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A Review on CDA Generation and Integration for Health Information Exchange Based on Cloud Computing System

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Abstract—CDA is a document mark-up standard that specifies the structure and semantics of a clinical document (such as a discharge summary or progress note) for the purpose of exchange. A CDA document is a defined and complete information object that can include text, images, sounds, and other multimedia content. It will transferred within a message and can exist in-dependently, outside the transferring message. In Electronic Health Record, helps improve patient safety and quality of care, but it has the prerequisite of interoperability between Health Information Exchange at different hospitals. The Clinical Document Architecture (CDA) developed by Health Level Eight could be a core document normal to make sure such ability, and propagation of this document format is important for ability. In hospitals are reluctant to adopt practical HIS as result of its preparation price apart from different countries. A drag arises even once many hospitals begin victimization the CDA document format as a result of the information scattered in numerous documents is an onerous to manage. In this paper, we have a tendency to describe our CDA document generation and integration Open API service supported cloud computing, through that hospitals are enabled to handily generate CDA documents while not having to buy proprietary software system.

Our CDA document integration system integrates multiple CDA documents per patient into one CDA document and physicians and patients will browse the clinical knowledge in written record order. Our system of CDA document generation and integration is predicated on cloud computing and the service is obtainable in Open API. Developer's victimization completely different platforms so will use our system to boost ability.

Keywords—*Cloud Computing, Infrastructure as a Service, Health information Exchange.*

I. INTRODUCTION

Clinical Document Architecture, Release One (CDA R1), became an American National Standards Institute (ANSI)–approved Health Level 7 (HL7) Standard in November 2000, representing the first specification derived from the HL7 Reference Information Model (RIM).1,2 CDA, Release Two (CDA R2), became an ANSI-approved HL7 standard in May 20053 and is the subject of this article, where the focus is primarily on how the standard has evolved since CDA R1, particularly in the area of semantic representation of clinical events.Health care industry being the largest and fastest growing industry, in all the top countries it consumes at most 10% of GDP. It plays a major role in the country's economy, but the biggest problem it faces is the exchange of information between different hospitals. Around 30% of the health care spending is wasting on the maintenance of the records and billing since there is no effective technique used for integration of the data. Standardization of all the medical records into a single platform is one of the best ways to maintain the records. In our system, we have implemented EHR in such a way that the platform is both patient and doctor friendly. Various authentication measures where used to provide security to the patient's documents. Using an Attribute Based Encryption technique for implementing the EHR with secured and effective way of exchange information can bring out.

A. Research of cloud computing

[1].Cloud computing is the use of computing resources (hardware and software) that are deliver as a service over a network (typically the Internet). The name comes from the common use of a cloud-shaped symbol as an abstraction for the complex infrastructure it contains in system diagrams. Cloud computing entrusts remote services with a user's data, software and computation [2].Cloud computing consists of hardware and software resources made available on the Internet as managed third-party services. These services typically provide access to advanced software applications and high-end networks of server computers [3]. The goal of cloud computing is to apply traditional supercomputing, or high-performance computing power, normally used by military and research facilities, to perform tens of trillions of computations per second, in consumer-oriented applications such as financial portfolios, to deliver personalized information, to provide data storage or to power large, immersive computer Games [4]. The cloud computing uses networks of large groups of servers typically running low-cost consumer PC technology with specialized connections to spread data-processing chores across them. This shared IT infrastructure contains large pools of systems that are link together. Often, Virtualization techniques are used to maximize the power of cloud computing.

II. LITERATURE SURVEY

This paper deals with the discussion of the implementing the EHR and secured and effective way of exchange of information can be bring out.

Health Level 7 has established CDA as a major standard for clinical documents [5]. CDA is a document mark-up standard that specifies the structure and semantics of 'clinical documents' for the purpose of exchange. The first version of CDA was developed in 2001 and Release 2 came out in 2005 [6]. Many projects adopting CDA have been successfully completed in many countries [7], [8], [9]. Active works are being done on improving semantic interoperability based on open EHR and CEN13606 [10], [11]. To establish confidence in HIE interoperability, more HIS's need to support CDA. However, the structure of CDA is very complex and the production of correct CDA document is hard to achieve

without deep understanding of the CDA standard and sufficient experience with it. In addition, the HIS development platforms for hospitals vary so greatly that generation of CDA documents in each hospital invariably requires a separate CDA generation system. In addition, hospitals are very reluctant to adopt a new system unless it is necessary for provision of care. As a result, the adoption rate of EHR is very low except for in a few handful countries such as New Zealand or Australia [12]. In the USA, the government implemented an incentive program called the Meaningful Use Program to promote EHR adoption among hospitals [13]. When a patient is, diagnose at a clinic, a CDA document recording the diagnosis is generate. The CDA document can be share with other clinics if the patient agrees. The concept of family doctor does not exist in Korea, hence it is common for a patient to visit a number of different clinics. The exchange of CDA document is trigger in the following cases: when a physician needs to study a patient's medical history; when referral and reply letters are draft for a patient cared by multiple clinics; when a patient is in emergency and the medical history needs to be review. It takes increasing amount of time for the medical personnel as the amount of exchanged CDA document increases because more documents means that data are distribute in different documents. This significantly delays the medical personnel in making decisions. Hence, when all of the CDA documents are integrate into a single document, the medical personnel is empowered to review the patient's clinical history conveniently in chronological order per clinical section and the follow-up care service can be delivered more effectively. Unfortunately, for now, a solution that integrates multiple CDA documents into one does not exist yet to the best of our knowledge and there is a practical limitation for individual hospitals to develop and implement a CDA document integration technology. In this paper, we present;first,a CDA document generation system that generates CDA documents on different developing platforms and Second, A CDA document integration system that integrates multiple CDA documents scattered in different hospitals for each patient. The benefits of adopting this system are as follows. First, the system is accessible through an Open API and developers can continue working on their developer platforms they specialize in such as Java, .NET, or C/CPP. Hospital systems can simply extend their existing system rather than completely replacing it with a new system. Second, it becomes unnecessary for hospitals to train their personnel to generate, integrate, and view standard-compliant CDA documents. The cloud CDA generation service produces documents in the CDA format approved by the National Institute of Standards and Technology (NIST) [14]. Third, if this service is providefree at low price to hospitals, existing EHR are more likely to consider adoption of CDA in their practices. This paper is organize as follows. In Section 2, detailed explanations are giving on the format of CDA document, cloud computing, and the overall architecture of our proposed system. Section 3 describes the efficacy of the proposed system and contrasts it to different HIE systems in various countries to highlight the strength of our system.

B. Existing system

At the point when a patient is, analyze at a center, a CDA report recording the diagnosis is generate. The CDA report can be impart to different facilities if the patient concurs. The idea of family specialist does not exist in Korea;consequently, it is normal for a patient to visit various diverse centers. The trading of CDA archive is activate in the accompanying cases: when a physician needs to study a patient's medical history; when referral and reply letters are drafted for a patient cared by multiple clinics; when a patient is in crisis and the restorative history should be looked into. It requires expanding measure of investment for the restorative faculty as the measure of traded CDA report increments since more archives implies that information are dispersed in various records. This essentially postpones the medicinal faculty in deciding. Thus, when the greater part of the CDA records are coordinated into a solitary archive, the medicinal work force is enabled to audit the patient's clinical history helpfully in sequential request per clinical segment and the subsequent care administration can be conveyed all the more viably. Tragically, for the present, a solution that integrates multiple CDA documents into one does not exist yet to the best of our knowledge and there is a practical limitation for individual hospitals to develop and implement a CDA document integration technology.

C. Proposed system

In this paper, we show (1) a CDA document generation system that creates CDA reports on various creating stages and (2) a CDA record integration system that incorporates numerous CDA records scattered in various hospitals for every patient. The advantages of receiving this system are as per the following. First, the system is available through an Open API and developers can keep taking a shot at their developer platforms they specialize in such as Java, NET, or C/CPP. Hospital systems can broaden their existing system rather than completely replacing it with a new system. Second, it gets to be superfluous for healing facilities to prepare their staff to create, incorporate, and see standard-agreeable CDA records. The cloud CDA era benefit produces records in the CDA organize affirmed by the National Institute of Standards and Technology (NIST). Third, if this administrationgiven to free at low cost to healing facilities, existing EHR will probably consider reception of CDA in their practices.

Advantage of Proposed System

Our cloud computing based CDA generation and integration system has a couple declared focal points over other existing activities.

- Hospitals do not need to buy appropriateness software to create and incorporate CDA reports and bear the cost as before.
- Our administration is readily applicable to various developer platforms because an Open API is to drive our CDA document generation and integration system. Despite the kind of the stage, CDA reports can be effectively produce to support interoperability.
- CDA record generation and integration system in view of cloud server is more helpful over existing administrations for CDA document if the assortment of CDA report increases.

III. SYSTEM ARCHITECTURE

In this implementation, we have two Main modules,

- CDA Generation System Module
- CDA Integration System Module

A. CDA Generation System Module

1. Software as a Service (SasS): This service model provides software.
2. Platform as a Service (PaaS): Cloud providers supply a computing platform to its clients where they can deploy applications of its own, program language of its own.

3. Infrastructure as a Service (IaaS): Vendor integrates basic infrastructure such as IT systems and database and then rents them to client. In this paper, we chose a widely used cloud service, Amazon Cloud, and provide the CDA generation and integration system as SaaS

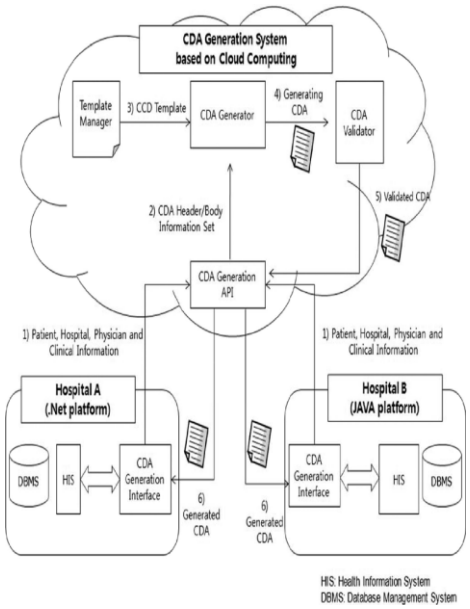

Figure. 1. The architecture of our CDA generation system based on cloud computing.

CDA Generation System Based on Cloud Computing Figure1 shows the overall architecture of how CDA documents can be generate on the health information systems of different hospitals by using our cloud computing-based CDA generation system. Hospital A and Hospital B are demonstrate to show that it is easy to generate CDA documents on a variety of platforms if done via cloud. The purpose of each of the components is as follows:

- CDA Generation API generates CDA documents on cloud
- CDA Generation Interface uses the API provided by the cloud, relays the input data, and receives CDA documents generated in the cloud.
- Template Manager is responsible for managing the CDA documents generated in the cloud server. Our system uses CCD document templates.
- CDA Generator collects patient data from hospitals and generates CDA documents in the template formats as suggested by the Template Manager.
- CDA Validate inspects whether the generated CDA document complies with the CDA schema standard. The DBMS at each hospital and the HIS are link as follows. Hospital A, which uses a .Net-based system, is connecting via ODBC to connect to the DBMS while Hospital B, which uses a JAVA-based system, which is link with Hibernate. At a hospital, the clinical information of patient, hospital, and physician is entering via CDA GenerationInterface and sending to the cloud server via CDA Generation API. We utilize SOAP (Simple Object Access Protocol) as transmission protocol for enhancing interoperability among different HIS when a hospital sends data to the cloud.

CDA Generation API relays the data in the CDA Header/Body in the list type. The items included in CDA Header are: Patient ID, Birth Date, Gender, Given Name, and Family-Name. In CDA Body, the following items are included: Problem, Medication, Laboratory, immunization, and so on.The data sent to the CDA Generation API is package in CDA Header Set and CDA Body Set and relayed to CDA Generator. CDA Generator retrieves a CCD template from

Template Manager and fills in the appropriate fields of the CCD template with the data from the CDA Header/Body Sets. The generated CDA document is inspecting by the CDA Validate whether the CDA standards are being satisfied. It is inspect whether there is any missing element or the format is adequately following. If no error where found, a CDA document is return to the recipient hospital. Hospitals A and B are presented to demonstrate that it is possible for different development platforms to extend to generate CDA documents via a cloud server.

B. CDA Integration System Module

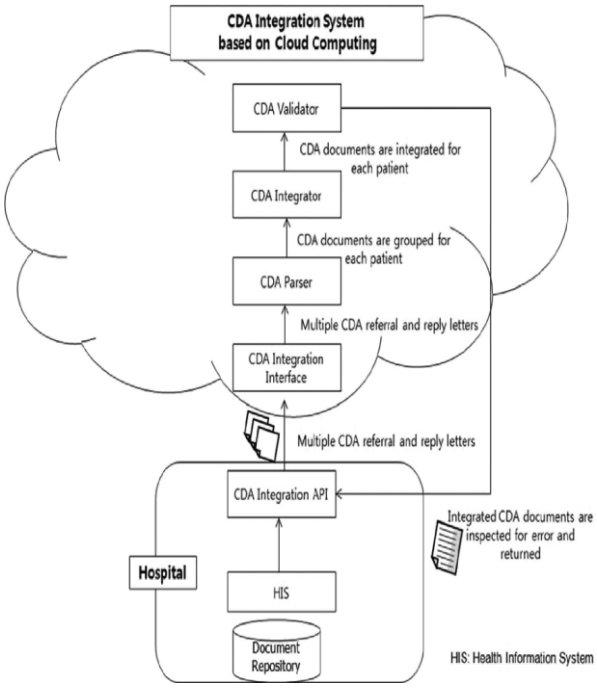

Figure. 2. The architecture of CDA integration system based on cloud computing.

Figure two shows how multiple CDA documents are integrate into one in our CDA Document Integration System. The standard for this is Korean Standard for CDA Referral and Reply Letters (Preliminary Version). Templates, which generate a CDA, use CCD part of Consolidated CDA, which is release by ONC and made by HL7. However, an actually generated CDA has a form of CDA Referral and Reply Letters. The rationale for CDA document integration is as follows. When CAD-based HIE (Health Information Exchange) is actively used among hospitals, the number of CDA documents pertaining to each patient increases in time. Physicians need to spend a significant portion of their time on reading these documents for making clinical decisions. In Korea, physician's consultation time spent per patient is very short since the insurance model is fee for- service. Chronic patients especially are very likely to have been consult by multiple physicians, in different hospitals. In this case, CDA documents may be scattered in different locations. Therefore, multiple CDA documents needs to be integrate into single CDA document. If the medical history of a patient is available in a single CDA document, the physician's time can be more efficiently use. This is evident when a patient is being refer to a different

hospital or when a referral reply letter is send. Our survey of physicians shows that displaying each section in chronological order helps improve the quality of care. This paper shows how we integrate CDA documents on a cloud server so that a variety of existing systems can be easily extend to generate integrated CDA documents. At a hospital, the CDA documents to be integrate are process through our CDA Integration API. The CDA Integration Interface relays each CDA document sent to the cloud to the CDA Parser, which converts each input CDA document to an XML object and analyzes the CDA header and groups them by each patient ID. The CDA Document Integrator integrates the provided multiple CDA documents into a single CDA document. In this process, the data in the same section in the document body are merge, following the LOINC values that set apart each section in the CDA document. The integrated CDA document is inspect for error in the CDA Validate, and the result is return as string to the hospital that requested CDA document integration. This is because the CDA Integration System and the CDA Generation System are separate entities, and a new CDA document is create after document integration, hence it is necessary to determine whether the new document complies with the CDA document integration, especially whether there is any missing element, or the format is wrong. Error messages are return if found. Then the received string is convert to a CDA document file and saved. The validation process by CDA Validate is depend on the CDA schema. An error is generating when a required field has left blank or the wrong data type has been use. Example: The CDA document generation time, 'effective Time,' needs to be set, at least, in the YYYYMMDD format such as 20140806.

IV. RESULTS

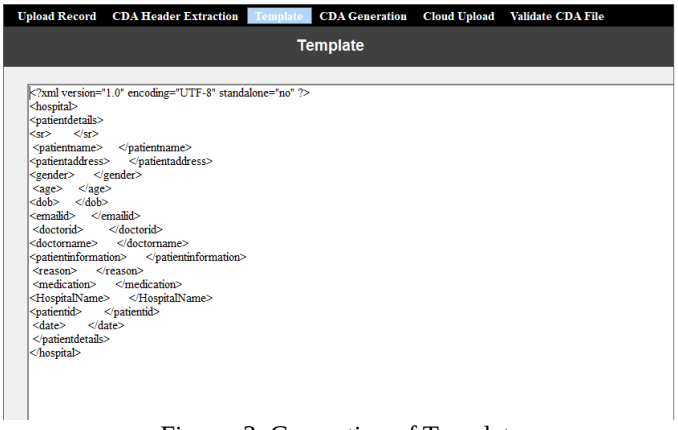

Figure. 3. Generation of Template

The figure 3 shows the structure of template format in this paper.

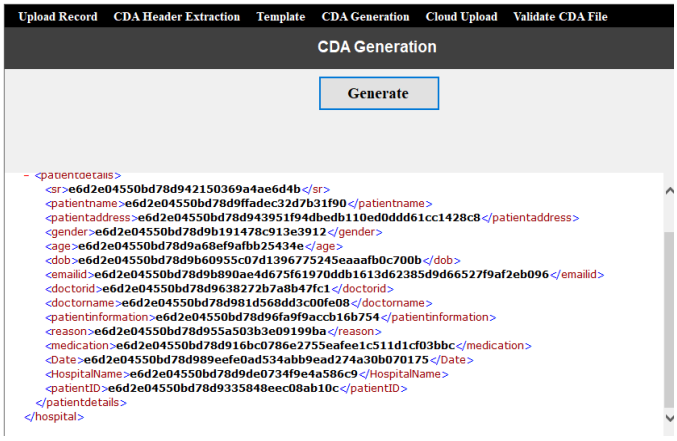

Figure. 4.Generate CDA Document

The figure 4 show that how the CDA document is generated and also the data in CDA document is in encrypted format.

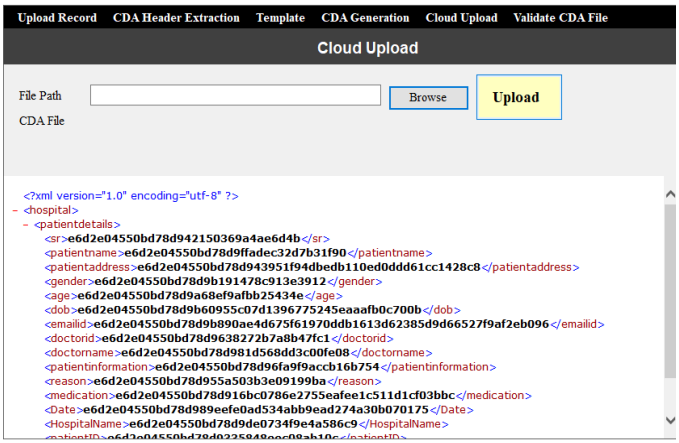

Figure. 5. Upload CDA document to Cloud

The figure shows that what the document format is when the document is upload to cloud. The important thing is the data in document should be in encrypted format hence the data cannot be forge.

CONCLUSION

As the number of HIE based on CDA documents increases, interoperability is achieved, but it also brings a problem where managing various CDA documents per patient becomes inconvenient as the clinical information for each patient is scattered in different documents. The CDA document integration service from our cloud server adequately addresses this issue by integrating multiple CDA documents that have been generate for individual patients. The clinical data for the patient in question is provide to his/her doctor in chronological order per section so that it helps physicians to practice evidence-based medicine. In the field of document-based health information exchange, the IHE XDS profile is predominant and our cloud computing system can be readily link with the IHE XDS profile. The approach employed in this paper is applicable in adopting other standards, too, such as the EHR Extract based on open EHR. If a hospital sends the content archetype, admin archetype, and demographic archetype to the cloud server, then the server extracts necessary information from each archetype. Next, it generates an Extract containment structure that fits with a designated template and returns the structure to the requested hospital.

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