

# Health Sensor Data Management in Cloud

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**Abstract--**Wearable sensor devices with cloud computing feature have great impact in our daily lives. This technology provides services to acquire, consume and share personal health information. Apart from that we can be connected with smart phones through which we can access information through sensor devices equipped with our smart phone. Now smartphones has been resulted in the new ways. It is getting embedded with sensor devices such as cameras, microphones, accelerometers, proximity sensors, GPS etc. through which we can track information and significant parameter about physiology. Some of the wearable tech devices are popular today like Jawbone Up and Fitbit Flex, HeartMath Inner Balance Sensor, Tinke. This paper is survey in area of medical field that represents why cloud technologies used in medical field and how health data managed in cloud.

**Index Terms-Sensor devices,RDBMS,NoSQL,XML Database,CDA.**

## 1. INTRODUCTION

Sensor Devices like AliveCor Heart monitor that reads ECG measurements, Withings Smart blood pressure monitor that reads Blood level, Scanadu scout reads heart rate and body temperature, BACtrack Mobile Breathalyzer that specifies Blood Alcohol Content(BAC) in our body. These devices have various software and applications. In simple words you can consider your smart phone that has software and applications and can store your sensitive health data in your smart phone. Means your sensitive health data and information are with you at any point of view at your finger point. These type of services are provided out by commercial web services that is provided by Cloud Services providers for example Amazon, Google, IBM etc.

As posted in Dec 2014 46% of Health organization now serving using Cloud Computing technologies.[9] EPIC System Corp is a private held health care software company. Hospitals

uses its software holds 54% of patient records in US and 2.5% of patient records in world wide.[9]

## How resource wastage can be refused by using cloud technology

Suppose there are 3 Hospitals A,B,C. Each hospital maintains their own network database server, they have management department and softwares, maintainance department and softwares. They organizes their own data and they maintained by their own. But there is resource wastage, means three different health organizations utilizing resources having paid and costs three times of single plus waste of data space also. so why can't we organize a such way so that we centralize these resources in a centralized web location and can be served by cloud service provider.[1] For example PACS-Picture Archiving Communication System that is medical image technology provides convenient storage and access to medical image from different source machine and DICOM-Digital Imaging and Communication in Medicines. This is a standard for handling, storing, printing and transmitting medical image files. It includes File format and network communication protocol details.

Medical data are dynamic in nature having a very heterogeneous variety of data, coming from different sources. RDBMS is not suitable for managing and analyzing medical data. For storing, managing and analyzing medical data in cloud, healthcare organization uses NoSQL and XML database technology. Medical data can be structured or nonstructured. Structured data means predefined tables having predefine rows contains some of the data valued by measurement.[2] For example body temperature, ECG measurements, Sugar level, heart beat rate, alcohol level in blood, blood pressure level etc. But in RDBMS we can't store

patient description about his pain or the description of complications during the surgery as specified by the surgeon on call which capture human interable nuances that numbers and code can not,pictures etc.For that we use NoSQL technology.So that structured and unstructured data can be handled simultaneously.

## 2.CLINICAL DOCUMENT ARCHITECTURE(CDA)

CDA is XML based Markup standard.It is to specifies the encoding,structure and semantics for exchanging clinical documents. CDA is an ANSI-certified standard from Health Level Seven International (HL7.org). Release 1.0 was published in November, 2000 and Release 2.0 was published with the HL7 2005 Normative Edition. A CDA can contain any type of clinical content. Typical CDA documents would be a Discharge Summary, Imaging Report, Admission & Physical, Pathology Report and so on. CDA uses XML, although it allows for a non-XML body (pdf, Word, jpg and so on) for simple implementations.[10]

## 3.WHY NOSQL

NoSQL does not required predefined schemas,relationship and keys.So,for cloud based medical data storage NoSQL is playing a big role,is a common database approach in the area of cloud based database management. Carlo Strozzi used the term NoSQL in 1998 to name his lightweight, open-source relational database that did not expose the standard SQL interface. Strozzi suggests that, as the current NoSQL movement "departs from the relational model altogether; it should therefore have been called more appropriately 'NoREL'",[5] referring to 'No Relational'. Eric Evans reintroduced the term NoSQL in early 2009 when Johan Oskarsson of Last.fm organized an event to discuss open- source distributed databases.[6] The name attempted to label the emergence of an increasing number of non-relational, distributed data stores. Most of the early NoSQL systems did not attempt to provide atomicity, consistency, isolation and durability guarantees, contrary to the prevailing practice among relational database systems.[7].

## 4.NOSQL DATA MODELS

RDBMS data modeling refers like mapping of logical data to physical data. But NoSQL practitioners focus on physical data model design rather than the traditional logical data model process.Different NoSQL data models are:

- Key-value stores – Collections comprised of unique keys having 1-n valid values
- Column families – Distributed data stores in which a column consists of a unique key, values for the key, and a timestamp differentiating current from stale values
- Document databases – Systems that store and manage documents and their metadata (type, title, author, creation/modification/deletion date, etc.)
- Graph databases – Systems that use graph theory to represent and store data as nodes (people, business, accounts, or other entities), node properties, and edges (lines connecting nodes/properties to each other)

The following diagram illustrates the comparison landscape based on model complexity and scalability:

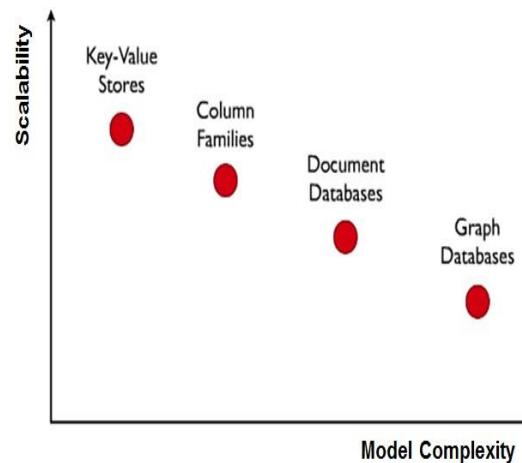


Fig. 1

## 5.COMPARING RDBMS AND NOSQL

The traditional relational databases required predefined fixed schema before data is inserted.For example, hospital might want to store data about a patient such as phone numbers, first and last name, address, city, state, and also his blood cell count and his present medications – a SQL database needs to know what you are storing in advance.

PatientID	Symptoms	Valu	Subsympto	Subvalue
P0001	Fever	Yes	Duration	4 days
P0001	Temp	Yes	Unit	C
P0002	Cough	Yes	yes	3 days

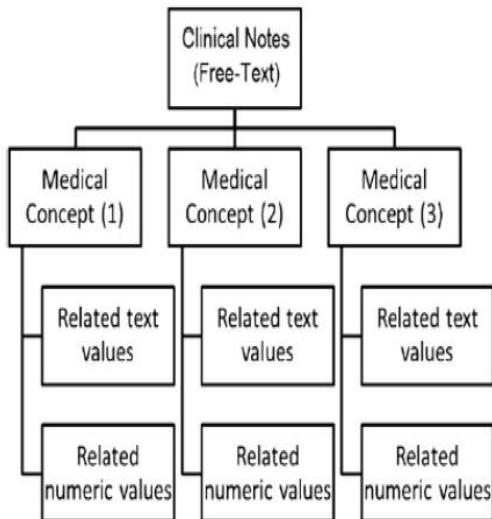
But NoSQL data model allows to insert data without predefined schema.For example consider below table that

shows NoSQL can handle the dynamic nature of medical data.:

PatientID	Key	Value1	Subkey1	SubKey2	...
P0001	Fever	Yes	Duration	4 Days	...
P0001	Temp	37.7	Unit	C	...
P0002	Cough	Yes	yes	3 Days	...

## 6.XML Databases

An XML database is a data persistence software system that allows data to be specified, and sometimes stored, in XML format. A document-oriented database is a computer program designed for storing, retrieving, and managing document-oriented information, also known as semi-structured data. Document-oriented databases are one of the main categories of NoSQL databases. As I earlier explained about structured and unstructured data, raw medical data can be structured and unstructured. To process this data and make them searchable it is necessary to convert the data format into computer structured format. Medical data can be structured into tree data structure.



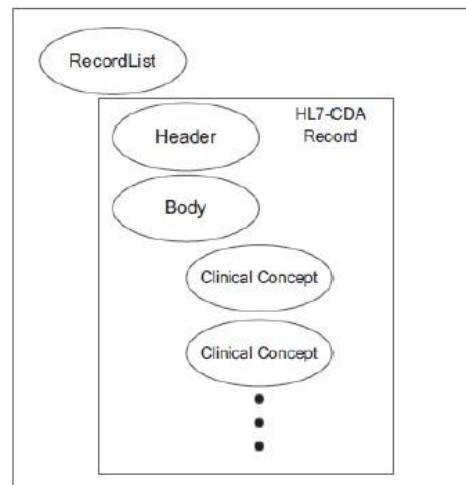
The figure shows organization of clinical data in a hierarchical manner. In this structure Clinical notes in their natural form are stored at the apex level. The next level is governed by medical concepts that are derived from the clinical notes at the top level. And each medical concept has certain textual and numeric values associated with it. Clinical data which is document-centric requires a database which accepts data in its natural format and this facility is provided by XML databases.

## Major classes for XML databases for clinical data

1.XML-ENABLED DATABASES	XML data are stored as individual field in XML ENABLED DATABASE.
2.NATIVE-XML DATABASES	XML files containing clinical data are stored as a list of files in NATIVE-XML DATABASE

## 7.XML-Database Modelling

In XML database modeling the highest level is "Record List" next is a whole block that is standardized named "HL7-CDA Record" which contains each and every individual items in the record. Records contains field like name, gender etc using HL7-CDA data format.



**Fig. 2**

Figure shows that Each record can have zero or more medical concepts associated with it. Each medical concept can have zero or more attributes associated with it. Each attribute can contain zero or more properties which can be textual as well as numeric.

## 8.CONCLUSION

RDBMS is having 20 years of its history for storing and analysis of data successfully. This is our traditional database. But medical data is very dynamic and heterogeneous. That is medical data changes very frequently and flows across different source and are of different types. So

this type of data can not be handled by traditional database. It is taken care by NoSQL and XML databases. In this paper I had explored the details of regarding this. Basics of CDA and data modeling for XML databases had been explained. The key aspect of CDA includes the XML formating CDA is being machine and human readable.

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