electronic Health Record (EHR) is a collection of patient and population electronically is stored the health information through systematized in digital format. It is a digital version of a patient's paper chart. The records are shared through different healthcare settings. The authorized providers can be created and managed of an EHR is that health information in a digital format capable shared with other providers across more than one health care organization. The EHR has the capacity to generate a complete record of a clinical patient come across, as well as supporting other care related activities directly or indirectly via interface. The important note is, EHR is generated and maintained within an institution, like a hospital, integrated delivery network, clinic, or physician office. The patient receives those service from an auxiliary department are created as an electronic record[16].

Clinical Document Architecture is in XML based format. It is classified from the HL7 RIM (Reference Information Model)and uses HL7 version 3 data types. The documents contain any relevant information to a healthcare provider or government entity and all information about a patient's medical history, such as allergies, medications, insurance information or lab results. Each piece of clinical data is allocated a section and given a code as defined in the Logical Observation Identifiers Names and Codes (LOINC). For the integrated CDA document, we chose the Korean Standard for CDA Referral and Reply Letters format as the number of clinical documents generated when patients are referred and replies made, is large. The CDA is divided into two categories such as Header and Body. In CDA Header that includes Patient ID, Birth Date, Gender, Given Name, and Family- Name. In CDA Body, the items are included as Problem, Medication, Laboratory, Immunization, and so on. Different subcategories are inserted in a CDA document depending on the purpose of the document, and chose the Continuity of Care Document (CCD) because it contains the health summary data for the patient and it is also widely used for interoperability [4].

4. Experimental Result and Analysis

Construction of cloud computing environment and deployment of CDA generation and integration based on it Amazon Elastic Compute Cloud (EC2) we used as the cloud platform for our CDA generation to build our CDA generation and integration system. Microsoft Windows 7 was selected as its operating system. PHP is used for the implementation, health information management, CDA generation and exchange information on the cloud environment. Wamp server is selected as the web server platform for service deployment. CDA document and integration system development is made and deployment is done on the selected Amazon Cloud Server. Hospitals conveniently generate and integrate CDA document based on exploiting the API offered by our system.

Generation of CDA documents through cloud CDA documents that we generated by using the API offered at our server from different development platforms. The sample patient data is considered as a input data. The data does not pertain to an actual person and it is fictional data.

Integration of CDA documents via cloud Integrated multiple CDA documents of patient referrals and replies by using the API at our server. The scenario and patient uses the data are considered for our work are fictional. The generation of different patient CDA document is made successfully and integration is also verified.

5. Conclusion

This System not only provides an opportunity to the hospital to enhance their patient care but also can increase the profitability of the organization. Hospital Management System would enable hospitals or Nursing homes to serve the rapidly growing number of health care consumers in a cost-effective manner. Check up with our executive to more on these Hospital administrators would be able to significantly improve the operational control and thus streamline operations this would enable to improve the response time to the demands of patient care because it automates the process of collecting, collating and retrieving patient information. Very important for some, the reduced cost of the manpower would pay for the cost of this product within a short time after its implementation. The CDA document format for clinical information in normal design to promise interoperability between hospitals, a large number of HIE projects that use the CDA file arrangement have been under taken by lot of countries. Our cloud computing based CDA production and combination structure has a few articulated advantages over other existing projects.CDA file generation and integration system based on cloud server is more useful over accessible services for CDA file if the variety of CDA file increases.

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