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Cloud based Information Management System Model for Rural Health Care in India

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Abstract

InIndia, most of the urban hospitals use the modern information management systems for the healthcare of their patients to improve the impacts on patients, to bring the transparency and efficiency in treatment with cost effective service. The current development of cloud computing in the healthcare context will have a big impact on the healthcare sector. It provides key computing platform for sharing resources that include infrastructures, software, and applications and business processes. Virtualisation is a core technology for enabling cloud resource sharing. Cloud Computing may be applied to solve problems in many domains of Information Technology like GIS (Geographical Information Systems), scientific research, e-governance systems, drug/chemist supplier, health product industry, food industry. Rural health care centres can largely benefit from cloud based models in terms of cost reduction and resource utilisation. It will not only reduce the development cost but improve the maintain ability and adoption of evolving technologies and also will help to improve the rural health and will make closer to doctors. The M-health and E-health literature is studied and recommendations are suggested in the paper.

Keywords: E-healthcare, Cloud Computing, Rural Healthcare Services, Online Information Services, Broadband Connectivity

Introduction

Cloud computing is a fast growing trend that includes several categories of service, all offered on demand over the Internet in a pay-as-you-go model. It promises to increase the velocity with which applications are deployed, increases innovation, and lowers costs, all while increasing system agility. Using a cloud computing strategy for information support systems will help in conducting core business activities with less hassle and greater efficiency. Organisations can maximise the use of their existing hardware to plan for and serve specific peaks in usage. Thousands of virtual machines and applications can be managed more easily using a cloud-like environment. The cloud can help to access the data for particular disease or patient history and study the case, do the diagnosis and recommend the further treatment. The live video conferencing with patient, primary health centre units and super specialist hospitals also can play major reliefto the patient. Video recording of patients in case of ECG/X-ray/sonography, CT scan etc. or different sensors output which are connected to patient in the hospitals can be transmitted to super specialist hospitals for analysis. The database of patients which is created in cloud will be useful for researcher for development and to improve the rural health. There is need to develop number of mobile applications for health sectors to access the m-health service or e-health service in case of emergency or if you are in remote area or if you cannot afford the heavy transportation charges, in case of natural disaster, epidemic or due to financial constraints.

Tele-medicine Technology Evolution (www.isro.org)

There can be three modes of connecting patients with the doctors:

1. Point to Point System - One patient connecting to one specialist doctor within the hospital

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2. Point to Multi-Point System - One patient at a time connecting to any of the specialist doctors within the hospital
3. Multi-Point to Multi-Point System - Several patients simultaneously connecting to different doctors at different hospitals at different geographical locations

Major Sreas of Tele-medicine Technology

The patient with the local doctor consults the specialist and obtains the line of treatment which are

- Tele-consultation
- Tele-diagnosis
- Tele-treatment

For continuing medical education, training for doctors & paramedics from a higher level hospital/institution, the technology can be uses as

- Tele-education
- Tele-training

Regular monitoring for intensive care and emergency care is categorised under

- Tele-monitoring

Support during disaster management is categorised under

- Tele-support

Apart from this, different e-health services can be created throughe-portals which can be accessed by rural population through Internet like finding blood donors, organ donors, death and birth certificates issue, fitness certificates, licensing and registration of food safety, complaint register, child vaccination alert, pregnant women registration, and checkup alerts. It also includes major diseases' information, entry on portal, national health insurance programme, toll free service in case of health, primary healthcare information portalsetc.

Cloud Service Models

SaaS (Software as a Service)

The capability provided to the consumer is to use the provider's applications running on a cloud infrastructure. The applications are accessible from various client devices through either a thin client interface, such as a web browser (e.g., web-based email), or a program interface. The consumer does not manage or control the underlying cloud infrastructure including network, servers, operating systems, storage, or even individual application capabilities, with the possible exception of limited user specific application configuration settings. Numerous applications can be provided as standard services, where departments can request and manage. Some of the applications can be

- Complaint Resolution System
- Employee Management Systems
- Attendance Resolutions Systems
- E-police, E-court
- Municipal Maintenance
- Water Board Billing, Payment Systems
- District Management Solutions
- Service Desk
- M-health service
- E-health service

PaaS (Platform as Service)

The capability provided to the consumer is to deploy onto the cloud infrastructure consumer-created or acquired applications created using programming languages, libraries, services, and tools supported by the provider. The consumer does not manage or control the underlying cloud infrastructure including network, servers, operating systems, or storage, but has control over the deployed applications and possibly configuration settings for the application-hosting environment Some of the standard platforms are:

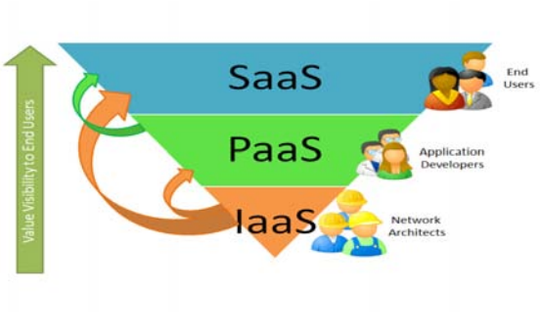
- OS provisioning
- Queuing Service
- Database Services
- Middleware Services
- Workflow Services

IaaS(Infrastructure as a Service)

The capability provided to the consumer is to provision processing, storage, networks, and other fundamental computing resources where the consumer is able to deploy and run arbitrary software, which can include

operating systems and applications. The consumer does not manage or control the underlying cloud infrastructure but has control over operating systems, storage, and deployed applications; and possibly limited control of select networking components (e.g., host firewalls).

Figure 1: Value Visibility to End-User



Government of India Initiation in Case of E. Health (www.cghealth.nic.in)

Department of Information Technology (DIT) has launched the National e-Governance Action Plan (NeGP) to support the growth of e-governance within the country. The National Informatics Center (NIC) is the DIT arm that provides a range of services to all the government departments at the centre, the states, and the districts. A separate "e-Governance Standards Division" has been created by NIC to steer the process of evolving the standards. DIT has formulated a proposal to establish 100,000 common service centres (CSCs) in rural areas, which will serve not only as the front-end for most government services, but also as a means to connect the citizens of rural India to the web. Telemedicine has been identified as one of the service modules. It is envisaged that initially, 20,000 CSCs would have tele-health outlet service managed by a village-level entrepreneur. Telemedicine working group setup has already finalised a nucleus framework, "Recommendation on Guidelines, Standards and Practices for Telemedicine in India".

What is Telemedicine? (www.isro.org)

Telemedicine is defined as the delivery of healthcare services, where distance is a critical factor, by all healthcare professionals using information and communication technologies for the exchange of valid information for diagnosis, treatment and prevention of disease and injuries,research and evaluation, and for the continuingeducation of healthcare providers, all in the interests of advancing the health of individuals and their communities.

Infrastructure for E-health

Figure 2 shows the telemedicine infrastructure with WiFi and WiMAX connectivity and Figure 3 shows the remote access between different health centers. The primary health centre (PHC), community health centre (CHC), district health centre (DHC), state health centre (SHC), and national super specialist health centre (NSSHC) have to form a network to exchange the data and information basedon WiFi and WiMAX connectivity. Telemedicine applications (Mignanti *et al*., 2008) include high resolution video and data streaming from medical equipment, for the clinical user communities. The WiMAX may offer at reasonable costs the necessary bandwidth in mobility conditions for applications like: tele-diagnosis (remote diagnosis), emergencies (remote diagnosis in an emergency situation, i.e. real time response needed), remote second opinion (a specialist opinion is needed butthe specialist is available only in remote area), and patient follow up (patients followed up by a specialist visit in an authorised remote medical centre where results and images can be collected and forwarded to the principal centre). In rural area all centres should be made active to give service to the rural community and to give medical aid from distance.The rural health care requires the following infrastructure:

Primary Health Centre(PHC)/ Community Health Centre (CHC)/Village Unit Infrastructure

- Tele-consultation room
- Patient engagement facilities (bed, scopes, etc.)
- Telemedicine platform
  - Selective medical and medico-IT equipments, preferably IT compatible, with interface to tele-medicine and/or other software/ hardware
  - Computer hardware/ software platform (PC, switch, etc.) and IT electronics equipments
- Connectivity/ bandwidth requirements (e.g. ISDN, leased line, VSAT, broadband, wireless)
- Point-to-point video-conferencing system (may be portable)

District Hospital Infrastructure Telemedicine Room

- Patient engagement facilities (bed, scopes, etc.)
- Telemedicine Platform
  - Selective medical and medico-IT equipments, preferably IT compatible, with interface to telemedicine and/or other IT software/ hardware
  - Computer hardware/ software platform (PC, server, switch, etc.) and IT electronics equipments
- Connectivity/ bandwidth requirements (e.g. ISDN, leased line, VSAT, broadband, wireless)
- Multi-point video conferencing system
- Optional telemedicine software access facility at consultant's room through hospital-LAN
- Optional secure centralised long-term electronic record storage

State Hospital/ National Super Specialty Hospital Infrastructure

- Telemedicine room
- Telemedicine platform
  - Computer hardware/ software platform (PC, server, switch, etc.) and IT electronics equipments
- Connectivity/ bandwidth requirements (e.g. ISDN, leased line, VSAT, broadband, wireless)
- Multi-point video conferencing system
- Optional telemedicine software access facility at consultant's room through hospital-LAN
- Optional secure centralised long-term electronic record storage

Figure 2: Telemedicine Network Based on WiFi and WiMAX (Hamid, 2013)

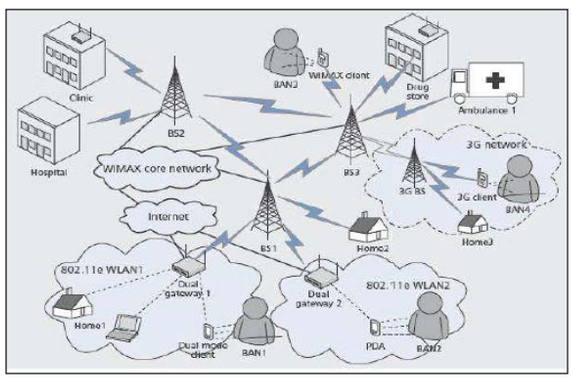


Figure 3: Remote Access Between Different Healthcentres

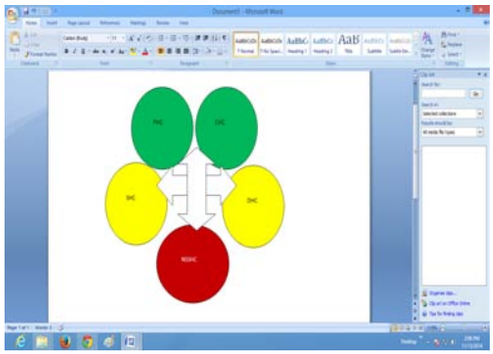
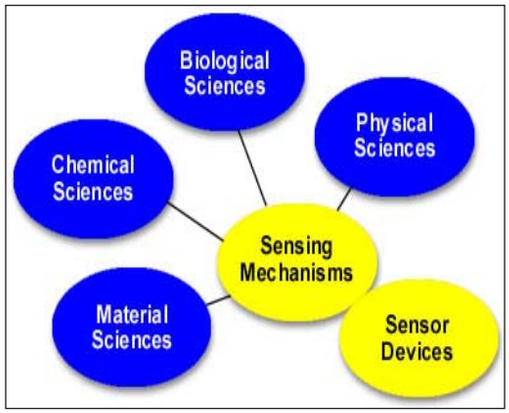


Figure 4: Sensing Process Requirement



Biological Sensors

A biosensor (http://brc.mui.ac.ir; http://www.news-medical.net) or biological sensor is made up of a transducer and a biological element that may be an enzyme, an antibody, or a nucleic acid that uses a combination of two steps: a recognition step and a transducer step. The recognition step involves a biological sensing element, or receptor, on the surface that can recognise biological or chemical analytic in solution or in the atmosphere. The receptor may be an antibody, enzyme, or a cell. This receptor is in close contact with a transducing element that converts the analyte-receptor reaction into a quantitative electrical or optical signal. The signal may be transduced by optical, thermal, electrical, or electronic elements. A transducer should be highly specific for the analyst of interest. Also, it should be able to respond in the appropriate concentration range and have a moderately fast response time (1-60 sec). The transducer also should be reliable, able to be miniaturised, and suitably designed for practical application. Figure 4 shows the sensing process

requirement. Sensing process involves physical science, biological science, chemical science, and material science with sensing mechanism.

Parts of a Biosensor Every Biosensor Has

- A biological component that acts as the sensor
- An electronic component that detects and transmits the signal

Biosensor Elements

A variety of substances may be used as the bio-element in a biosensor. Examples of these include:

- Nucleic acids
- Proteins including enzymes and antibodies. Antibody-based biosensors are also called immunosensors.
- Plant proteins or lectins
- Complex materials like tissue slices, microorganisms and organelles

Biosensors Application for the Nation (www.gwent.org)

1. **Industry**: process monitoring and control, particularly food and drink
2. **Medicine**: diagnostics, metabolites, hormones
3. **Military**: battlefield monitoring of poison gases, nerve agents & people
4. **Domestic**: home monitoring of non acute conditions

Mobile Telemedicine

Mobile telemedicine unit consisting of medical equipment along with telemedicine hardware, software, and WiMAX system mounted in a bus/van can establish a mobile telemedicine centre at any place. The major areas of mobile telemedicine applications are in the field of tele-ophthalmology and community health. Under mobile tele-ophthalmology, rural eye camps can be conducted and the rural population can undergo eye screening for cataract, glaucoma, and diabetic retinopathy. Under community health programme, mobile tele-medicine units are very useful not only for disease prevention but also for health promotion in terms of running awareness camps and teaching hygienic practices. The requirements for telemedicine are given below:

(a) Broadband Internet connectivity at doctor and patient end:

The broadband Internet connectivity is must to access sensors response from patient side or to communicate the patient and other doctors' team available with patient and also for sharing the data which is available in the cloud.

(b) Use of ZigBee/ Bluetooth between sensors and PDA:

ZigBee is a wireless mesh networking standard which is intended to be simpler and cheaper than other Wireless Personal Area Networks (WPAN) technologies like bluetooth. It also consumes less-power. Thus the target applications are those that require low data rates, long battery life, and secure networking.

(c) Use of NFC enabled mobile phones by health worker

The smart card would store the private key for the patient. NFC (www.biocomfort.com) enabled mobile phones used by the health worker can read the data from the smartcard and authenticate the patient to the system. Once the prototype is found to be feasible, biometric smart cards could be used for better security.

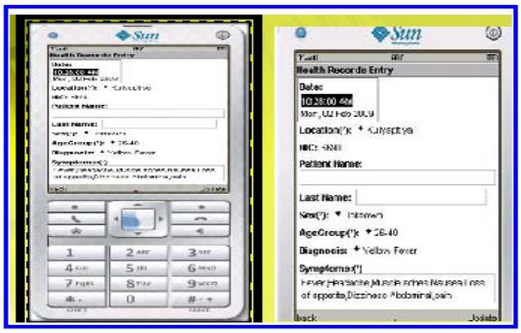
Possible Medical Help

In very remote areas where there is lack of medical facilities and lack of specialised doctors and other required equipment, tele-medicine setups can be established. In some places mobile network is used, in which the symptoms of the patient can be sent to the doctor using software installed in the mobile phones. As a feedback after studying the case, appropriate treatment can be recommended by the doctor on the phone using SMS system. It is shown in Figure 5.

Recommendations

1. The separate cloud should be available for rural healthcare.It may help for speedyanalysis, study, diagnosis,and treatment forrural community.
2. The high speed broadb and Internet connectivity should be available in rural remote places.

Figure 5: Possible Medical Help by Installing Software in Mobile Unit (Chaudhari, 2008)



3. The number of CHC should be increased with basic telemedicine infrastructures.
4. The PHC, CHC, DHC, SHC, and NSSHC staff should be trained to adoptthe new technology.
5. The sensor kits should be available at low cost or free for poor community.
6. Need to bring awareness in the rural area regarding m-health, e-health service.
7. The smart mobile phones should be made available at low cost or free for those who are below poverty level.

Conclusions

M-health or e-health has been defined as medical and public health practice supported by mobile devices, such as mobile phones, patient monitoring devices, personal digital assistants (PDAs), and other wireless device with Internet broadband connectivity which needs to integrate its use in the rural area to improve the healthcare system for rural community. The cloud computing technology may play major role for storage and access of medical data which may bring the efficiency in work. There is need to bring the awareness in the community to make use of this advance technology for healthcare. The women and childcare will be helpful for poor community.

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