

Research Journal of Pharmaceutical, Biological and Chemical Sciences

Analysis of Data Transfer Metrics of Internet of Things in Health Care Services.

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ABSTRACT

Health Internet of Things that integrates smart devices with advanced communication technologies has greater potential to offer better health care services. Identification of communication technologies that provides efficient data transfer mechanism is a great challenge in Internet of Things environment. In this paper, different metrics are analyzed that can be used for efficient data transfer mechanism. This analysis can be implemented in mobile application so that the information can be transmitted in an efficient and cost effective manner. IoT can provide better health care by periodic monitoring and diagnosis of the user and can also provide precise treatments and healthier lifestyle.

Keywords: Health IoT, Data transfer, Mobile application, Health monitoring metrics

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INTRODUCTION

Technological advancements have made mobile devices smarter and its presence is felt like never before in this decade. Applications present in mobile devices especially in smart phones can be also used for Industrial monitoring, environmental monitoring, healthcare monitoring etc. Applications in smart phones can be efficiently utilized in health care management by providing solutions for various health issues faced by diverse set of people. The concept of Internet of Things (IoT) can be used to provide health care anywhere and at any time [1]. It involves integrating various smart devices with identification and communication capabilities and able to provide solutions to everyday health problems faced by people [2].

Mobile devices integrated with various sensors allow individuals to monitor their health parameters of the body and in case of any abnormality communicate the information with the physician for further suggestions and treatments. The major challenge in implementing IoT in health care services is to link the medical devices with the internet in terms of heterogeneity and to achieve efficient data transfer utilizing the existing communication technologies.

This paper presents methods to maximize the rate at which the information can be transferred in health care IoT. The method suggested in this paper identifies the suitable data transfer technique based on the kind and amount of data to be transmitted. This aids in reducing the communication costs and also increases the rate at which the information is transmitted thereby making health IoT an efficient one to implement for health care management services. IoT in health care delivers monitoring of health parameters in an easy and efficient manner and provides faster diagnosis and treatments.

HEALTH IOT

The health care services sector in a connected environment is progressing due to advancements in these technologies like MEMS and communication technologies. Personal health care devices consist of wearable sensors [3] that gather the data and these sensor data are collected and it is communicated with the local device which is transmitted to the remote systems in hospitals and further actions can be taken in response [4]. The information from these sensors can be monitored continuously by persons in hospitals or by employing a software agent for every patient [5]. This system also keep track the behaviors and also assist in improving the quality of life of an individual.

There are variety of applications available in smart phones that helps in recording blood pressure, blood glucose level, diet intake and calories spent and other purposes like monitoring patients with dementia using GPS present in mobile phones etc. This system aims in reducing the human participation thereby creating a doctor and patient friendly system that can be implemented in various hospitals.

Information systems in medical domain

The information systems used in medical domain includes reports from scanning and other diagnostic reports, prescription information, pharmacy information. These information from various medical systems may be diverse in the form of images, text, numerical data etc. and has to be stored accurately with patient ID for future reference.

Communication Technologies

GSM is a mobile telecommunication system that connects billions of devices around the world. SMS can be used as an efficient tool to provide short message service to the user however GSM cannot be used efficiently to transfer data of larger size. Hence to transfer larger amount of data GPRS can be used. HTTP is not an efficient protocol to implement Internet of Things. The protocol used in the application layer of Internet of Things should be compatible to work in energy constrained environment.

Bluetooth works in low energy environment and is also cost effective [6]. Bluetooth can be efficiently used for various applications in short distance communication and not suitable for long distance communication. RFID is one of the efficient communication technology that can be utilized in IoT environment [7]. It provides communication between objects by identifying the information stored in electronic chips. This

technology has greater impact on wireless sensor networks that can be deployed in health care management services. NFC enabled smart phones can provide a new mode of communication between objects that can operate in IoT environment.

EXISTING TECHNOLOGIES

Information Transmission Architecture

Three technologies that are used for efficient data communication are SMS based on GSM, GPRS and ADSL/Wi-Fi(8). In this analysis, User is assumed to have a health device or a wearable device with various sensors that communicates the data to the smart phone or PC using above mentioned communication technologies. PC or smart phone will transfer the data to the remote server.

In the SMS based data transfer architecture, the application running in the mobile phone receives the data from the sensors. The mobile phone sends the data through SMS to the SMS server which in turn transfer its request to web server. The SMS based data transfer architecture is shown in Figure 1.

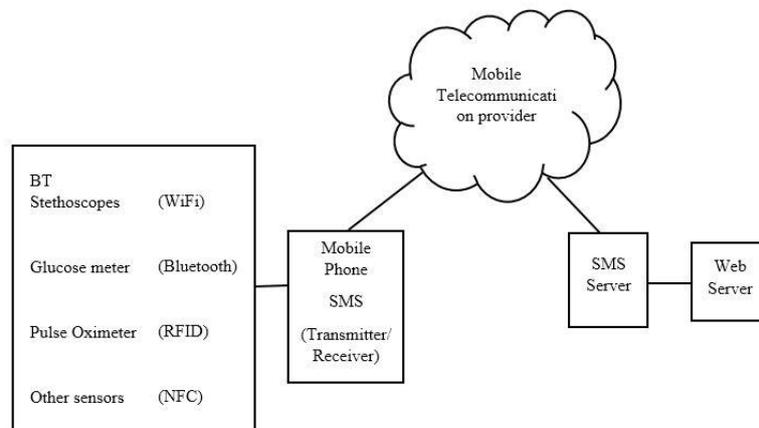


Figure 1: SMS based data transfer

In the GPRS based data transfer architecture, the application running in the mobile phone utilizes GPRS technology to transfer the data received from the sensors to the web server. The architecture is illustrated in Figure 2.

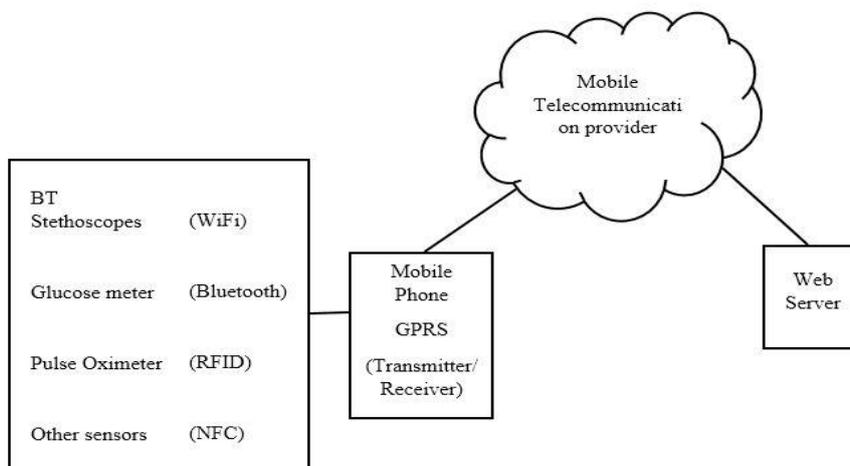


Figure 2: GPRS based data transfer

In ADSL based data transfer architecture, data from the sensors are sent to the web server utilizing WiFi technology and wireless router. The architecture utilizing ADSL technology is shown in Figure 3.

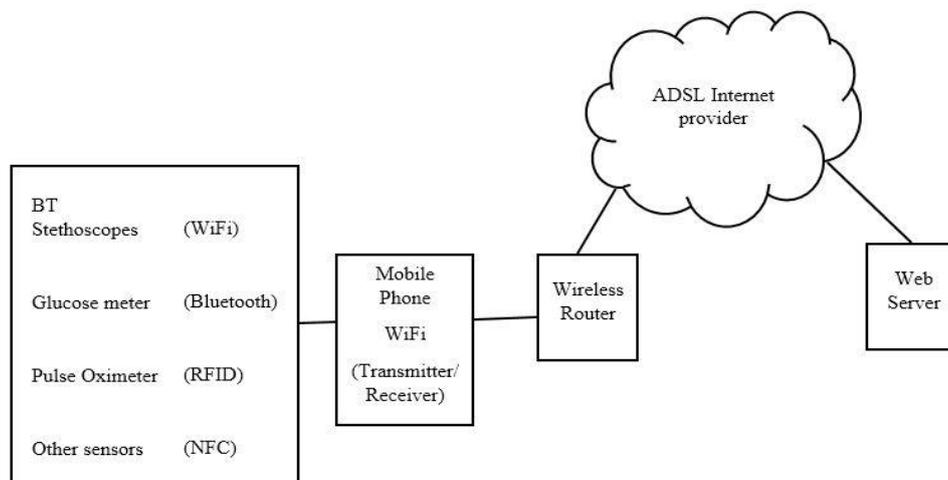


Figure 3: WiFi/ADSL based data transfer

Information Transmission Cost Analysis:

The application installed in Mobile phone transfers the data to the web server and using any one of the above illustrated architecture. Various data transmission and it costs is given in Table 1.

Data Transfer Method	Average Cost(Rupees)	Scope
SMS	1.2/SMS	160 characters/SMS
MMS	5/MMS	510 kb/MMS
Mobile Internet	135/month	1 GB
ADSL @home	600/month	Unlimited data usage

Table 1: Average data transmission costs in India

Hence the mobile application should choose the architecture that minimizes the overall cost of data transmission for the user and also depending upon the type and format of the data being transferred. In case the user does not have internet package balance, the application has to choose the SMS based data transmission for transferring the data to the web server. In case of transferring scanned report, image has to be sent through MMS.

Metrics Used:

The information from these medical devices can be transmitted in the form of values in its plainest form or it can also be coded in XML format depending upon the mode of data transfer employed for communication(9). The mobile application sends the information form the medical devices to the web server. It measures the total size of data along with its cost based on the format of the data and chooses the transfer mechanism that better suits the user with cost efficiency.

$$S_{total} = S_{org} + S_{add} \tag{1}$$

Where S_{total} is the total size of data to be sent, S_{org} is the size of original data to be sent, S_{add} is the size of additional overhead to be added. The data measured for HTTP method is in the form of bytes. For SMS, the data measured is in the form of characters.

$$X_{sms} = S_{total} / X_{ch} \tag{2}$$

X_{sms} is the number of SMS required to send the data, X_{ch} is the number of characters that can be sent in an SMS. Depending upon the format of transmission, the size of overhead added to the original data differs. The mobile application also measures the amount of times the measurements are taken and the cost of data transfer method.

$$C = \sum_{x=1}^n C_x * N \tag{3}$$

Where C is the total cost of data transfer, N is the number of times the parameters are measured C_x is the cost of data transfer of x^{th} time. For a monthly analysis the value of x varies from 1 to 30 or 31.

Mobile application(10) also contemplate a parameter session ID. The user will be authenticated with is ID and based on communication, cost is evaluated.

EXPERIMENTAL ANALYSIS

In this experiment, two different scenarios are analyzed for patients having different health issues. In the first scenario, Blood pressure and Temperature of the patient are measured for fever conditions. In the second scenario, Blood glucose level, ECG and Weight of the patient are measured. These measured values can be sent through SMS or HTTP method along with patient ID and the date. Some measured values are time sensitive and it has to be transmitted immediately but some values are not time sensitive, based on the scenario data transfer has to take place either using SMS or HTTP method [6,11]. Different health issues faced by people and the rate at which the measurements are taken is listed in Table 2.

S.No	Parameters measured	Health condition	Rate
1	Blood pressure Temperature	Fever or other conditions	1 time/day
2	Blood glucose level Weight ECG	Heart disease and Diabetes	1 time/week

Table 2: Different health conditions analysis

The information can be transmitted in four methods using SMS for transferring data of smaller size utilizing GSM technology, using MMS in case of ECG or any image file format, Internet services in case of using mobile or ADSL technology for transmitting data of larger size.

The cost analysis shown in the Figure 4 compares the cost of four data transfer methods in a daily basis. These information are transmitted every day because it is time sensitive.

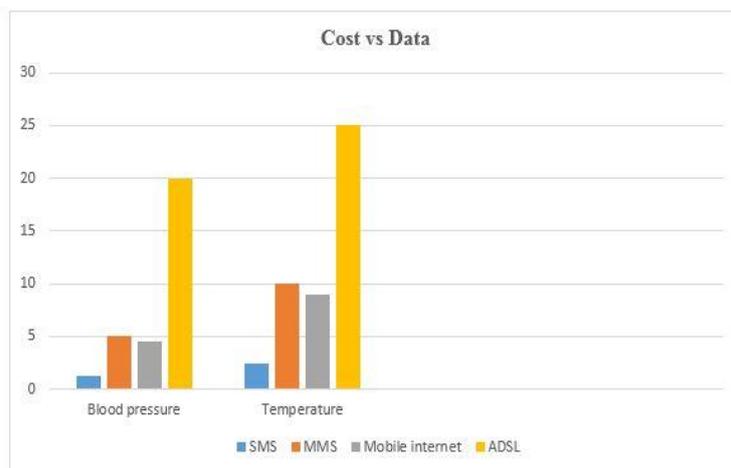


Figure 4: Time sensitive data cost daily analysis

The cost analysis for time insensitive data is shown in Figure 5. These information are transmitted on a weekly basis.

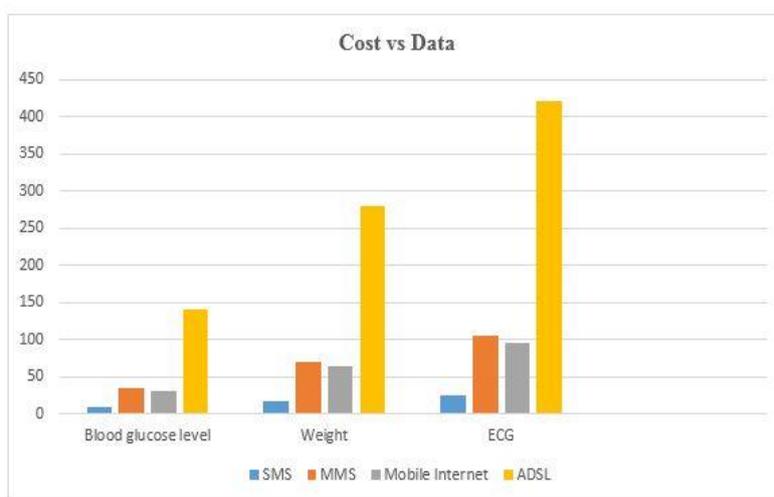


Figure 5: Time insensitive data cost weekly analysis

The cost analysis for various methods of data transfer is done and the result proves that for transmitting data of smaller size, SMS proves to be the cost effective solution while HTTP method can be used for transmitting data of larger size.

CONCLUSION

The Internet has greater influence towards health care services which gives rise to new paradigms like health informatics, health big data analytics, digitizing health records etc. The information available in the health care can be presented to the user in a user friendly format in the form of texts or images that can be perceived by normal people. The metrics that are being analyzed in this paper can be applied for various practical scenarios for improving the efficiency in data transfer and provides the services to the user in a cost effective manner. These metrics can have greater potential to maximize the efficiency of the data transmission in Internet of Things environment. The application can be developed in the smart phone that can make use of these metrics that are analyzed and choose efficient data transfer techniques depending upon the sensitivity of the information that has to be transmitted.



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