

# The Healthcare Industry's Use of Cloud Computing

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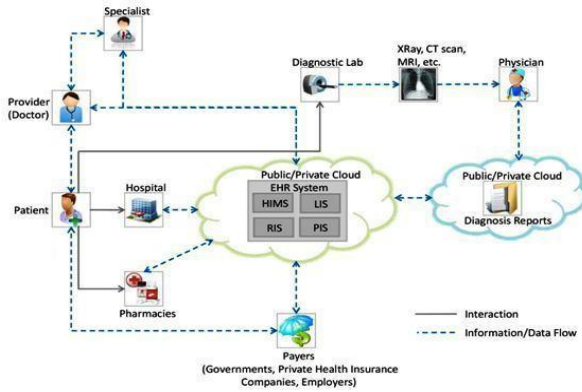
**Abstract:** We suggest an Information Integration and Informatics framework for healthcare applications hosted in the cloud, as data integration is essential for cloud-based systems. We utilize informatica to integrate data from multiple databases, since the data generated by the EHR system has to be smart and connected. Conventional EHRs use a wide variety of programming languages, hardware, and Electronic Health Record (EHR) standards. The information gathered from patient-provider interactions is saved in an electronic health record system. It is necessary to create cutting-edge healthcare applications, and there are distributed and heterogeneous healthcare systems as well as scalable cloud infrastructures. This state-of-the-art healthcare app facilitates rapid communication between patients and medical professionals and enhances data integration. This leads to the growth of smart and linked data in cloud-based healthcare applications. The Aneka cloud platform is used in the development of the suggested solution.

**Keywords:** Informatica, Aneka, Cloud Computing, Data Integration, EHRs

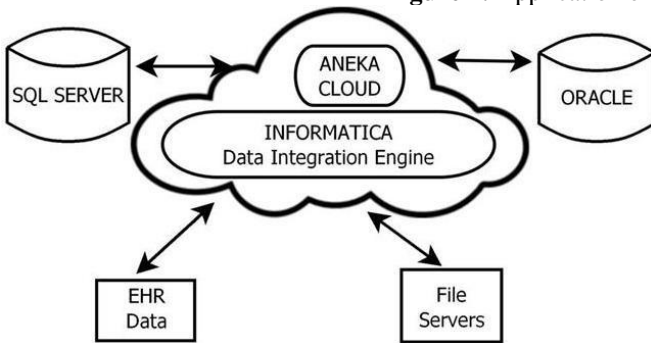
## 1. Introduction

As part of the presentation, an experimental system and a cloud-based methodology for designing interoperable EHRs were introduced. Hybrid Infrastructure for Systematic Health Record Administration (CHISTAR). By using a reference model to describe the usual purpose set of data structures and an archetype model to define the clinical data logic, CHISTAR is able to accomplish many sorts of interoperability using a generic design technique. For safe access to medical records, CHISTAR offers enhanced security features including identity management, authorization, and authentication. A framework for information integration and informatics is proposed in this study. One of the main benefits of the proposed framework is that it facilitates data integration, which involves standardizing the naming of data from various sources and making better use of clinical data derived from various electronic health records.

(2) Data Access—using the cloud to access and query healthcare records, (4) Data Storage—management of healthcare data storage and lifecycles—and (3) Data Analytics—efficient data analysis of huge healthcare data acquired in the cloud. In order to maximize the advantages and economics of cloud computing, which are already in use in other domains or are about to be, the proposed work relies on utilizing and developing technologies for clinical data tools, integration, and methods to effectively explain healthcare data. How to evaluate large amounts of healthcare data and how to get data from disparate systems are becoming more problematic as the volume of clinical data continues to grow. Better healthcare applications will result from data integration strategies that gather clinical data from disparate health IT systems. Healthcare application development, prediction quality, and decision-making speed will all see significant improvements with the use of approaches to large-scale clinical data analytics. Data from many sources (databases, unstructured and structured), as well as various stakeholders (doctors, patients, payers, specialists, physicians, etc.), may be gathered and organized using the suggested Information Integration and Informatics framework (Fig. 1). formats, etc) as in Fig. 2. With Information Integration and Informatics framework healthcare data can be safely exchanged between different stakeholders to assist more accurate and timely healthcare delivery. The proposed Information Integration and Informatics framework will assist the evolution of advanced healthcare applications. We now list a few healthcare applications that can be developed using the Information Integration and Informatics framework: Informatica Administrator is a Web application that is used to administer the PowerCenter domain and Power Center security. We can also administer application services for the Informatica Analyst and Informatica Developer Application services for Informatica Analyst and Informatica Developer include the Analyst service the Model Repository Service and the Data Integration Service[13].



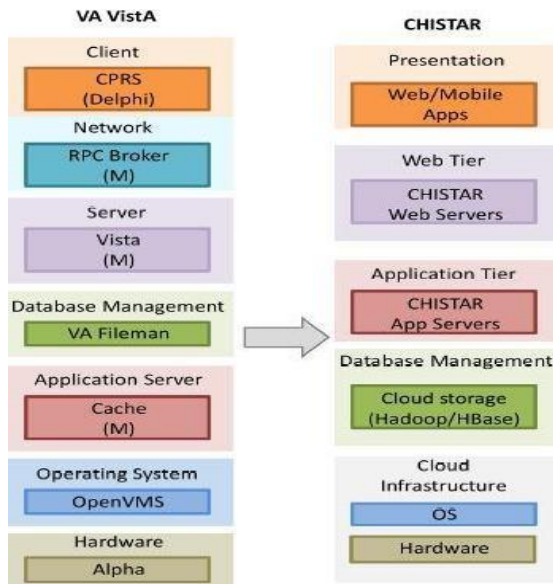
**Figure 1:** Application of cloud computing environment



**Figure 2:** Data integration approach

## 2. Literature Survey

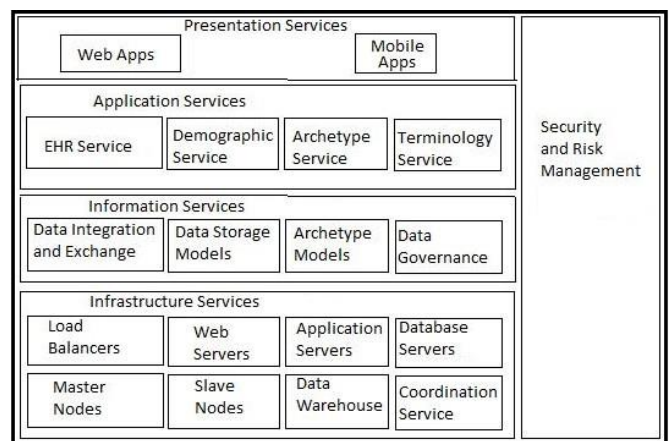
Vista[3] is widely used EHR system in the United States of America. Open EHR[4] is an EHR system which is for getting semantic interoperability. Open EHR puts particular emphasis on semantic interoperability better the kind of data interchange between different stakeholders in the healthcare ecosystem. Open EHR is based on a two – level approaching which a reference model consist the first level of modeling and the formal meaning of clinical content in the form of a archetypes and templates is the second level. To have exchange of healthcare data different solutions have been made that allow combining data from different sources. Mirth Connect[5] is an open source integration engine which supports different protocols and messaging standards to connect to databases and external systems. FM Projection[6] is a set of tools which allows examining Vista File Manager data and structure by using SQL like representations. Manager data and structure by using SQL like representations.



**Figure 3:** Technology stacks of VA VistA, CHISTAR system

A. Bagha et al[7] which proposes a data collection framework for collecting massive sensor data in a cloud. For CHISTAR a same approach for data collection which is based on a cloud – based distributed batch processing infrastructure in Fig.3. Since EHR systems handle big healthcare data, surveying the performance of such systems is very important to make sure the correctness of such systems in providing healthcare. For testing cloud – based system like EHRs there is an approach for prototyping and surveying cloud – based systems[8][9]. A similar way will be used to determine the performance of CHISTAR. CHISTAR uses the Cloud Component Model approach for application

design[10]. For the design of mobile application of cellular networks, CHISTAR adopts as in[11]. Fig4 shows the layered architecture of CHISTAR system. The infrastructure service layer comprises of the cloud instances ( for application servers, load balancers, slave nodes, Hadoop masters etc.) on which CHISTAR is used. The information service layer comprises of model for data storage, data integration engine, and clinical concepts and data governance module. The application service layer provides various services such as demographic service, EHR service, terminology service and archetype service. The presentation services layer comprises of the smart and connected healthcare applications like web and mobile based.



**Figure 4:** Architecture of CHISTAR

### 3. Proposed Scheme

The proposed technology stack consists:

#### A. Informatics Application Builder

The Informatics Application Builder furnishes tool and APIs for constructing web and mobile healthcare application. Application developers can use the Informatics Application Builder to construct healthcare application without worrying about deployment configuration, cloud infrastructure management and data management in cloud. The Information Integration and Informatics framework and CHISTAR middleware take control of all the cloud configuration and maintenance activities. It gives platform for advancement of informatics application development.

**B. Information Integration and Informatics Framework** Informatics framework makes storing, integrating and analyzing EHR data in the cloud. The Information Integration and Informatics framework consist of

- a) Data Integration Framework
- b) Data Access Framework
- c) Data Orchestration
- d) Data Analytics Framework
- e) Data Storage Framework

#### C. CHISTAR Security Service

CHISTAR gives the key requirements of HIPAA and HITECH acts that requires entities (that create, transmit, maintain, disclose and use an individual's protected health information) to make sure their customers that the availability, confidentiality and integrity of information key security features of CHISTAR contains authentication, authorization, identity management, securing data at rest, securing data in motion, key management, data integrity and auditing. The data – level integration system comprises of data storage model, archetype model, data sources and mapping as shown in Fig.2. Data sources shows the containers of data, the domain model provides a conceptual technique of the applications, data storage model gives the logical structure of data storage and mapping which maps the source data with the target data. In the data – level integration the representation of the data structure is different from the clinical information.

Ink-jet printers use a frequency modulated halftone process. The screens consist of small dots where the density of the color is determined by how closely together the dots are printed. The greater the density of the color, the more dots are required. Regular distribution of dots is possible. Halftone is the reprographic technique that simulates continuous tone imagery through the use of dots, varying either in size, shape or in spacing [15].

#### D. CLOUD – BASED Application:

The CHISTAR middleware and the proposed Information Integration and Informatics framework gives at a time development of advanced healthcare applications. For making the development of user interfaces for healthcare application CHISTAR gives platform tools for desktop platforms and mobile platforms. Application services of the CHISTAR middleware are platform independent services where the platform tools customize to handle features of required platforms. Application services and platform tools help in making healthcare application for variety of platforms and devices. The Information Integration and Informatics framework provides tools and APIs for data access, integration, analytics and storage.

### 4. Implementation

**Figure 5:** shows the Informatica Power Center Designer, which consist of D- Designer Interface R- Repository Manager W- Workflow Manager M- Mapping

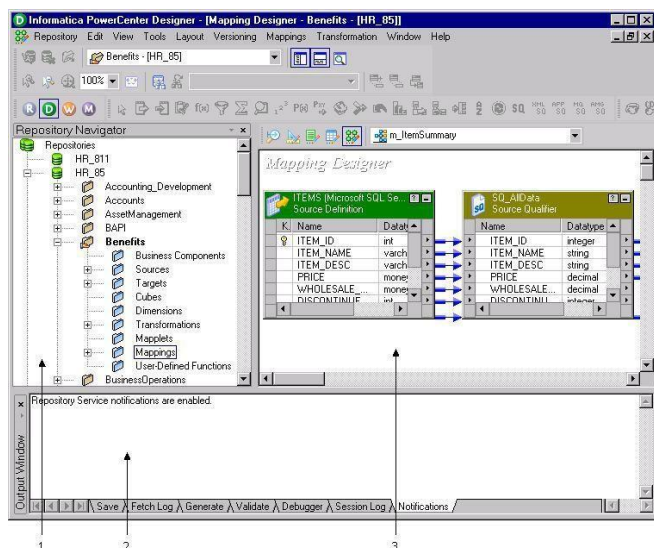


Figure 5: Architecture of CHISTAR

In Designer Interface we connect repository and import database of source where we select ODBC datasource : remote sql server (SQL Server). Then we import target database. Mapping in menu and map as shown in workspace. In Workflow Manager we connect repository and select session and create workflow by name WFOracleToSQL. Creating a task and linking the task with workflow. Then Mapping is done by giving source and target as \$source: Relational MicroSoft\_SQL\_Server\$Target: Relational Oracle. By right clicking on workspace we start workflow. In Fig.8 we see the successful linking of source and target. In simple CHISTAR's multi-tier deployment configuration the naming convention are as ( $\#L(\text{size}) = \#A(\text{size}) = \#H(\text{size})$ ), where L is the number of instances running load balancers. A is the number of instances running application servers. H is the number of instances running the database of cluster. Fig.6 shows the vertical and horizontal scaling options of CHISTAR. Comparing ( $1L(\text{Large}) = 2A(\text{small}) = 2H(\text{Large})$ ) and ( $1L(\text{small}) = 3A(\text{small}) = 2H(\text{Large})$ ) we get that by horizontal scaling (increasing the number of application server) lower response time is achieved. Fig.7 shows the average response time for the CHISTAR application for different configuration and varying number of simultaneous users. The results in Fig.7 were obtained with 1000 patient health records in the CHISTAR application with increase in number of user the mean request arrival rate increases since CHISTAR services higher number of request per second, therefore an increase in response time is observed. The entire interface which is developed in C# is connected to cloud by using cloud platform Aneka[12]. As Aneka has workload distribution capabilities and its thread model

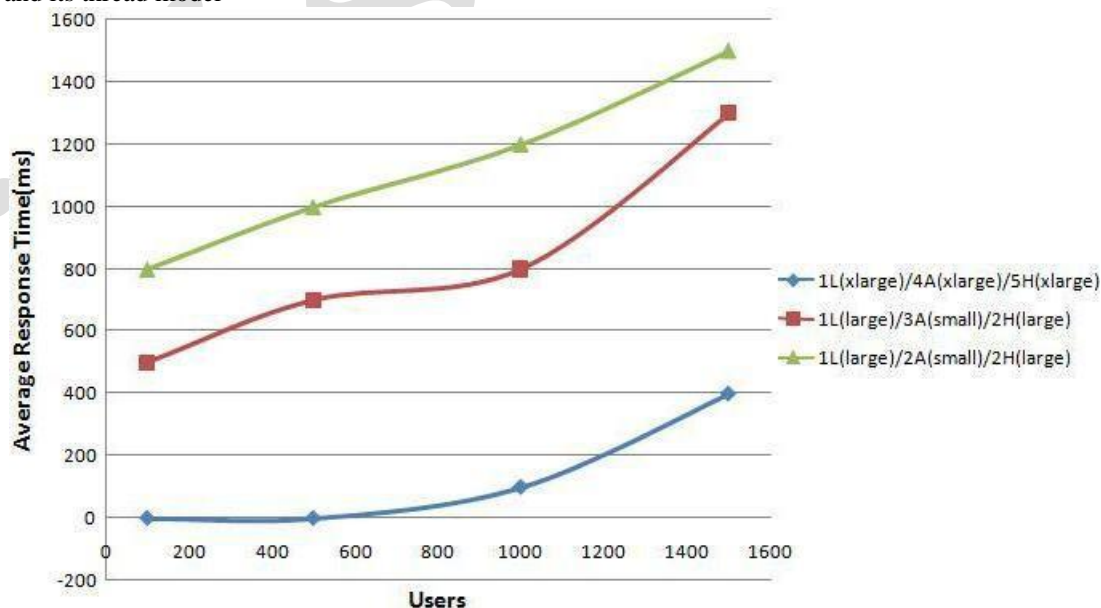


Figure 6: Average response time for patient records



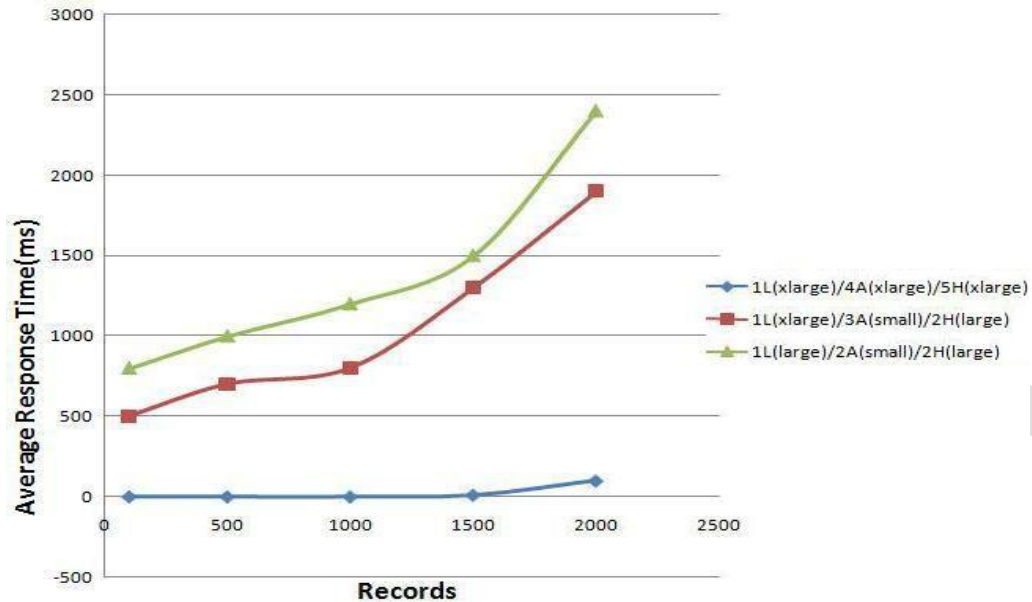
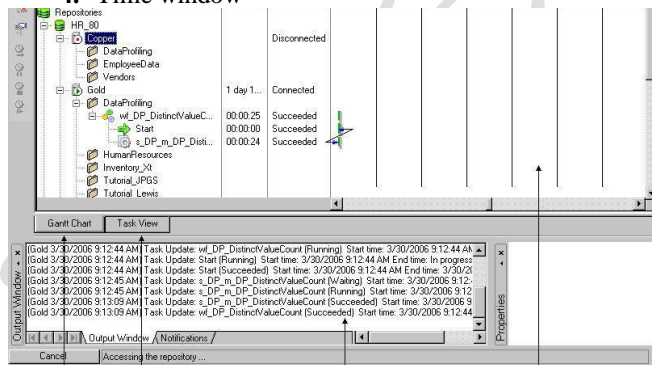


Figure 7: Average response time for simultaneous users.

1. Gantt chart view
2. Task view
3. Output window

#### 4. Time window



5.

Figure 8: Informatica Workflow Monitor.

## 5. Performance Evaluation

### A. Rapid Application Development:

Traditional health IT system are related on client – server architectures and store all data in house which requires a server, software and hardware which are installed locally. Cloud computing makes data to be stored on external servers that can be accessed with the help of web. The proposed stack contains CHISTAR middleware and Information Integration and Informatics framework which facilitate rapid development of cloud – based healthcare application.

### B. Integrated Health Data

The data Integration framework makes integrating specific data from different data sources such as Oracle, SQL Server, file servers and EHR standards in a cloud – based storage.

### C. Accessibility

Cloud – based applications built along with Information Integration and Informatics framework have high approach and understanding over client – server applications because users can securely log in to the system from everywhere if they have Internet connectivity. Information Integration and Informatics framework given a compatible representation, elucidation and access of the integrated healthcare data. Improved security application of CHISTAR middleware such as role access control allows specialists, doctors, and physicians to access more strongly in a secure environment and provides good continuity of care.

### D. Scalability

Cloud – based applications which are built with Information Integration and Informatics framework have good scalability compared with client – server EHRs. The computing facility can be scaled up on demand as large data is combined and new users are added. Applications which are built with Information Integration and Informatics framework can lead both horizontal (scaling out) as well as vertical scaling (scaling up) options. Information Integration and Informatics framework uses HBase in storing data. Applications which has HBase storage can be scaled linearly and at a time by adding of new nodes.

### E. Reduced Costs

Cloud – based applications which are built with Information Integration and Informatics framework have reduced services and operation costs as related to traditional client – server applications. Client – Server applications needs a team of IT experts to configure, install run, test, secure and update software and hardware. In cloud – based applications all of that is done in the cloud by the cloud provides.

## 6. Conclusion and Future work

This paper describes the design of an Information Integration and Informatics framework that allows storing, integrating and analyzing healthcare data in the cloud. The Information Integration and Informatics framework allow the development of advanced healthcare application with data integrated in difference database. Application developers can quickly develop healthcare applications by not thinking about the data management in cloud and cloud infrastructure management deployment configuration which are taken care by the Information Integration and Informatics framework. We use Aneka Cloud Platform for the development. The effectiveness of the framework is demonstrated with Health Mapper Applications and Patient Health Records.

## 7. Acknowledgments

The authors thank to the principal and the management for constant support and encouragement.

## References

- [1] In the 2013 issue of the IEEE Journal of Biomedical and Health Informatics, Bhaga and Madiseti presented a cloud-based method for interoperable electronic health records (EHRs). Second, in Methods Mol Biol., 713(2011):27–39, C. Hajat provides an introduction to the field of epidemiology. View the Vista monograph online at [3]. Visit [www.va.gov/vista](http://www.va.gov/vista) for the 2012 monograph. In 2012, OpenEHR was established. Website: <https://www.openehr.org>. “Mirth Connect” (2012). The website may be accessed at: <http://www.mirthcorp.com/products/mirth-connect> online. MedsphereFMProjection (2012) is cited as [6]. This information is accessible online at: <http://medsphere.org/community/project/fm-projection>. Referenced in [7] "Analyzing massive machine maintenance data in a computing cloud" by A. Bahga and V.K. Madiseti in the October 2012 issue of the IEEE Transactions on Parallel Distributed Systems, volume 23, issue 10, pages 1831–1843. In their 2011 article "Synthetic workload generation for cloud computing applications," published in the Journal of Software Engineering and Applications, A. Bahga and V.K. Madiseti discuss this topic.