

In light of Cloud Computing System CDA Generation and Integration for Health for Data Exchange

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Abstract— *Theoretical Successful sending of Electronic Health Record enhances tolerant security and nature of care, however it has the essential of interoperability between Health Information Exchange at various doctor's facilities. The Clinical Document Architecture (CDA) created by HL7 is a center record standard to guarantee such interoperability, and engendering of this archive configuration is basic for interoperability. Lamentably, clinics are hesitant to receive interoperable HIS because of its organization fetched with the exception of in a modest bunch nations. An issue emerges notwithstanding when more healing facilities begin utilizing the CDA archive arrange on the grounds that the information scattered in various reports are difficult to oversee. In this paper, we portray our CDA report era and incorporation Open API benefit in light of distributed computing, through which doctor's facilities are empowered to advantageously create CDA archives without purchasing restrictive programming. Our CDA archive combination framework incorporates various CDA records per tolerant into a solitary CDA report and doctors and patients can peruse the clinical information in sequential request. Our arrangement of CDA report era and joining depends on distributed computing and the administration is offered in Open API. Engineers utilizing distinctive stages along these lines can utilize our framework to improve interoperability.*

Keywords--- *Health information exchange, HL7, CDA, cloud computing, software as a service.*

I. INTRODUCTION

Electronic Health Record (EHR) is longitudinal accumulation of electronic wellbeing data for and about per-children, where wellbeing data is characterized as data relating to the strength of an individual or social insurance given to an individual and it can support of proficient procedures for human services conveyance. Keeping in mind the end goal to guarantee fruitful an operation of EHR, a Health Information Exchange (HIE) framework should be actualized. In any case, the greater part of the

HIS in administration have diverse attributes and are commonly contradictory. Henceforth, successful wellbeing data trade should be institutionalized for interoperable wellbeing data trade between healing facilities. Particularly, clinical archive institutionalization lies at the center of ensuring interoperability.

Wellbeing Level Seven has built up CDA as a noteworthy standard for clinical archives . CDA is a report markup standard that indicates the structure and semantics of 'clinical records' with the end goal of trade. The main adaptation of CDA was produced in 2001 and Release 2 turned out in 2005 . Many ventures receiving CDA have been effectively finished in numerous nations. Dynamic works are being done on enhancing semantic interoperability in light of openEHR

To build up trust in HIE interoperability, more HIS's have to bolster CDA. Be that as it may, the structure of CDA is exceptionally mind boggling and the creation of right CDA report is difficult to accomplish without profound comprehension of the CDA standard and adequate involvement with it. What's more, the HIS advancement stages for healing centers shift so extraordinarily that era of CDA records in every doctor's facility constantly requires a different CDA era framework. Likewise, healing facilities are exceptionally hesitant to receive a new framework unless it is completely important for arrangement of care. Subsequently, the selection rate of EHR is low with the exception of in a couple of modest bunch nations, for example, New Zealand or Australia. In the USA, the administration actualized a motivator program called the Meaningful Use Program to advance EHR selection among healing facilities .

At the point when a patient is analyzed at a center, a CDA report recording the analysis is created. The CDA archive can be imparted to different centers if the patient concurs. The idea of family specialist does not exist in Korea, henceforth it is normal for a patient to visit various distinctive centers. The trading of CDA record is activated in the accompanying cases: when a doctor needs to concentrate a patient's restorative history; when referral

and answer letters are drafted for a patient minded by numerous facilities; when a patient is in crisis and the therapeutic history should be investigated.

It requires expanding measure of investment for the therapeutic faculty as the measure of traded CDA record increments since more reports implies that information are dispersed in various archives. This fundamentally defers the medicinal faculty in deciding. Thus, when the greater part of the CDA records are incorporated into a solitary report, the medicinal faculty is enabled to audit the patient's clinical history advantageously in sequential request per clinical segment and the subsequent care administration can be conveyed all the more successfully. Sadly until further notice, an answer that incorporates numerous CDA archives into one doesn't exist yet to the best of our insight and there is a down to earth confinement for individual clinics to create and execute a CDA report combination innovation.

In this paper we exhibit a CDA record era framework that creates CDA archives on various creating stages and a CDA report joining framework that coordinates numerous CDA records scattered in various clinics for every patient. The advantages of embracing this framework are as per the following. Initially, the framework is open through an Open API and designers can keep taking a shot at their engineer stages they have practical experience in, for example, Java, .NET, or C/C++. Healing center frameworks can essentially expand their current framework instead of totally supplanting it with another framework. Second, it winds up plainly superfluous for healing facilities to prepare their faculty to create, coordinate, and view standard-agreeable CDA reports. The cloud CDA era benefit produces records in the CDA design endorsed by the National Institute of Standards and Technology (NIST). Third, if this administration is given to free at low cost to healing facilities, existing EHR are more probable to consider appropriation of CDA in their practices.

This paper is composed as takes after. nitty gritty clarifications are given on the configuration of CDA report, distributed computing, and the general design of our proposed framework. depicts the viability of the proposed framework and complexities it to various HIE frameworks in different nations to highlight the quality of our framework.

II. MATERIALS AND METHODS

In this segment, we show the fundamental methods in detail for the outline, and clarify the execution of our CDA era and reconciliation framework in view of distributed computing.

The CDA Document

The HL7 Clinical Document Architecture Release 2 (CDA R2) was affirmed by American Nation Standards Institute in May 2005. It is a XML-based record markup standard that indicates the structure and semantics of clinical reports, and its main role is encouraging clinical archive trades between heterogeneous programming frameworks. A CDA archive is separated into its header and body. The header has an obviously characterized structure and it incorporates data about the patient, healing facility, doctor, and so forth. The body is more adaptable than the header and contains different clinical information. Each bit of clinical information is assigned a segment and given a code as characterized in the Logical Observation Identifiers Names and Codes (LOINC). Diverse subcategories are embedded in a CDA record contingent upon the reason for the report, and we picked the Continuity of Care Document (CCD) in light of the fact that it contains the wellbeing synopsis information for the patient and it is likewise broadly utilized for interoperability. Outstanding information incorporated into CCD are recorded in the bellow figure 1.

For the incorporated CDA record, we picked the Korean Standard for CDA Referral and Reply Letters (Preliminary Version) design as the quantity of clinical archives created when patients are alluded and answers made, is vast. It has the indistinguishable structure as the CCD and the sorts of information contained in the body are recorded in figure 2.

III. FIGURES AND TABLES

Data Items in CCD Header and Sections in the CCD Body

| <u>CDA Location</u> | <u>Dataitems</u> |
|---------------------|--|
| CDA Header | Document Information (creation time, template ID, language code, purpose) Patient's information (ID, name, gender, birth date) Author's information (ID, name, represented organization) Organization's information (name, address, phone number) |
| CDA Body | Payers Advance Directives Support Functional Status Problems Family History Social History Allergies Medications Medical Equipment Vital Signs Results Procedures Encounters Plan of Care |

Fig.1: Information Items in CCD Header and Sections in the CCD Body.

Sections in the Korean Standard for CDA Referral and Reply Letters Body (Preliminary Version)

| Sections in CDA body | CDA Referral letter | CDA Reply letter |
|-----------------------------------|---------------------|------------------|
| Diagnosis | Yes | Yes |
| History of past illness | Yes | No |
| History of Medication Use | Yes | Yes |
| Laboratory studies | Yes | Yes |
| Radiology studies | Yes | Yes |
| Pathology studies | Yes | Yes |
| Function Status Assessment | Yes | Yes |
| Surgical Operation Note | Yes | Yes |
| Relevant Diagnostic Tests | Yes | Yes |
| Reason for referral | Yes | No |
| Special Treatments and Procedures | Yes | No |
| Subsequent Evaluation Note | No | Yes |
| Plan of Treatment | No | Yes |

Fig.2: Segments in the Korean Standard for CDA Referral and Reply Letters Body (Preliminary Version)

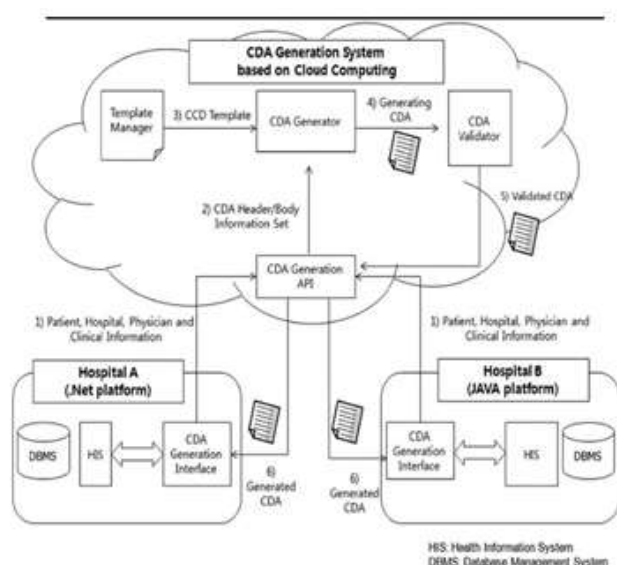


Fig.3: The engineering of our CDA era framework in light of distributed computing.

1. Programming as a Service (SaaS): This administration show genius vides programming.
2. Stage as a Service (PaaS): Cloud suppliers supply a processing stage to its customers where they can send uses of its own, program dialect of its own.
3. Foundation as a Service (IaaS): Vendor coordinates fundamental foundation, for example, IT frameworks and database and after that rents them to customer.

In this paper, we picked a generally utilized cloud benefit, Amazon Cloud [20], and give the CDA era and joining framework as SaaS.

CDA document Generation System Based on cloud computing

Fig. 3 demonstrates the general design of how CDA reports can be created on the wellbeing data frameworks of

various doctor's facilities by utilizing our distributed computing based CDA era framework. Healing center An and Hospital B are exhibited to demonstrate that it is anything but difficult to create CDA reports on an assortment of plat-structures if done by means of cloud. The motivation behind each of the segments is as per the following:

- CDA Generation API produces CDA reports on cloud.
- CDA Generation Interface utilizes the API given by the cloud and transfers the info information and gets CDA records produced in the cloud.
- Template Manager is in charge of dealing with the CDA reports produced in the cloud server. Our framework utilizes CCD archive formats.
- CDA Generator gathers quiet information from doctor's facilities and produces CDA archives in the format for-mats as recommended by the Template Manager.
- CDA Validator investigates whether the created CDA Archive consents to the CDA blueprint standard.

The DBMS at every healing center and the HIS are connected as takes after. Healing center A, which uses a .Net-based framework is associated by means of ODBC to interface with the DBMS while Hospital B, which utilizes a JAVA-based framework, is connected with Hibernate. At a doctor's facility, the clinical data of patient, healing facility, and doctor is entered by means of CDA Generation Interface and sent to the cloud server by means of CDA Generation API. We use SOAP (Simple Object Access Protocol) as transmission convention with the end goal of improving interoperability among various HIS when a healing facility sends information to the cloud. CDA Generation API transfers the information in the CDA Header/Body in the rundown sort. The things incorporated into CDA Header are: PatientID, BirthDate, Gender, Given Name, and Family-Name. In CDA Body, the accompanying things are incorporated:

The information sent to the CDA Generation API are bundled in CDA Header Set and CDA Body Set and transferred to CDA Generator. CDA Generator recovers a CCD layout from Template Manager and fills in the fitting fields of the CCD format with the information from the CDA Header/Body Sets. The produced CDA record is examined by the CDA Validator whether the CDA norms are being fulfilled. It is assessed whether there is any missing component or the configuration is satisfactorily taken after. In the event that no mistake is found, a CDA report is come back to the beneficiary healing center. Healing facilities An and B are introduced to show that it is workable for various improvement stages to reach out to produce CDA reports through a cloud server.

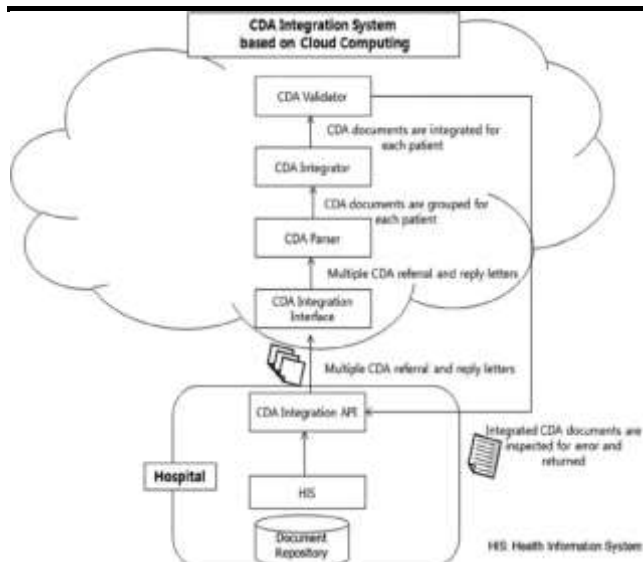


Fig.4: The design of CDA reconciliation framework in light of cloud computing.

CDA Integration System Based on Cloud Computing

Fig. 4 shows how multiple CDA documents are integrated 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 released 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 CDA-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 consulted by multiple physicians, in different hospitals. In this case, CDA documents may be scattered in different locations. Therefore, multiple CDA documents needs to be integrated 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 used. This is evident when a patient is being referred to a different hospital or when a referral reply letter is sent. 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 extended to generate integrated CDA documents.

At a hospital, the CDA documents to be integrated are processed 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 merged, following the LOINC values that set apart each section in the CDA document. The integrated CDA document is inspected for error in the CDA Validator, and the result is returned 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 made 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 returned if found. Then the received string is converted to a CDA document file and saved. The validation process by CDA Validator is based on the CDA schema. An error is generated when a required field has been left blank or the wrong data type has been used. Example: The CDA document generation time, 'effective Time,' needs to be set, at least, in the YYYYMMDD format such as 20170310.

IV. RESULTS

In this section, we report the results concerning the implementation of CDA generation and integration system based on cloud computing construction of a cloud computing environment and deployment of CDA generation and integration system based on it we chose Amazon Elastic Compute Cloud (EC2) as the cloud platform for our CDA generation and integration system. Microsoft windows server 2008 base was selected as its operating system. We chose Singapore as the server location. Java (jdk 1.6) was used for CDA document generation and integration system and tomcat 6.0.26 was selected as the web server platform for service deployment. As discussed in, we developed the CDA document integration and integration system and deployed the system on the amazon cloud server. Hospitals conveniently generate and integrate CDA documents by exploiting the API offered by our system.

Generation of CDA documents on different developer platforms through cloud to verify whether the system functions as designed, we requested CDA document generation on multiple systems implemented on different developer platforms via our API. For input data, we used the sample patient data offered by the us EHR certification program, meaningful use. The data does not pertain to any actual person. It is fictional, and available for public

access. The use case scenario and data for CDA document generation are shown in figure 5.

We verified the validity of our CDA documents with the CDA document validation tool provided by us NIST (<http://CDAvalidation.nist.gov/CDAvalidation/validation.Html>), which has the authority to certify CDA documents, to validate the CDA documents generated by using the API at our cloud server. The CDA documents generated by two clients developed with java and c#, respectively, passed the validity test.

The Use Case Scenario and Patient Data Used for Integration

| | |
|------------------------------|---|
| Patient | The patient is a 50-year-old White male |
| Characteristics | with a history of asthma controlled by albuterol for breakthrough. He also has a history of type II diabetes and hypercholesterolemia controlled on Novolog, Lantus, and Lipitor. |
| Diagnosis | 8/6/2012 pneumonia with mild hypoxemia |
| History of Medication Use | albuterol inhaled, Inhalant Respiratory, 2.5mg/3ml NEB 3 times daily PRN wheezing/shortness of breath ceftriaxone, IV, 1 gram IV once daily |
| Diagnosis Procedures | 08/15/2012 Costal Chondritis |
| Laboratory Studies | Pulmonary function tests |
| Diagnosis | CO2, 25 mmol/L |
| History of Medication Use | 08/15/2012 Angina |
| Procedures | Aspirin 81 MG Oral Tablet once daily |
| Functional Status Assessment | Electrocardiographic Procedure |
| Laboratory Studies | Intranasal oxygen therapy |
| | Memory impairment |
| | Dependence on walking stick |
| | Na, 140 mmol/L |
| | K, 4.0 mmol/L |
| | Cl 100 mmol/L |

Fig.5: The Use Case Scenario and Patient Data Used for Integration

V. CONCLUSION

Interoperability between healing facilities not just makes a difference enhance persistent security and nature of care additionally lessen time and assets spent on information designer plat-shapes in light of the fact that an Open API is to drive our CDA report era and coordination framework. Notwithstanding the sort of the stage, CDA reports can be effectively created to bolster interoperability. Third, CDA archive era and reconciliation framework in light of cloud server is more helpful over existing administrations for CDA record if the assortment of CDA report increments. As of December 2013, there are 54 unique sorts of CDA

reports perceived by US NIST, and the number keeps on developing step by step. Among 54 CDA Document Templates, the approach recommended in this paper is being tried for CCD some portion of CCDA and Korean Standard for CDA Referral and Reply.

Customarily, when another kind of CDA record configuration is built up, doctor's facilities need to overhaul or buy restrictive programming to oblige documents in that new organization. With our API notwithstanding, there is no compelling reason to change the product on the customer end; just the product at the server-end should be adjusted to receive the new CDA archive organize. With the cloud-based engineering proposed in this paper, it winds up noticeably advantageous to create records that agree to new report measures. In this manner, the cloud server can promptly furnish archives that agree to CDA Release 3 if just the server embraces its model, information sort, and execution rules. As the quantity of HIE in view of CDA reports expands, interoperability is accomplished, yet it additionally brings an issue where overseeing different CDA archives per persistent ends up plainly badly arranged as the clinical data for every patient is scattered in various records. The CDA report joining administration from our cloud server satisfactorily addresses this issue by incorporating numerous CDA archives that have been produced for individual patients. The clinical information for the patient being referred to is given to his/her specialist in sequential request per area with the goal that it helps doctors to practice confirm based drug. In the field of archive based wellbeing data trade, the IHE XDS profile is transcendent and our distributed computing framework can be promptly connected with the IHE XDS profile. The approach utilized in this paper is appropriate in embracing different models, as well, for example, the EHR Extract in light of open EHR. On the off chance that a healing center sends the substance prime example, administrator paradigm, and statistic original to the cloud server, then the server separates important data from every model. Next, it produces an Extract regulation structure that fits with an assigned format and returns the structure to the asked for healing center. What's more, patients are empowered to utilize the CDA report combination administration to get Personal Health Record (PHR) which contains clinical archives as well as Personal Health Monitoring Record (PHMR) [and Patient Generated Document (PGD)]. Patients can viably produce and deal with their PHR by utilizing our cloud-based CDA archive combination benefit. The accompanying issues were experienced while building up our CDA archive era and incorporation sys-tem. To begin with, the default dialect of the Amazon Cloud OS is US English and it didn't enough deal with Korean dialect in the CDA records. While the

customer took care of the strings in Korean dialect without issues, the server did not, which was settled by introducing Korean dialect pack in the server OS. At the point when SaaS is offered focusing on doctor's facilities of various dialects, designers should give careful consideration to this issue. Second, the API parameter for our CDA report era administration was of the rundown sort, however under the C# dialect condition, the parameter was changed over to the string cluster sort. This is suspected to have been created by the IDE programming of C#, which naturally makes this sort transformation. Subsequently, the returned information should be as non specific as conceivable to be material to however many plat-shapes as could be expected under the circumstances.

In our future work, we will investigate the accompanying focuses. Initially, we will make a solid estimation of the lessening in cost when the EHR framework moves toward becoming cloud-based. Building up a sensible charge framework is an essential issue for distributed computing . There is abundant confirmation that distributed computing is successful and effective in cost lessening, and the medicinal field is by all accounts no special case. Security and strength is beat need for distributed computing assets as it is utilized by numerous clients. Future work will endeavor to improve security while guaranteeing sensible nature of administration even with numerous clients signed on the framework in the meantime.

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