Delivering LBA with LBS using Service-Oriented Architecture

Melwyn D'Souza
Department of Information Technology
National Institute of Technology Karnataka, Surathkal
Mangalore, India
melwyn_in@yahoo.com

Ananthanarayana V. S.
Department of Information Technology
National Institute of Technology Karnataka, Surathkal
Mangalore, India
anvs@nitk.ac.in

***Abstract*—Location-Based Advertising (LBA) is the most happening and latest thing in the marketing process. LBA provides advertisements (ads) based on the mobile user's current geographic position. LBA becomes more effective when advertisements are made available to mobile users according to their choice and taste. This paper covers a simple pull based LBA system which is integrated with a Service-Oriented Architecture (SOA) based Location-Based Services (LBS) system. This system is implemented using open standards based Web services technology which supports dynamic discovery and interoperability. This is a special kind of system which allows service providers to publish both services and their advertisements together at one place. The proposed system is demonstrated using a restaurant finder mobile application.**

Keywords- Service-Oriented Architecture; Location-Based Services; Location-Based Advertising; Web Services.

I. INTRODUCTION

In any business, advertising is an important part of the marketing process. Advertising is a form of communication used by business organizations to promote and market their goods and services to the public. Some of the most widely used advertising media includes television, radio, newspapers, magazines, leaflets, books and the internet.

Communicating advertisements to mobile users according to the relevance of their geographic position is known as Location-Based Advertising [1]. Advertisements on mobile devices can be communicated using various modes like Audio, Video, SMS, MMS and Mobile Web. Organizations and companies who want to publish their ads would register themselves with LBA providers and provide advertisement details. The LBA providers would then provide these ads to subscribed mobile users according to their current geographic location.

Recently, mobile marketers are turning more attention toward in-app advertising. In-app advertising is a model in which advertising functionality is integrated with mobile applications to display only those advertisements that have much more in common with the application itself. For example, a restaurant finder application integrated with an in-app advertisement feature would displays only restaurant related advertisements.

At present, the LBA provided by most of the LBA providers are tightly coupled with their own systems. This architecture ensures security and the convenience of billing but limits the scalability, extensibility and interoperability of the LBA. The end user has no control over ads displayed on their mobile applications. Also, mobile user location privacy is another concern as user location is shared with those LBA providers. Thus, there is a strong need for an LBA system which provides scalability, extensibility, interoperability and also maintains mobile user privacy.

The major contribution of this research work is to develop a SOA based LBS and LBA system which extends existing UDDI service to support LBA with LBS and demonstration of the proposed system using a restaurant finder mobile application. The next section gives an overview of the related work. The SOA based LBS system which allows service providers to publish their services along with their ads in a local registry is explained in section III. The SOA provides scalability, extensibility and interoperability along with dynamic discovery of local services. Details about extending the UDDI service to support LBA are provided in section IV. The proposed system is developed and tested with a restaurant finder mobile application and is covered in section V and the conclusion is given in section VI.

II. RELATED WORK

Services provided to mobile users according to their geographic location are known as location-based services [2]. Requesting the location of a point of interest like nearest ATM, petrol pump, restaurant and hospitals are some examples of location-based services in a mobile environment. Location-based advertising is a subset of location-based services.

A. LBA Models

There are two models of location-based advertising: push and pull [1]. Push based ads are the ones which are triggered automatically to mobile users on the basis of their current location. For example, a pizza restaurant sends a discount coupon when a mobile user comes within some close proximity of that restaurant. Such advertising would require LBA providers to monitor in real time the mobile user location to trigger ads to mobile users. Pull based ads are always explicitly invoked by the mobile user. Then based on the mobile user's current location, LBA providers would provide the requested ads accordingly. For example, a mobile user, who is hungry, could use his mobile phone to check for discounts from various restaurants in and around his current location.

Location-based advertising exploits the position of mobile terminals to provide ads that are relevant to the current location of mobile users. Thus, location is an essential parameter for all location-based advertisements.

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B. Postioning Technologies

There exist several positioning technologies which can be used to determine mobile user's current location. These positioning technologies can mainly be classified into three categories: Network-Based technologies, Handset-Based technologies and the Hybrid systems [3]. The classification of positioning technologies is shown in Fig. 1.

The network-based positioning technologies (Cell-ID, Enhanced Cell-ID(ECID), Angle of Arrival(AOA), Time Difference of Arrival(TDOA)) use mobile network infrastructure to determine the user position. The network-based technology has the advantage of not requiring changes to hardware or software in the user's mobile device and hence all existing mobile phones can be used without any modifications. Handset-based technologies use a satellite positioning system to determine the user position. The satellite positioning system does not require any mobile network coverage as it is totally independent of the mobile network. GPS is a handset-based positioning technology which uses satellite system and requires GPS receiver in the handset to determine user position. Hybrid technologies (Enhanced Observed Time Difference (EOTD), Assisted GPS (A-GPS)) use both the hand-based and network-based positioning technologies.

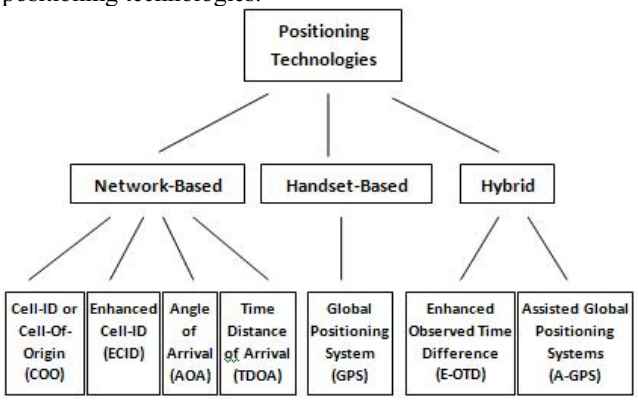

Figure 1. Classification of positioning technologies.

C. Service-Oriented Architecture

Service oriented architecture (SOA) [5] is the latest paradigm in the evolution of software development aimed at facilitating the design and development of flexible and loosely coupled platform independent applications. SOA uses the publish-find-bind and execute model to facilitate dynamic discovery of services. Service providers publish their services by registering them with a broker. This broker is used by the service consumers to find required services. The broker provides consumers with a contract and an endpoint address for those services which match the search criteria.

Web Services technology is the preferred standards-based solution to realize SOA. Web services [6] are loosely coupled components and use open standards to provide interoperability between various applications. Web Services support openness, heterogeneity and dynamic discovery of services by using eXtensible Markup Language (XML),

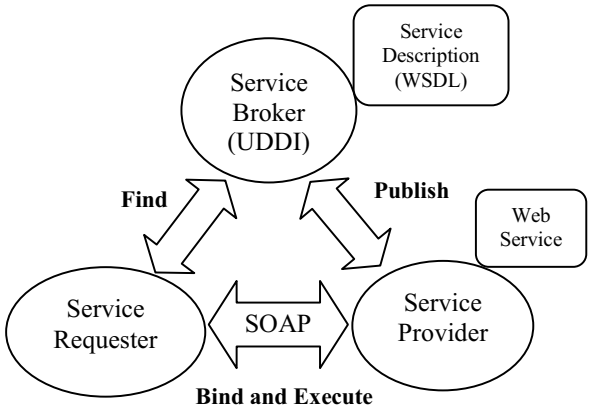

Figure 2. SOA using Web Services technology

Simple Object Access Protocol (SOAP), Web Services Description Language (WSDL) and Universal Description, Discovery, and Integration (UDDI) open standards. The data is tagged with XML [7] and transferred using SOAP [8]. Services are described using WSDL [9] and published in UDDI [10]. The block diagram of service oriented architecture using web services technology is shown in Fig. 2.

Major contribution of the research work in this paper is the design and integration of LBA with an LBS system. A decentralized registry based LBS system is explained in [11]. Demonstration on how to dynamically discover and consume local services in a decentralized LBS environment is given in [12]. There exists various mobile LBA systems like [13-16] but the simple pull based system presented in this paper is a unique one and allows publishing of LBA and LBS together and is implemented using Web services technology to realize SOA.

III. DECENTRALIZED LBS SYSTEM

A. Registry Organization

In the proposed system, cellular network system is considered in order to divide the entire geographical area into locations. In a cellular network system [17], a cellular service area is divided into smaller areas called cells. A cell or group of cells is considered as a location in the proposed system. Whenever a mobile user is roaming in cell X, the user is considered to be in location X. Service registry is decentralized and the registries are placed in each of these locations. Registry located in each location or cell is called as Local Registry (LR). The Local Registry enables service providers to register their services and allows service consumers to search for required services. Service providers publish interface and binding information of their services to the local registry. Service consumers use this information to bind and execute provider services. Each local registry contains service registrations belonging only to its own corresponding location. Search response time improves when compared to centralized registry based system due to less number of service registrations in each LR and location based service search accuracy increases as LR contains only

local service registrations. Decentralized registry organization in a cellular network is shown in Fig. 3 along with the main components of LBS system at each location.

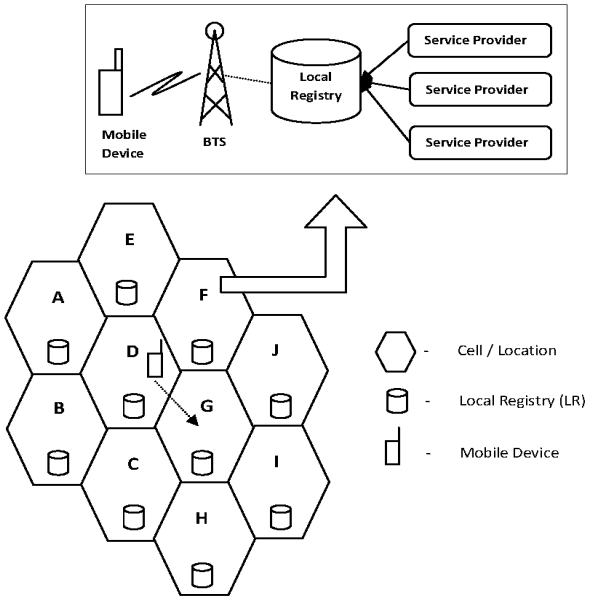

Figure 3. Decentralized registry organization for LBS.

B. Registry Discovery

The In the proposed system, by-broadcast mode has been used to discover the local registry. In the by-broadcast mode, a broker in every location periodically broadcasts the local registry address over the wireless channel. Mobile clients listen to the wireless channel and download the local registry address to discover local services. In the cellular network system, each cell is served by a Base Transceiver Station (BTS), also known as a Base Station (BS). Each BTS broadcasts both the Location Area Identity (LAI) and the Cell-ID on the broadcast control channel to its cell. A mobile terminal always knows its Cell-ID and LAI as it always receives these broadcast messages. In the proposed method, the cellular network base station is configured to broadcast the local registry address along with other existing parameters.

The other option is to use the Cell Global Identity (CGI), unique to each cell, as part of the local registry address. The CGI is a major network identity parameter. CGI consists of Location Area Identity (LAI) and Cell Identity (CI). LAI includes Mobile Country Code (MCC), mobile network code (MNC), and Location Area Code (LAC). For example, for a given cell, if MCC=111 and MNC=22 and LAC=33333 and CI=12345 then the address of local registry could be represented in terms of web URL as www.111223333312345.reg. In case of multiple cells grouped as a single location, one could configure multiple URLs to point to the same LR which is associated with that location. Once the local registry address is obtained, users can proceed with the service discovery process.

C. Functional Details

The location based application functionality mainly consists of three steps. They are local registry discovery, local service discovery and local service consumption as shown in Fig. 4. Whenever a mobile user is interested in searching for local services, the location based application listens to the base stations broadcast channel and downloads the local registry address (step 1). Once the local registry address is discovered, it proceeds with the web services discovery process (step 2). It then binds and executes a web service based on the user's choice (step 3). An algorithm is given below with the steps which are required to be executed to search and consume local services by the location sensitive applications.

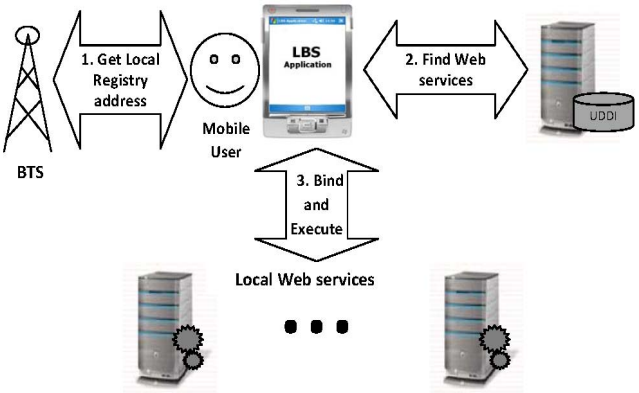

Figure 4. Functional flow diagram of a decentralized registry based web services environment.

Algorithm: Search&ExecuteLocalServices
/* Executed by Location based applications whenever mobile users need to consume local services */.
Begin
1. Get location sensitive application input from the mobile user.
2. Get Local Registry address by listening to the BTS's Broadcast Channel.
3. Find Web services in the local registry by using the address obtained in step 2 and passing the input parameters obtained in step 1.
4. Download binding information of a Web Service based on the user's choice.
5. Bind and execute the selected Web service.
6. Display results to the user.

End

IV. LBA INTEGRATION WITH LBS

The LBS system does not support LBA by default. In order to integrate LBA with LBS, the local registry is extended further with LBA related components. The local registry architecture which supports LBA with LBS is shown in Fig. 5. The LBA system, illustrated in Fig. 5 is composed of three main entities: mobile device, Location System (LCS) and the Local Registry (LR).

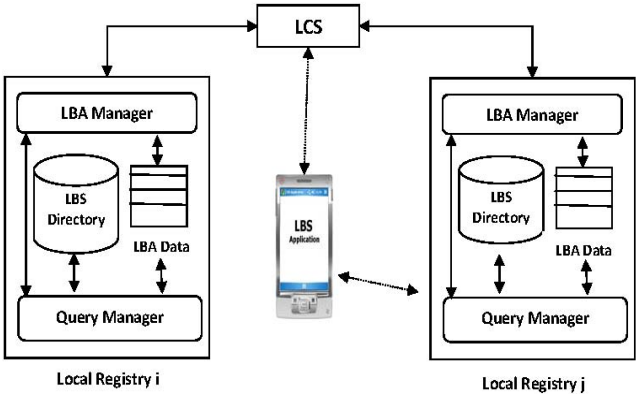

Figure 5. Functional diagram of LBA System.

A. *Mobile Device*

Mobile devices like cell phones, smart phones, etc are used by the end users to access local services. Location sensitive applications deployed on these wireless devices are used by the end users to consume services available in their current geographic location. These applications are responsible for providing user interface to the end user to accept inputs and to display the results by dynamically searching and consuming services available in the current location.

B. *Location System*

Location System provides the location information of a mobile device. In the proposed system, the LCS is part of the network provider and provides location information like Cell-Id, latitude and longitude of mobile phones under their coverage. Various positioning technologies are covered in section III. To maintain mobile user location privacy, access to the location information is given only to the mobile device and the LR. User location information is not shared with any third party LBA providers as the LR belongs to the network provider itself. Local registry finds the Cell-Id information of a mobile phone from this LCS and maps to corresponding local registry address. Mobile terminals can get their own current position by using either GPS receiver attached to them or from the location system of their network provider.

C. *Local Registry*

The local registry is the main component of the proposed system which is extended to support LBA with LBS. This extended local registry is composed of three main components: Directory, Query Manager and LBA Manager.

1) Directory: In service oriented architecture, directory is used as a broker where service providers register their services and service consumers search for required services. The proposed system is developed using Web services technology to realize service oriented architecture. The Web services technology uses UDDI, a registry that employs a search service based on keyword matching. The UDDI registry supports four core data structure types. They are the businessEntity, the businessService, the bindingTemplate and the tModel. The businessEntity contains descriptive information about a business or an organization and information about the services that it offers. The businessService structure represents a logical service and contains descriptive information in business terms. The bindingTemplate structure contains technical descriptions of Web services. The tModel structure is used to provide a reference system based on abstraction.

The existing UDDI service does not support LBA. Thus, the local registry is extended with serviceAdvertisement data structure type. The attributes of serviceAdvertisement data structure is shown in Table 1. During advertisement discovery process only those ads are considered whose Enable attribute is True and the time of discovery is between OpenTime and CloseTime. There are a few ads which are time bound and thus OpenTime andCloseTime attributes are included. For example, a restaurant may offer discount on food during off hours or if the customer turnout is very less. The Message attribute is the textual description and the Image attributes is the URL of the advertisement image. Other attributes like ServiceKey and BusinessKey are used to associate the advertisement with businessService and businessEntity respectively.

A business entity could have multiple services and they can publish advertisements for each of their services. Thus, the serviceAdvertisement data structure is associated with the businessService data structure to facilitate advertisements with each service. The Fig. 6 shows UDDI data structures along with their relationships. The serviceAdvertisement, a new data structure along with its relationship with the businessService data structure is shown in shaded boxes.

TABLE I. SERVICE ADVERTISEMENT ATTRIBUTES

Data structure: serviceAdvertisement	
Attribute Name	**Decription**
Name	Name of the Advertisement
Message	Advertisement text message
Image	Advertisement image URL
Enabled	True if advertisement is enabled. False otherwise.
OpenTime	Time duration during which advertisement is effective
CloseTime	
Latitude	Geographic location of the Service provider. Used to display route location map.
Longitude	
AdKey	Unique Key for the advertisement
ServiceKey	Key of the associated businessService
BusinessKey	Key of the associated businessEntity

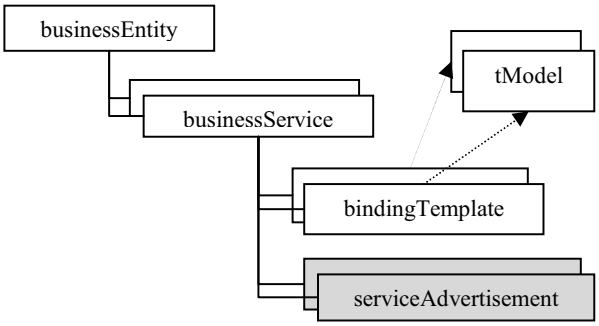

Figure 6. Extended UDDI data structures for LBA

2) Query Manager: The query manager is responsible for supporting functionalities like publishing and inquiring location based services at the local registry. The query manager supports all exiting UDDI Publish and Inquiry APIs along with additional functionalities for LBS and LBA.

The query manager includes a find_advertisement() function as part of the Inquiry API. This find_advertisement() function allows mobile user applications to discover local service advertisements from the local registry. Whenever find_advertisement( ) function is invoked, the query manager simply forwards the request to LBA manager.

3) LBA Manager: The LBA manager is responsible for managing the LBA data. The LBA manager supports publishing and inquiry of LBA on local registry. The LBA manager includes a find_advertisement() function to search LBA. This function is not directly accessible to mobile applications but indirectly accessed by calling find_advertisement() function of Inquiry API available at the query manager. The sample output returned by the find_advertisement() function is shown in Fig. 7. The output is in XML format and transferred using SOAP protocol.

V. EXPERIMENTAL RESULTS

A Restaurant Finder application has been developed to illustrate how a mobile device could search and invoke the local services dynamically anywhere and anytime using the internet connection. Restaurant Finder is a location-based application which allows mobile users to search for local restaurants based on their choice of cuisine and then book a table at the selected local restaurant.

The local registry Web service interface is developed by using Microsoft .NET Web services which internally uses Microsoft UDDI as a service registry. The Restaurant Finder client program is a location sensitive application and runs on the mobile device. It is developed in Microsoft .NET CF 3.5. The location map is generated using Google maps API. The extended UDDI attributes are stored in MS SQL server. The restaurant mobile application is successfully tested on Windows Mobile 5.0 Pocket PC R2 emulator.

```
- <adList>
  - <adInfos>
    - <adInfo serviceKey="9c08a280-6602-479c-bb02-b4ce6ac4167f"
      businessKey="8f7fcebf-b12b-4915-b06d-01c92fcf939d">
        <name>Discount Offer</name>
        <image>http://10.100.52.191/Ads/b4ce6ac4167f.JPG</image>
        <message>20% Discount on Chinese Food at My China</message>
        <latitude>12.867993</latitude>
        <longitude>74.842386</longitude>
      </adInfo>
    - <adInfo serviceKey="6fae41da-87ff-4e5d-9564-3e617c88a100"
      businessKey="f7aa2f44-8d99-4b4d-8deb-01d37221c8bd">
        <name>Mega Offer</name>
        <image>http://10.100.52.191/Ads/3e617c88a100.JPG</image>
      - <message>
          Flat 25% off at Wine & Dine between 11:30AM and 1:00PM. Offer
          Code: WD5835
        </message>
        <latitude>12.871922</latitude>
        <longitude>74.842111</longitude>
      </adInfo>
    </adInfos>
  </adList>
```

Figure 7. Sample output of find_advertisement() function

A screenshot of the Restaurant Finder application without in-app advertisement functionality is shown in Fig. 8. A screenshot of the same application with in-app advertisement functionality is shown in Fig. 9. The mobile user gets free subscription to the local registry if he opts to view local ads and network provider gets money from service providers. Service providers have option to register their LBS with or without LBA. In the restaurant finder application, all displayed advertisements are relevant to local restaurants and are displayed one by one. If mobile user wants to get the location map of the displayed advertisement then he would simply click the advertisement and the application displays the location map as shown in Fig. 10.

Figure 8. Restaurant Finder application without in-app advertisement functionality

Figure 9. Restaurant Finder application with in-app advertisement functionality

Figure 10. Restaurant route map for the selected advertisement

VI. CONCLUSION

This paper presented a simple pull based LBA system. The LBA is integrated with LBS system by extending existing UDDI service. The entire system is based on SOA and implemented using Web services technology. The open standards based Web services technology allows scalability, extensibility, interoperability and dynamic discovery. End user location privacy is also maintained as the location data is not shared with any third party LBA providers. This is a special kind of system which allows service providers to publish both their services and advertisements together at one place. The future work involves development of push based LBA.

REFERENCES

[1] Unni and Harmon, "Perceived effectiveness of push vs. pull mobile location-based advertising", Journal of Interactive Advertising, Vol 7, No 2, pp. 28-40, 2007.

[2] R. Beaubrun, B. Moulin and N. Jabeur, "An architecture for delivering location-based services", International Journal of Computer Science and Network Security (IJCSNS), Vol.7 No.7, pp. 160 - 166, 2007.

[3] Unni and Harmon, "Location-based services: models for strategy development in M-Commerce", International conference on Management of Engineering and Technology, 2003. PICMET '03. pp. 416-424, 2003.

[4] R.K. Moloo and V.K. Digumber, "Low-cost mobile GPS tracking solution", 2011 International Conference on Business Computing and Global Informatization, pp. 516 - 519, 2011.

[5] B.W. Agustinus, T. David, R. Wenny and S. Bala, "Mobile service oriented architectures for NN-queries", Journal of Network and Computer Applications, pp. 434-447, 2009.

[6] H. Kreger, "Web services conceptual architecture (WSCA 1.0)", IBM Software Group. (2001).

[7] Extensible Markup Language, Available at http://www.w3.org/TR/2008/REC-xml-20081126/

[8] Simple Object Access Protocol, Available at http://www.w3.org/TR/soap12-part1/

[9] Web Services Description Language, Available at http://www.w3.org/ TR/wsdl20/

[10] Universal Description, Discovery and Integration, Available at http://www.oasis-open.org/specs /index.php#uddi

[11] M. D'Souza and V.S. Ananthanarayana, "Decentralized registry based architecture for location-based services", Sixth International Conference on Industrial and Information Systems , ICIIS 2011, pp. 136 – 139, 2011.

[12] M. D'Souza and V.S. Ananthanarayana, "Dynamic discovery and consumption of local services in a decentralized registry based web services environment", Proc. of Int. Conf. on Advances in Computer Science 2011, pp. 121-125, 2011.

[13] C. Evans, P. Moore and A. Thomas, "An intelligent mobile advertising system (iMAS)", Sixth International Conference on Complex, Intelligent, and Software Intensive Systems, pp. 959-964, 2012.

[14] C. Dow, Y. Lee, J. Liao, H. Yang and W. Koo, "A location-based mobile advertisement publishing system for vendors", Eighth International Conference on Information Technology: New Generations, pp. 24-29.2011.

[15] A. Mazaheri, N. Rafiee and P. Khadivi, "Location based targeted advertising using bayesian network and fuzzy TOPSIS", 5th International Symposium on Telecommunications (IST'2010), pp. 645-650, 2010.

[16] S. De, S. Das, A. Chakbraborty, P.K. Das, and S. Paul., "MyPULSE: Mobile yellow pages with user interest and location sensing ensemble", TENCON 2008 - 2008 IEEE Region 10 Conference, pp. 1-6, 2008.

[17] U.R. Patel, and B.N. Gohil, "Cell identity assignment techniques in cellular network: A Review", 3rd IEEE International Conference on Computer Science and Information Technology (ICCSIT), pp. 594-596, 2010.