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Framework for Distributed Database System Using Smart Phone in Cellular Network

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***Abstract*—** Due to advancement in technology and the features the mobile phone users are increasing with tremendous speed so the way of accessing information is changing day by day. Peoples are requiring the information or getting connected to their business when they are on move. The mobile computing applications have given rise to store data on mobile phones. Database developers have created light versions of databases for mobile devices. A trend of storing business-related data on mobile phones has already begun. Large data storage requires different frameworks. A framework for Distributed database system using Smart phone has been presented in this paper.

***Keywords*—** Distributed Database, Smart phone, SMS

I. INTRODUCTION

The mobile data management differs from the conventional data management in terms of the mobility of the users, the accessing nodes connected to the system and the resource constraints such as wireless bandwidth and battery life [1]. The computational and networking power of mobile devices is still constantly increasing and new technologies are integrated into them to support new functionalities, services and databases [2].

Several modern database management supports small-footprint databases that can be installed on mobile devices and admit disconnected computing and synchronization [3].
Cellular network provides many ways of communication, Bluetooth, NFC, Wi-Fi and Internet. These are having its advantages and disadvantages. Bluetooth costs nothing to use but is limited by a transmission distance of up to 100 meters. In comparison, SMS need no attention and the cost is decreased up to the fraction of a penny. WAP costs more to use, but it can not only send text and multimedia messages. Short Message Service (SMS) is the universal communication successful service [4] having success delivery ratio more than 94.9% [5].

Distributed databases are used to increase the scalability and to increase the availability of data for the applications where data and access of data are required to be of distributed in nature [6] the users are connecting form mobile devices to access the information. The examples of distributed database are the systems such as Airline reservations, financial institutions, and automated manufacturing [1,7].

Rest of the paper is organized as follows, Section II contain the review on various communication technologies using mobile devices and its applications, Section III describes the architecture of the proposed system and its working, Section IV discuss the implementation and results and Section V concludes research work with future directions

II. RELATED WORK

Various methodologies regarding Ad-hoc network, distributed database, lightweight database for smartphones, and data communication in ad-hoc network are reviewed during this research.

Bluetooth
Bluetooth defines 40 Radio Frequency (RF) channels in the Industrial Scientific Medical (ISM) 2.4 GHz band. Such channels are divided into three advertising channels, which are used for broadcasting purposes, and 37 data channels, which allow bidirectional message exchange between two connected devices. The physical data rate is 1Mbit/s.

Communication using Bluetooth
In many research, it is found that the Bluetooth has been used to connect to various sensors to the mobile devices. Wearable sensors like ECG monitor [8, 9], Oximeter [10, 11], Blood pressure monitor [8, 9, 11], Scale [8, 9], Cardiac activity

monitor [9, 10, 11], Blood pressure [9, 10, 11], Thermometer, Glucometer [8, 10, 11] etc. are connected to a smart phone using Bluetooth. The sensors act as a slave and the mobile device as master. The sensor readings are collected and analyzed after each specified time interval and sent to a smart phone through Bluetooth for storage. The connection lives until the energy source or range lasts. MAvBT consists of a server installed on a Bluetooth enabled computer, a mobile application installed on student's mobile phones [12].

Wi-Fi (Wireless Fidelity)

Wi-Fi is a high-speed internet connection and network connection without the use of any cables or wires. The wireless network is operating three essential elements that are radio signals, antenna, and router [13, 14]. The radio waves are keys which make the Wi-Fi networking possible. The computers and cell phones are ready with Wi-Fi cards. At present, the four major types of WI-FI Technologies used are Wi-Fi-802.11a, Wi-Fi-802.11b, Wi-Fi-802.11g, and Wi-Fi-802.11n [14, 15, 16].

Communication using Wi-Fi

Many researchers have worked on databases on mobile devices connected by Wi-Fi connectivity. In emergency conditions, the patient information from the SQLite database on Android is sent to caregivers, doctors using Wi-Fi and /or 3G/4G networks [16, 17]. The health data collected through Bluetooth is transfer to the server using Wi-Fi [11]. The learning environment which signifies the anytime, anywhere learning uses a wireless network with both 3G and Wi-Fi to connect with the University server at all time using Web [17]. QOrder application utilizes Wi-Fi to easily reach to remote corner hotspot in the establishment [18]. Wi-Fi is used to send information to and retrieve data from an automated food ordering system [19]. Wi-Fi network is used to implement WiFiRemote [20].

Mobile Data (Internet)

Cell phones have a built-in antenna which is used to send packets of digital information back and forth with cell-phone towers via radio waves. Mobile phones connect to a cell tower in the area which is having structure of overlapped hexagonal cells [21, 22]; each cell is defined by a tower at its center. These cells are then connected to the higher network by communication with satellites. Through this network information is passed to and from wireless enabled devices. There are usually two ways to connect to the internet through mobile phone by using cellular telephone service provider and by using standard Wi-Fi [7, 21, 23].

Communication using Mobile Data

It is found that the internet connections are used to connect mobile devices to the centralized database server for transferring as well as for retrieving information.

In these researches, the collected sensor data is sent to the mobile terminal via Bluetooth wireless communication, and mobile terminal uploads it to a back-end Web server using internet [9].

Also, it is presumed that all ambulances will have fast wireless Internet access through a General Packet Radio Service (GPRS) or Worldwide Interoperability for Microwave Access (WiMAX) [23].

The implementation of iTrust is based on the Hyper Text Transfer Protocol (HTTP), which is most appropriate for desktop or laptop computers on the Internet [24].

Health data collected by sensors is communicated to an external location using internet using cloud module [10].

Short Message Service (SMS): SMS are sent through a radio channel. When a user sends an SMS message, it reaches to SMSC through BTS and MSC [4, 7]. SMSC uses store and forward mechanism for the messages. The message is stored in the SMSC and, when possible, it is forwarded to the intended destination. If the destination is unavailable, the message is spooled for later transmission.

Communication using SMS: An intelligent database program for an interactive auto-responsive opinion poll system is designed based on SMS [4]. A generic information system is presented using SMS gateway [27]. An application is developed for school usage using SMS [28]. A request message is sent to the Web server [29, 30] or a stationary server [31], connected with a cell phone with GSM modem. When the system receives a simple or location based request message into the phone a trigger is fired to answer the query from database server [29, 30]. An application for a decentralized search and retrieval system named iTrust is described with SMS-HTTP Bridge [25]. A complete integrated solution is presented using mobile phone and web [28].

SMS is the universal communication service technology which can be used where there is no internet connectivity. The requirement of information by the user is very small than the information searched. Smart phones are capable of storing small amount of data. Data of big size can be fragmented and placed on number of devices to form a cluster which resembles a structure of distributed database.

III. FRAMEWORK

A distributed database system consists of collection of mobile devices such as Smart Phone performing the role of Database Directory (DD) and Database Nodes (DBN). RN, the requesting node is a mobile phone of the user seeking information.

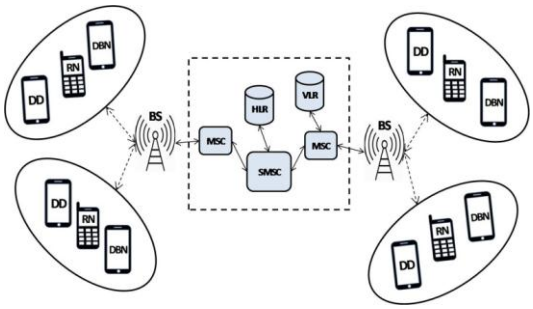

Figure 1. Architecture of distributed database using Smart phones

The Requesting Node (RN) starts the communication by sending a request to DD containing information about desired attribute(s) for particular region with the particular format specified by the system. The DD acknowledge to RN if the request can be satisfied or not. Figure 2,3,4 shows the flow of service when one, two and three nodes are involve in the service.

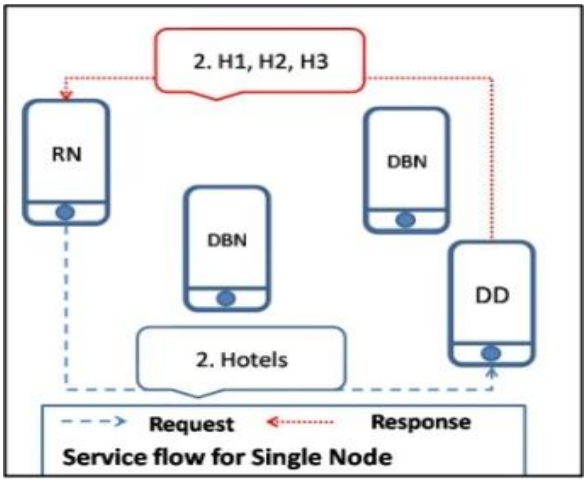

Figure 2. Service using single Node

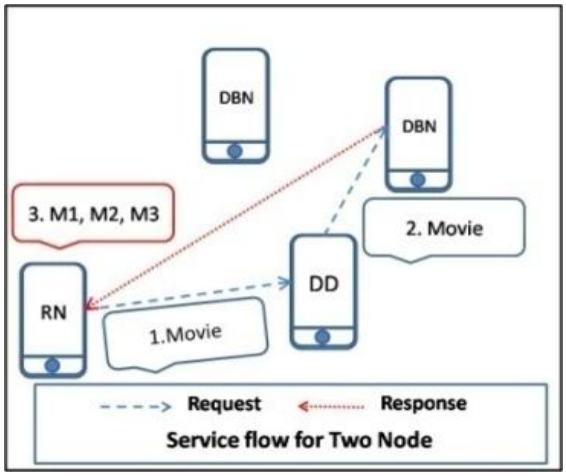

Figure 3. Service using Two Nodes

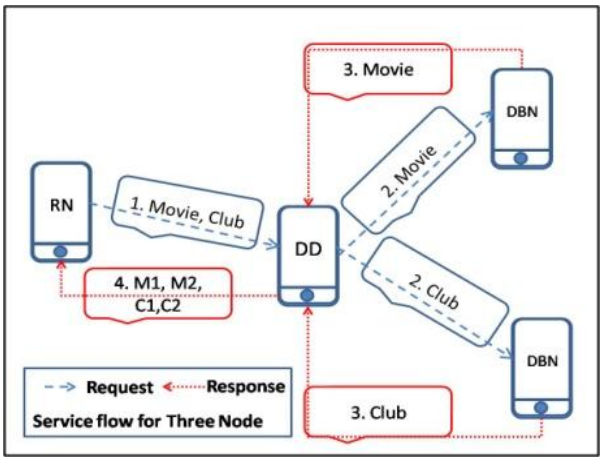

Figure 4. Service using Three Nodes

The DD extracts the attributes and find out the participating DBN required for processing the request. The participating DBNs are prioritized and stored.

The query is forwarded to the DBN. The DBN processes the request. If the DBN is in network, after processing the request, DBN generates a response and sends back to the RN otherwise failure message received at DD then the DD sends the query to the next DBN.

Update Protocol:

The Peer-to-Peer update strategy for asynchronous replication is modified for implementation. The write request is always set highest priority, than the read request. A DBN which initiates the update (INSERT/UPDATE/DELETE) transfers the update log to all replicas of DBN and DD. The node holding replica acknowledge to DD if they perform the update. The DD mark updated nodes and further queries routes to updated nodes only.

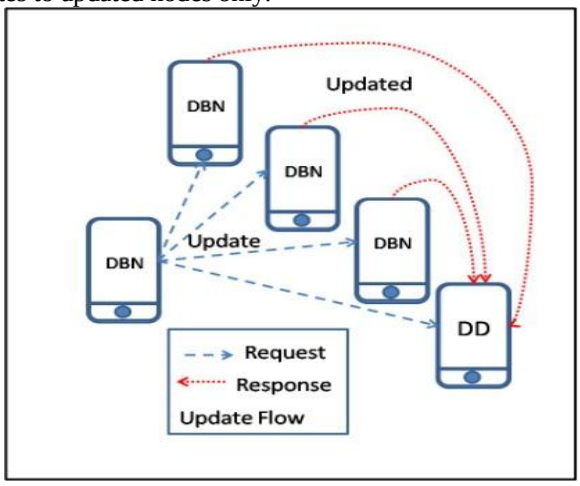

Figure 5. Update Protocol

In the system if any node is out of network of switch off it will receive the message whenever it will switch on or enter enters into the network.

IV. RESULTS

For the Distributed Database system three DD and five DBN nodes are considered. Each DBN is having its own database for an attribute in a region.

The design of the system includes database relations fragmented horizontally and replicated at three distinct nodes for enhancing the performance, availability and for faster execution of the queries using local copy of data.
After sending request SMS using different cell phones from different locations for various services to all the nodes the result have been analyzed.

The time taken by SQLite database for SELECT query is 0.001 seconds [32] and the average time to deliver a SMS is 4.6888 seconds [5, 21].
It is found that the service response time increases as per the number of participating node increases. The SMS (Figure.6.) took the minimum time 9.3776 seconds to reach and maximum 24.3776 seconds. The minimum time taken (Fig.7.) for processing the request is 0.001 seconds and the maximum is 0.002 seconds.

The minimum time (Figure.8.) for service response taken by the system is 9.3786 seconds when all the nodes are in network and the maximum time taken 24.3786 seconds when some of the nodes are out of network.

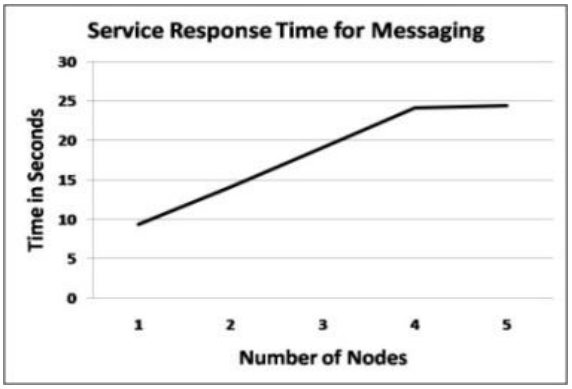

Figure 6. Response Time for Messaging

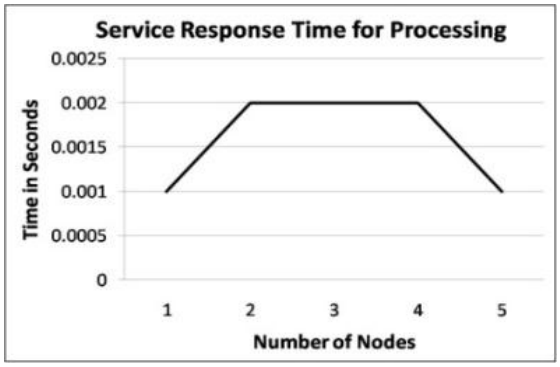

Figure 7. Response Time for Processing

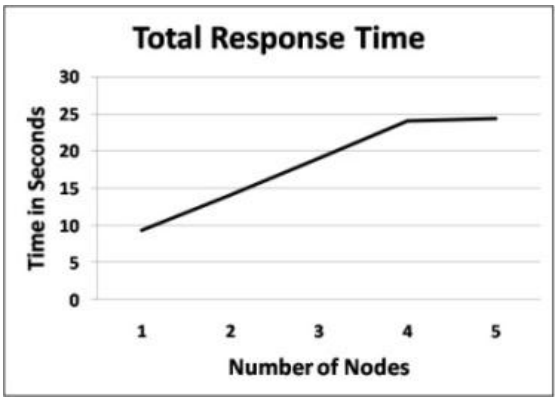

Figure 8. Total Response Time

V. CONCLUSION

The framework is capable of accessing small amount of information from distributed database on moving mobile devices where there is low connectivity or no internet. Group of such databases may form a large distributed database across regions. An framework is designed for distributed database utilizing smart phone as database server and SMS as communication technology. Any service request can be satisfied in less than 25 seconds even if some of the nodes go out of network.. The data storing and processing is efficiently handled by the framework for smartphone. The system only support for basic information retrieval as the database on each mobile device is of small size due to space constraints. The system is implemented using homogeneous databases.

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