Clinical Document Exchange : Grid Approach

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Abstract

The need of clinical document standard is for representing normative structure and semantics to exchange clinical document having different structure among institutions. The CDA is clinical document standard to specify the structure and semantics of clinical documents for the purpose of exchange. However, the CDA is just to provide a common frame to encode the content of documents, in order to share the documents in many institutions, it should be considered the basic methodology that manages the documents and supports to communicate between many institutions. In this paper we propose the clinical document exchanging system with grid approach which is generalized high level of distributed and parallel processing. Using the information service from grids, we purpose the system architecture and components.

Keywords:

Document Management, Grid, CDA, Medical Informatics

Introduction

The need of clinical document standard is for representing normative structure and semantics in order to exchange clinical document having different structure among institutions. The CDA (Clinical Document Architecture) was an ANSI-approved clinical document standard adapted from HL7 (Health Level 7) which is a standards-setting organization related to health care. For the purpose of exchange, the CDA specifies the structure and semantics of clinical documents. The CDA was composed of header and body part. The CDA header identifies and classifies the document and provides information on authentication, the encounter, the patient, and the provider. The body contains the clinical report. From the technical point of view, it is easy to exchange clinical document between two health institutions. Especially, the documents from CDA make easy to capture the meaning and structure. However, if many institutions want to share the clinical documents and exchange, using CDA is not sufficient. That is just to provide a common frame to encode the content of documents. Therefore, in order to share the documents in many institutions, it should be considered the basic methodology that manages the documents and supports to communicate between many institutions. In the simplest way, we can consider a centralized system gathering all data from institutions. In this case, there are some problems as follows.

- How to reserve a large amount of storage space about data.
- How to process many requests quickly and reliably.
- How to manage policy problems between institutions caused by a centralized database without considering of security.
- How to manage the database if a new institution is registered.

To avoid the problems, clinical document exchanging system should be developed with considering an independence and peculiarity of each institution. In this paper, we suggest a decentralized and distributed clinical document exchanging model to combine the heterogeneous systems. It enables to share the documents between institutions. In our investigation, we adopt “grid” concept, which has been rising as next generational computing architecture. Grids are generalized high level of distributed and parallel processing. As related to grids, globus [1] toolkit has been developed by Argonne Laboratory, and in many research areas [2,3,4,5] such as meteorological observations or high energy physical experiments, grids has been worked variously to solve an enormous storage and computing power. We use the concept of information service from grids. The concept is about to provide information which resource can be available in organized grids. Using information service, all scattered clinical document can be accessed just as one system while maintaining own system independently.

Assumption & Requirements

In this paper we assume that each institution has its own CDR (Clinical Document Repository) and each CDR is based on CDA or not. Based on the assumptions, we consider the following requirements.

- We would partially adjust or substitute CDR Manager in order to save cost, instead of reorganizing a legacy CDR to communication clinical information.
- We would strengthen the security by restriction on the access of information in CDR.
- We would develop the flexible system which can be managed easily.

- We would store and control the usage information of CDR.
- We would develop the system to communicate easily between other institutions.
- We would develop the system which is possible to exchange the clinical document between all institutions while maintaining their own CDR.

In the next section we design the system based on these requirements.

System Component & Architecture

System Organization in an Institution

Figure 1 shows the system architecture to be composed in an institution.

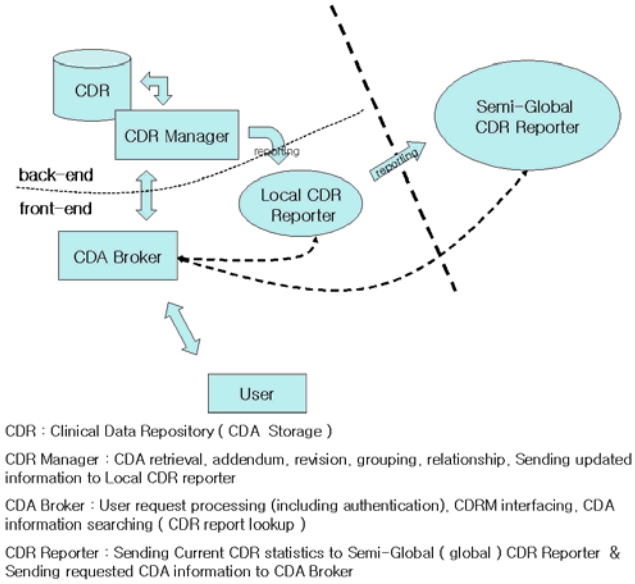

Figure 1 - System Organization in an Institution

The CDR is an internal part of existing system in institution, and it stores the actual patient data. The CDR Manager is institution-specific, and it is needed to modify by institution when the system is established. The CDR Manager makes possible to access the CDR, controls the authority and manages the function to add, revise and group the existing data. The other important functions of CDR Manager are to 1) transform the clinical document into standard document type –CDA, 2) register the information at information service component [6] called the CDR Reporter, 3) accept user's request from data service component called the CDA Broker, and 4) send the clinical document formatted CDA as replying to the CDA Broker. In the first case, the CDR Manager transforms the clinical document when the CDR is not organized with CDA. In the second case, it should register the information about CDA header – patient name, birth date, organization name, provider, patient ID, CDA version number – whenever a transaction about particular patient occurs. Local CDR Reporter stores and provides the patient-centric information in institution, and the only authorized users can access and search it. As Local CDR Reporter permits the Semi-Global or Global CDR Reporter which is operated in conceptually high level institution to search their information, one institution can search the desired clinical document. The Semi-Global and Global CDR Reporter would be described in next section. The CDA Broker has user interface, and receives the user requests and processes them by interacting with CDR Manager and CDR Reporter. To retrieve some information, the CDA Broker takes the particular data from the CDR Reporter, then requests to CDR Manager and returns the result to user. To input or renew the information by user, it interacts with the CDR Manager and returns the results to user. In this case, it should return the revised information to the CDR Manager and the CDR reporter.

System Organization between Different Institutions

When every institution is composed of CDR, CDR Manager, CDA Broker and CDR Reporter, the clinical document exchanging between them is clear. For example, when a user in institution requests a clinical document about particular patient, the CDA Broker searches the information through local CDR Reporter. However, in order to access the clinical document of other institution, users need the system architecture to process data between different institutions. Figure 2 shows system organization using Semi-Global CDR Reporter between institutions.

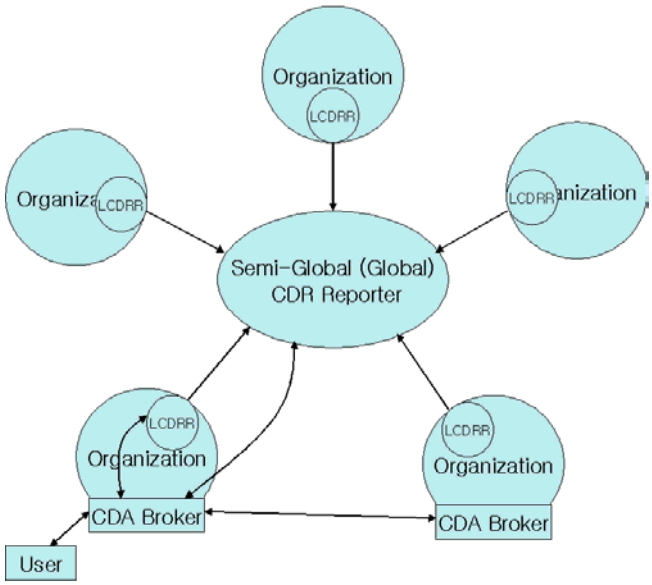

Figure 2 - System Organization between Institutions

If the clinical document could not be found in institution, the CDA Broker tries again through the higher CDR Reporter e.g. Semi-Global CDR Reporter. When the target information is found in another institution, the CDA Broker requests the clinical document to opposite CDA Broker. Then the requested CDA Broker receives the user information from requesting CDA Broker and checks its authority. If it is a permitted-user, the CDA Broker takes the information from CDR Manager and returns it to the

requesting CDA Broker. This is a case of searching the information scattered in many institutions using the Semi-Global CDR Reporter. In fact, as the several Semi-Global CDR Reporters provides the information to the high-level CDR Reporter, the higher level CDR Reporters give the information to the higher level, the multi-layer system is created. Therefore, users can search the information at any position not always top or local, because every CDR Reporter is connected and supports to search the desired information. Owing to directory service as LDAP (Lightweight Directory Access Protocol), this service is possible. Figure 3 shows the hierarchical scheme.

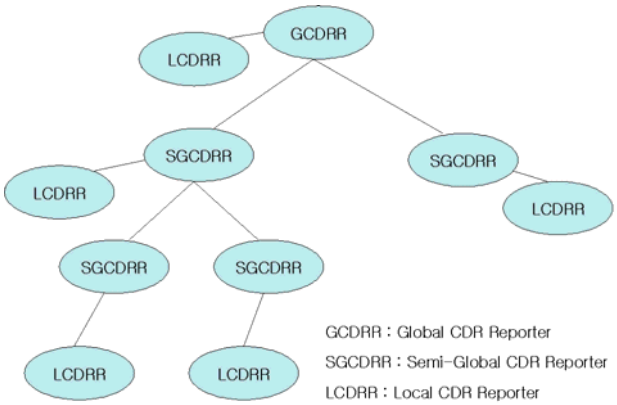

Figure 3 - Multi–layered system architecture

Example

Let's assume that several clinical institutions, which is composed of CDR, CDR Manager, CDA Broker, local CDR Reporter. Among them, if one institution manages the Semi-Global Reporter to control the clinical document from the institutions, it can be possible to share the information between institutions. If an institution wants to be participated, it registers its local CDR Reporter in the Semi-Global Reporter. If more institutions are entered, several institutions become the Semi-Global Reporters, and one of the Semi-Global Reporters becomes to be Global Reporter to receive the information from other Semi-Global Reporters. Finally, the institutions can connect and share all information between them.

Discussion

The proposed system can be classified into back-end and front-end. Back-end is a status to be isolated without any direct user-interface, and worked by the CDA Broker and CDR. Front-end is to process the tasks related to requirements and services by user interface. Back-end is implemented in institution-dependent way. Therefore, the messaging protocol between CDA Broker and CDR Reporter should be well defined according to specific institution. Front-end status can be applicable any institution as being institution-independent. The reason why it is classified into back-end and front-end is for reducing the bottleneek flow from lots of requests and security problems. For example, if the CDR Manager processes user requests alone, it is nearly impossible to schedule jobs and access to databases concurrently. It raises serious problems of system overload. So the CDR Manager delegates job scheduling to the CDA Broker whenever user requests happen, and it concentrates on processing takes related to data service. Using of distributed data not centralized is owing to information service - CDR Reporter. This is related to using LDAP, which has already been adopted in grid technology such as CERN or globus. Though the CDR Reporter provides the function to combine scattered data, the CDA Broker makes to use data service just like black-box. The CDA Broker supports user requirement analysis, searching data, job scheduling and communication between the Brokers. Communication between the CDA Brokers should have another protocol for exchanging data, resolve a confliction if the policy of CDR to be applied and managed in each institution is different, and control authority of access. Another issue is what data should be provided by CDR Reporter. Every patient can be identified with their own ID classified in a hospital. However, it is useless when every patient-ID in hospitals is mixed. Patient ID is not enough, so that various information such as patient name, birth date, hospital name, document version, service actor are needed. This is a policy problem what information is published by institution. When one institution sends a CDA document to another institution, the problem how received institution processes the CDA document remains. It is up to the received institution, but it should be considered whether it reports or not. When somebody revises the CDA document, it is different from received status. This is a data consistency problem that it happens when the received document is replicated. To solve the problem, the contents of received document should not be revised but only read. If the document is needed to add data, it should be created as the hospital's document or revised version number. In distributed environments, data consistency problem caused by replication is hard to handle. Therefore it is better to avoid the situation as possible.

Conclusion

In this paper, we describe the clinical document exchanging methodology to maintain the internal system of institution. In fact, our investigation is needed more improvements as it is early study. But in this paper we solve the problems caused by centralized scheme, and propose the decentralized, distributed, heterogeneous system. Our approach is more flexible to build the clinical document exchanging architecture to combine scattered data in every institution.

Acknowledgments

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