# Cloud computing for big data from biomedical sensors monitoring, storage and analyze

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***Abstract*—The paper present aspects regarding importance of using cloud computing technology for big data processing from biosensors. The wireless sensors for personal area network have applications have been used in healthcare monitoring application. There are some limitations of wireless sensors in terms of memory, energy, computation, communication, scalability and efficient management of the big data collected from biosensors. In healthcare area is need for powerful and scalable high-performance computing and massive storage infrastructure for real-time processing, storing and analyzing (online or offline) of the biosensors data by using complex algorithms for extract required values from database. The patients can interact with hospitals or doctor in offline or online, but the data must be storage by using cloud computing technology because this allow computing, storage and software services (SaaS) with customization possibilities and virtualization at low cost. The Cloud Computing can provide an open, flexible, and reconfigurable platform (PaaS) for monitoring and controlling applications.**

***Keywords—cloud; wireless; monitoring; sensors; database.***

## I. INTRODUCTION

Cloud computing architecture can be defined as a collection of services: applications, platforms, infrastructures and servers which allow data virtualization and data storage (fig.1). According to other classification cloud computing services can be private, public or hybrid [1]. The cloud computing solutions internet and platform as a service offer management solutions (replication, autoscaling, monitoring and backups) for database storage [2].

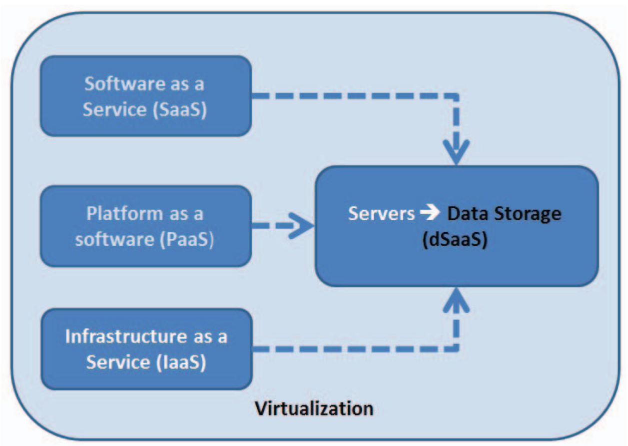


Figure 1. Cloud computing architecture

PaaS solutions, like Google and Microsoft Azure, required that the users to use a specific programming language and run on the service provider's infrastructure [2].

Public PaaS service providers manage the infrastructure, networks, storage devices, and operating systems. The maintenance activities like security patching, logging, monitoring, scaling and fail over are provided by the vendor and the developers should build only cloud applications [2].

Private PaaS offers the capability to deploy the PaaS software on both a private and public cloud (hybrid) but the service consumer to manage the application stack and the infrastructure [2].

PaaS service providers protect their platform from getting overloaded by an individual customer and its customers by throttling the database activity of customers [2].

The IoT trends (embedded electronics, software, sensors, and network connectivity) lead to increase the raw data volume and processing, which requires high power of parallel computing and storage (cloud computing services). Big data concept is familiar for physical sciences (meteorology, physics and chemistry), medical sciences (genomics, biomedical research), financial institutions (banking and capital markets) and government (defense). For medical, physical sciences and financial big data problem was huge volume of data collected. For solving these problems was necessary to design new technologies and complex algorithms and software for collecting, storage and managing the big data [3].

Clouds computing services have a high impact for scientific applications.

The Cloud Computing System and Grid Network System have in common with many distributed applications, parallel computing and programming models for big data science which can be execute in cloud [4, 5].

The cloud computing is flexible, reliable and usable due to the behind technologies [6]:

➔Virtualization (sharing physical instance of an application or resource among multiple organizations)

➔Service –oriented architecture (SOA - use applications as a service for other applications in function of the type of vendor, product or technology)

➔Grid computing (distributed computing in which a group of computers from multiple locations are connected with each other for solving a common objective).

➔Utility computing (Pay per Use model)

Cloud computing architecture can be divided in 2 parts front (client part of cloud computing system) end back end (all resources required for providing cloud computing services - data storage systems, virtual machines, security mechanism, services, deployment models, servers) [6].

The diseases associated with aging process require new measures to improve the quality of life and launch chronic disease surveillance for elderly people [7] because public medical resources allocated for hospitals and caregivers are usually insufficient and are not uniform distributed in geographical areas.

An example of cloud computing service for medical application is HCloud, a cloud-based system for preventive healthcare which implements the analysis of physiological signal data and the early warning mechanisms for diseases [7].

The cloud computing application for medical area are focused on storage, access, management of private health information and not use the entire computational power of the cloud platforms [7].

The telemedicine application based on cloud computing was developed by researchers from University of Ontario Institute of Technology in collaboration with IBM, for providing doctors support decision systems for rural and remote communities. The cloud computing approach is currently being tested using data from the Infants Hospital in Providence, Rhode Island [8].

Real-time embedded signal processing could be onto chips devices integrated into smartphones or garments for patients for monitoring from home.

## II. Biomedical Sensors Big Data Analysys

Biomedical sensors collect biomedical signals variables and convert them in electrical signal. The biomedical sensor is a interface between a biologic and an electronic system (fig.2).

According to scientific clasification, biomedical sensors can be physical and chemical (gas, electrochemical, photometric, bioanalytic) [9].

Physical sensors are used for measuring physical quantities (muscle displacement, blood pressure, blood flow, bone growth, body temperature, skin moisture) and chemical sensors are used to determine the concentration of chemical substances [9].

Big data information collected from biomedical sensors for monitoring patients' health it require high computing power and algorithms optimization for reducing the energy consumption that could be generated by big data transmission in time units.

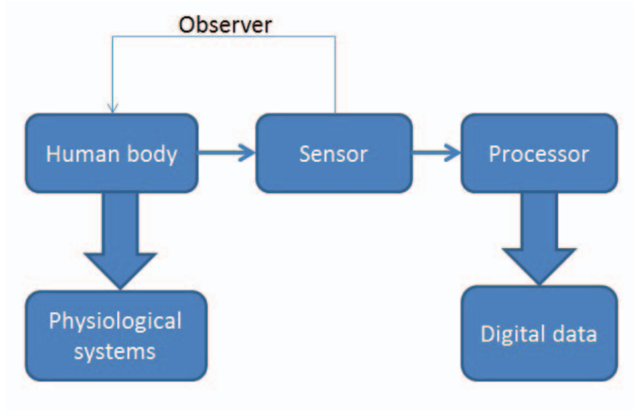


Figure 2. Biomedical sensors

Therefore big data collecting, storage and analyses should be subject of a support decision system (fig. 3). The system architecture consists in 5 levels:

➔Level 1 - data transmission (biosensors ➔aggregators);

➔Level 2 - big data (data collecting, discretization and storage);

➔Level 3 - medical information (data classification & analysis)

➔Level 4 - diseases knowledge (data synthesis)

➔Level 5 - medical actions (decision support system)

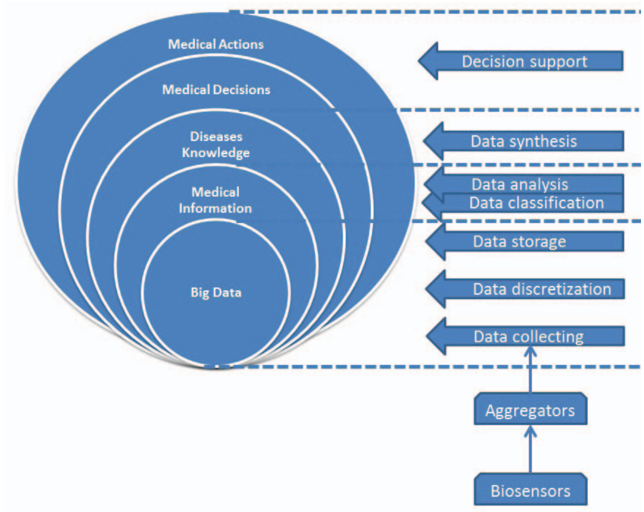


Figure 3. Decision support architecture

After execution data analyzed and integrated in decision support system will be part from diseases knowledge level.

Decision support system can be described synthetic by using an algorithm based on recursive function (1), which use stack data structure for collecting knowledge data.

$$K(i) = \begin{cases} p & ,i = n-1 \\ K(i-1)+p & ,i \geq n \end{cases}$$
(1)

Where:

p - Knowledge data for level 4;

$i = \overline{1,n}$ ;

n=5;

K(i) - recursive function;

Decision support system (DSS) for medical data analysis is based on data mining processes which allow predictive data analysis, correlations, clustering and classification.

## III. CLOUD COMPUTING MODEL FOR BIG DATA CONTROL

The big data obtained from biomedical sensors contain data with personal character, which require having data privacy protection by design. Cloud computing architecture (fig. 4) modeling is developed without compromising privacy.

By providing user privileges to dynamically check the status of the cloud services availed by remotely login to the cloud server [10]. For security and data protection it is required data encryption [11]. The role-based access control for user type – doctors or patients [11] determines the user access to the system by the job role. The role of a user is assigned based on the latest privileges concept. Permissions can be added or deleted if the role changes.

A doctor must have access to patients' data but patients must not have access to other patients' data or to doctor data.

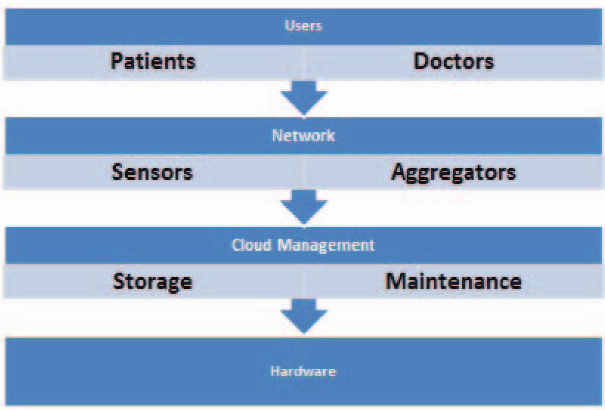

Figure 4. Cloud architecture

Cloud computing architecture for healthcare ecosystem must offer service life cycle management, security, responsiveness, intelligent service deployment, portability, environmental sustainability, service reliability, service availability and quality assurance [12].

For healthcare area is used hybrid cloud model architecture PaaS (Fig. 5). Patient data must be stored in private cloud while it's using shared infrastructure [13] and WPN (wireless personal area network).

For example in case of ECG monitoring the cloud computing technologies allow the remote monitoring of a patient's heartbeat data, data analysis in minimal time, and the notification of first-aid personnel and doctors should these data reveal potentially dangerous conditions [13, 14]. Software applications and data hosted in the cloud are accessible from any Internet device through simple interfaces (such as SOAP and REST-based Web services).

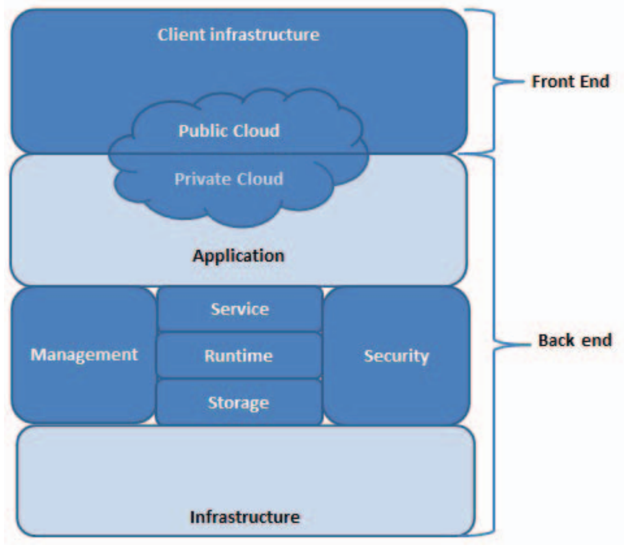

Figure 5. Hybrid Cloud as a Platform

## IV. CONCLUSIONS

Cloud computing technology use for healthcare leads to decrease costs with patients monitoring in hospitals.

Cloud services are pay-per-use basis and with volume prices for large numbers of service requests.

The advantages of using cloud computing for healthcare are:

-storage space for big data from biomedical sensors;

-data availability;

-data security and privacy by design;

-data analysis and predictive modeling;

-data classification and analytics;

-support decision in medicals acts;

-costs reduce for hospitals and with caregivers.

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