IOSR Journal of Mobile Computing & Application (IOSR-JMCA)
e-ISSN: 2394-0050, P-ISSN: 2394-0042.Volume 2, Issue 1. (Mar. - Apr. 2015), PP 11-17
www.iosrjournals.org

Prototyping the Future Potentials of Location Based Services in the Realm of E-Governance

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Abstract: *In the past few years tremendous work has been done in the area of mobile computing. The advent of ubiquitous computing has revolutionized the data access capability of users. It provides access to the user anytime, anywhere. For the past decade, application-driven research in ubiquitous computing had given rise to a wide variety of applications which is user centric. Use of mobile phones, sensor equipped devices, GPS devices have given new meaning to the technology. Location based services (LBS), context aware application and automated capture and access play a major role in moving this technology to the next dawn.*
State and Central Government by adopting mobile technology as a platform are in the process of fostering their capacity to be agile and ubiquitous. It has made it possible for the citizens to experience a new range of services through mediums like SMS, IVRS, mobile applications, etc. On its way to move towards ubiquity, the Government is trying to provide users with the proactive information which relates to their location, usage pattern, time of movement. The integration of context and location information with applications is fast becoming the next level of ubiquitous computing. For incorporating such features in the existing Governance model require careful analysis, prototyping and evaluation of the challenges involves in proposed services.
This paper is based on the investigation done for finding the future potentials of a mobile location based services. It covers the general framework for LBS communication model along with various technological components. Further, the paper presents a prototype of potential mobile location based service architecture. Lastly, it presents the challenges involved and use cases which can be extremely useful for the citizens.

Keywords: *Ubiquitous Computing; Mobile computing; Location based services (LBS); Geographic information system (GIS).*

I. Introduction

Ubiquitous computing facilitates the collection of information pieces from sensors, databases, or mobile devices in order to compose the context of entities like users, places, or things. The context obtained in this way can be used to automatically adapt the behaviour of the services, which results in the new range of context-aware services [1]. Context awareness implies the information regarding the user's environment (context) adapts services to his or her current situation, needs and preferences [2]. Context-aware systems provide application developers and end users to experience a new class of services by gathering context data and adapt to the system's behaviour accordingly. These mechanisms are of high value if used in combination with mobile devices and are used to increase the usability tremendously. An important type of context-aware services is location-based services that adapt to the current location of the user.

Location based services can be defined as services that integrate a mobile device's location or position with other information so as to provide added value to the user. LBS service is a wireless value-added service in which users' location information is obtained through a wireless communication network and the analogous service is provided with the support of GIS platform. LBS uses the location of the mobile device to deliver services, exploiting geospatial information like latitude and longitude parameters about the surrounding environment of the user, their proximity to other entities in space (such as people and places) [3]. Many mobile applications have been developed to provide LBS. Such services are being offered by smart-phones available in market today. These applications make use of context aware devices which use information about the circumstances under which they are able to operate and based on rules, react accordingly [4]. These devices try to make assumptions about the user's current situation. Typical examples are restaurant finders, navigation services or applications in the areas of mobile marketing and mobile gaming. Leveraging location information enables the user to experience value-added services.

Nevertheless, state and central Government are not behind in offering location based services to the citizens. The development so far done is still at a very preliminary stage, lots of unresolved challenges and issues are needed to be addressed to leapfrog the existing class of services to a new level by scrutinizing the details of such technological implementations.

II. Types of Location Based Services

By far the current investigation has helped us to identify two main classes of location based services in the horizon of mobile computing that offers services to the masses successfully. Those two classes can are:

A. PULL Class LBS -In this mobile terminal uses SMS or WAP access to request LBS. A user happens to use service by actively participating in retrieval of location based data from the network by submitting their request. These services allow mobile users to query their environment and they allow applications to monitor and track remote places and objects. This information may be location dependent content (e.g., where to find the nearest ATM, restaurant, route to reach places, etc.). Here the content must be personalized depending on user preference.

B. PUSH Class LBS -In this the networks under specific conditions take the initiative to push information to the mobile terminal. A user need not actively request it. Such services are activated by an event, which could be triggered if a specific area is entered or triggered by a timer. The information may be sent to the user with prior consent (e.g., subscription-based services) or without prior consent (e.g., an advertising welcome message sent to the user upon entering a new town, automatic airport check-in, Targeted advertising). The users are relieved from the task of manually entering location information which is automatically pinpointed and tracked once they enter the targeted location.
There are some applications which integrate both push and pull functionality.

C. Session Based LBS - Apart from the above mentioned services there exist a new class of service called session based services wherein the user need to establish a real time session with the application handling the service. Users will be able to access the service for the complete duration for which they are logged on in that session. Real time middleware comes in to picture for handling compatibility and interoperability issues under such circumstances.

III. LBS Communication Model

The LBS communication model consists of three layers – a positioning layer, a communication network layer, and an application layer [5] which correlates to the various components. Recently a middleware layer has been introduced between the positioning layer and the application layer to reduce the complexity of service integration. This middleware layer manages the interoperability between networks for location data. Various components of LBS communication are user devices like mobile phones, positioning system, communication network, application server and data server. All these components communicate together to produce a service to the mobile user.

A. User Devices: The field of hand held devices with geographical applications is developing rapidly fast. There are many devices available in the markets, which are capable of handling LBS applications. Users' request for LBS data originates from here and further carried away from the communication networks.

B. Communication Network: Communication network consists of various network components like gateway etc. to send the request across. The internet is the major communicating medium between the user and service provider. Services can be accessed using Wireless Application Protocol (WAP), 2G or 3G connections. Gateway acts as a middleware component which encodes and decodes the WAP request to HTTP and vice versa respectively. The communication network can relate to a cellular network with various base stations managing different mobile units.

C. Positioning System: Positioning is a very important key element in the location based service users and suppliers need to know what type of position technology fit their use or service such as

availability, accuracy, vulnerability and continuity. Positions can be obtained with the help of Global Positioning System or the mobile communication network including radio stations. In case of GPS the position can be determined with the help of tracking software that detects the device position by calculating the signals of the satellites [6].

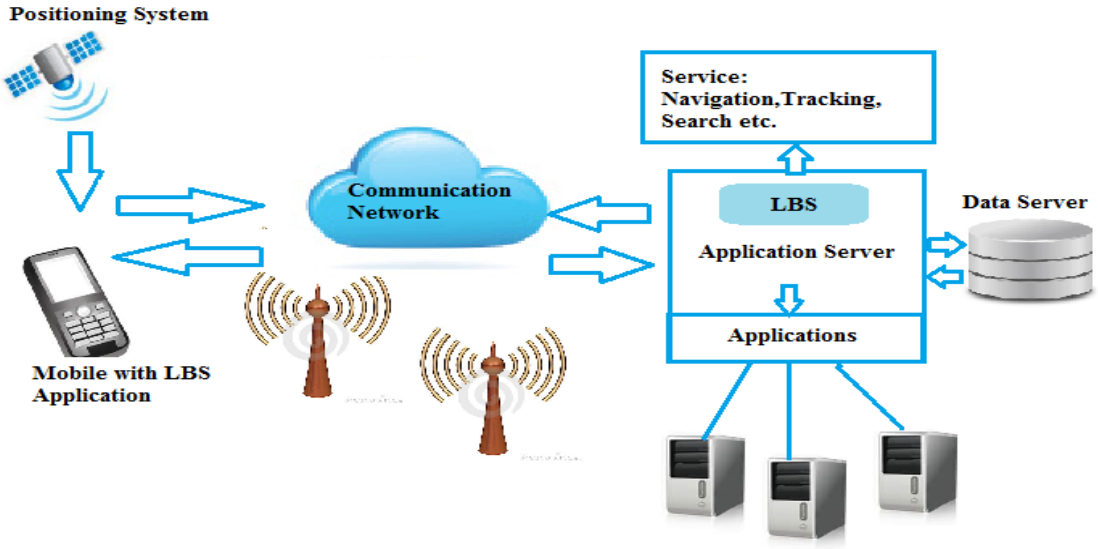

Fig 1. LBS Architecture showing various elements of the Communication Model.

However, there are other methods of positioning in addition to GPS, such as network based positioning that is based on various means of triangulation of the signal from cell sites serving a mobile phone. The serving cell site could be used as a broad location of the user. There exists some handset based positioning like Cell of origin technique (COO), Enhanced observed time difference (EOTD), Assisted GPS (A-GPS) etc[7]. In some case the user has to manually calculate the position of the device in respect to the known base station's positions.

D. Application Server: These servers maintain various application data with respect to the location entries. The server offers a number of different services to the user and is responsible for the service request processing. The application server uses various data servers to process the user request. Application server uses the positioning system to obtain the position of the user which can be combined with spatial information so as to integrate LBS system with Geographical Information Systems (GIS) or other location dependent information. This is done by location management function which acts as a gateway and mediator between the positioning equipment and LBS infrastructure [8].GIS provides the tools to administer base map data such as manmade structures (streets, buildings) and terrain (mountains, rivers). GIS is also used to manage point-of-interest data such as location of hospitals, petrol pumps, restaurants, etc. It allows the system to determine the serving cell site of the user. Once the serving cell site is known application specific data can be served to the user.

E. Data Server: Application Server will usually not store and maintain all the information which can be requested by users. It stores the subscriber data such as user profile, their navigation history, preferences, current location data, etc. Application servers rely on the data server for accessing user centric data. The data server also provides GIS information

The general working of this communication model includes following sequences. First of all when the user activates the positioning device in the mobile unit, the positioning system calculates the exact position of the receiver. In case of GPS, the operated satellite signals are used to calculate the position of the device. The cellular device should have a GPS receiver, an antenna and a processor to calculate. The GPS receiver sends the data to the server network and after determining the exact position, the result is transmitted back to the mobile phone. The user then requests their required queries and seeks answers from the application server,

which after analyzing data from its own directory and from other data servers resend back the desired result to the user.

In case of other LBS systems that run without satellite based navigation system depends on the radio signals transmitted from different ground based wifi stations. The receiver considers its own position taking account some of the surrounding base stations. This requires some special software and more and more ground base stations for better precision. As far as accuracy is concerned, it varies between positioning technologies.

Hence, in the whole process, the user's location information is first stored in a location management unit which acts as a gateway that also exchanges information between the user and the application server. Hereafter obtaining and detecting the user's request, the application server chooses the appropriate data from its present the directory and even sometimes collects content data from a data server (data provider) and then sends back the response to the user. The service depends on the geographical information database or GIS. Mobile applications running on the user mobile device receives data sent by the application server display the result on the handset screen.

IV. Proposed Prototype For LBS Implementation

In this paper we propose a prototype based upon web service based model for implementation which can be used by various government department to offer location based services over mobile devices. By means of this platform, citizens can gain access to a system that is integrated from different data sources. Real time data responses will be generated by tracking the location data.

The model consists of a central entity which is equipped with a centralized application server for handling integration of various location based services pertaining to different service providers.

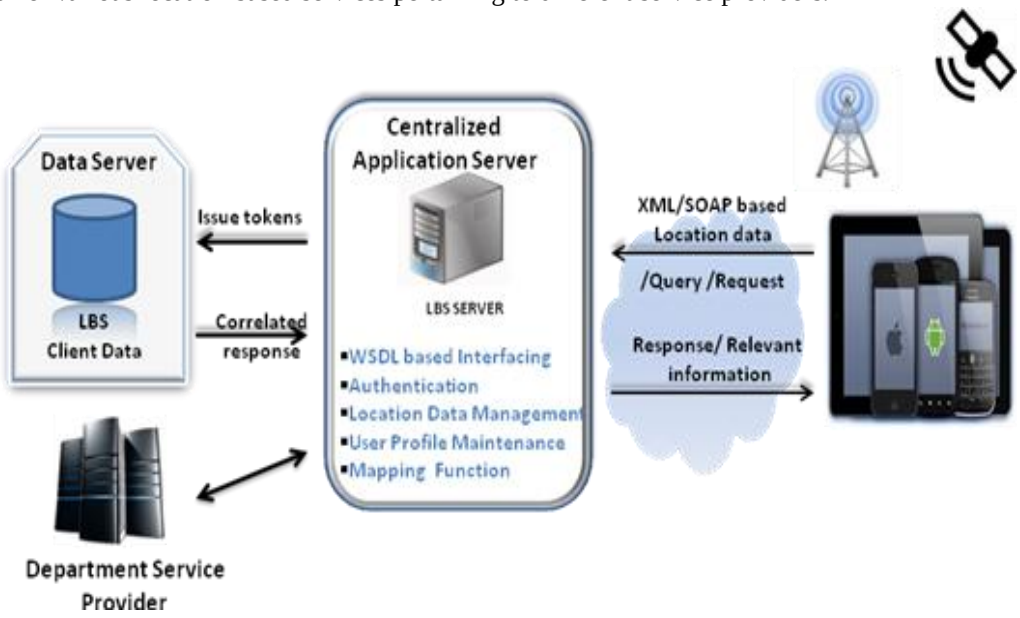

Fig 2. LBS Platform Prototype

All requests for location based services will land on the centralized application server. It will be connected with various data servers which provide GIS information, user profile information and department services.

Location tracking will be done on the application level as soon as the user uses the application. The position of the user will be obtained by either GPS based module installed on the user mobile device or through triangulation method using cellular network. The position obtained from positioning system can be displayed on the maps such as Google Maps. The service would be made available to the users by means of mobile application. Web service based communication model will be used to send the user request related data to application server.

The central application server is the processing centre for all location based service requests from the user and communicates with the data server. It plays the role of middleware for catering the interoperability

issues related to network, data conversion, synchronization, integration, etc. The middleware integrates with the GIS servers, network infrastructure, including location servers, WAP gateways, citizen profile, billing systems, accounting systems, etc.. Various departments who wish to provide location based services need to register their service to the centralized application server which makes an appropriate entry on the centralized server. User profile related information will contain preferences set by the user for using the specific service. Various functions carried out by the means of this server are authentication, location data management, user profile maintenance, mapping of the request with the response, generation of an appropriate token to represent the response to the user, etc.

Data from different department service providers can be integrated by using web services. All these exchanges happen using XML based message format. Web services make data transformation and manipulation easier, so it can be shared among different systems. Standard specifications based on Web Services Definition Language (WSDL) are used for service data exchange. The syntax of a web service allows a service provider to publish information related to service location, its status and capabilities. It covers the description of which arguments and results are involved in the interactions along with the data formats and protocols used for the message exchange between the applications [9][10].

The information exchange is performed through the Simple Object Access Protocol (SOAP), which sends and received information coded in XML through the internet [11].

V. Applications of Proposed Model

The proposed model helps in implementation of the applications which exploits the location traking phenomena of LBS for providing safety and value added service to the citizen. However, its application lie into various categories including emergency assistance, navigation , inquiry and information services, tracking, advertising, billing, management, games and leisure[12]. Potential applications are as follows:

A. M-Parking – This application will help citizen to locate and book parking slots for their vehicles in a thickly populated cities where it is very difficult to find a free parking slot. A mobile application will be made available which will help citizens to locate a free parking slot as per the location in which they are currently located. Citizens may register themselves with their vehicle number and related details with the application server for quick booking of the parking slot. The user's current location will be fetched by the application using GPS or triangulation method. The latitude and longitude of the user's current location will be passed to the application server. Various parking providers will be integrated with the application server. The Application server will fetch parking slot availability from the parking service providers who are in the vicinity of the user given location. The parking slot availability will be sent back to the user.

B. Rakshak - RAKSHAK is proposed one button application built specifically for women, senior citizen's safety. This application can be used in case of emergency wherein, on click of a button this application will send SMS having current location to 3 different (Relatives/Friends) numbers and will also initiate a voice call to an emergency number. The application can be configured by adding up to 3 relatives, friends numbers (one mandatory and two optional) and one mandatory number on which voice call will be initiated. In case of an emergency, user on clicking RAKSHAK icon, the user's current location will be fetched by the application using GPS or triangulation method and latitude and longitude of the user's current location will be passed to the application server. The application server will fetch the address from the GIS server and same will be returned to the Rakhsak application. The Rakshak mobile application will then send text message containing address obtained from application server to 3 numbers and a call will be initiated on emergency contact number.

C. Real Time Vehicle Tracking System - Mobile based vehicle tracking system can be used for real time tracking of vehicle, obtaining estimated time of arrival of the vehicle. The vehicle will have GPS module to fetch the vehicle location and same would be communicated to the application server by the communication module installed on the vehicle. The communication module will update its current location on regular interval to the application server. The system can be installed on public transports, and passengers registered to application server can obtain expected time of arrival of the vehicle based upon their current location.

VI. Challenges of the Proposed Prototype

Implementation of a full proof system is crucial, in case where various stakeholders are involved. The implementation of such system requires support of Government, Department service provider, network providers (if required), GIS bodies, Technology providers and application developers.

As per technological point of view, such implementation poses following challenges:

1. **Network Connectivity Requirement:** Network connectivity is mandatory for position tracking and fetching requested data from the application server. There is a need of IP-based networking technology to find real time data.
2. **Availability of Real time up to date information**: Department service provider need to update data on real time basis, only then the purpose of LBS application to provide real-time, up-to-date, correct, accurate, complete, and relevant information will be fulfilled. Real time synchronization of requested data is required.
3. **Reliability:** Such system need to be reliable to **w**withstand network failure and heavy load in case of any service breakdown, node and link failure.
4. **Efficient Query handling mechanism:** The architecture is needed to support continuous change in location parameters. Efficient query processing techniques needs to be employed to accommodate such time constraint changes.
5. **Need of standards with platform independent technological tools:** Interoperability between devices, operating systems and applications would be provide by use of standard and platform independent tools for development of such applications.
6. **Need of sophisticated geospatial data management techniques:** Location data is made available through GIS system. Such system require the tools to administer base map data such as manmade structures like streets, buildings etc. Specialized data management techniques are use to filter out the need data.
7. **Need of cache management:** Cache (if employed) needs to be refreshed with the change in location parameters. Some cache management technique for saving computation power and decreasing communication cost has been proposed [13]. Such techniques can leverage the cached results from prior spatial queries for answering future queries.

VII. Conclusion

This paper presents a prototype for the location based information service that enables the delivery of personalized content to users depending on their location.LBS is a domain rich with varied kinds of location services from the most elementary to the most sophisticated. Each service comes with its own set of requirements. One needs to carefully understand the service requirements to be able to map it to the infrastructure. The challenges highlighted in this paper, if tackled will surely synergize such implementation at a faster pace. Issues of inadequacy in positioning method, need of cooperation from operators, handset manufacturers, application developers, lack of standards, infringement of privacy make the implementation challenging. The implementation of this model will not be possible without the proactive support of government.

Acknowledgments

We are thankful to C-DAC Mumbai Mobile Seva team for their practical inputs and for helping us in providing the deeper understanding of LBS project implementation issues. We would like to pay our special thanks to Dr. Zia Saquib, Executive Director, C-DAC for supporting us in pursuing this investigation.

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