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# Mobile Cell Data Structure Quality Improvement For User Positioning Purposes

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## Abstract

In wireless telephony network, cell is a geographical coverage area which can distribute frequency among cellular networks for different specific mobile network regions. Good cell and bad cell are used in the cellular network to identify the proper user position in a certain geographical area. The good cell is identified by assuming a maximum distance between latitude and longitude of two cell points with reasonable shape in a particular geographical area. The bad cell is identified while the cell shapes are become as irregular shape. However, mobile location accuracy is important for good cells data. Some cell data are not precise in shape to become good cells. Moreover, locations of handset are dependent for the accuracy of cell data shape. Most of the cases mobile operators are facing problem for the positioning purposes due to inaccuracy of the shape of cell data. The proper position accuracy of user is not visualized due to inaccuracy of cell data shape. The proposed system identifies the bad cell and repairs as good cell using visualize tool. An XML data file contains cell data information with longitude and latitude. A data base has been created to store the longitude and latitude of cell data in a standard format using PHP code. The visualize tool identify bad cell and good cell from the database. Furthermore, the tool converts the bad cell into good cell. Moreover, the tool can able to repair the cells which are not converted as good cell shape. The system can able to help to improve quality of user position accuracy for GSM and CDMA mobile operator.

**Keywords:** Cell data; Cellar network; User positioning; XML data tool.

## 1 Introduction

The cellular network technology is able to provide location based service as a part of mobile communication. At present the market of mobile devices are trying to integrate service facilities among users in urban and rural areas. A cellular network or mobile network is a radio network which is distributed over geographical areas called cell. It is maintained by a cell site or base station. Radio coverage over a wide geographic area is provided by cell.

Mobile devices are connected with the cell through base transceiver station (BTS). The cell system works as frequency radiator on geographical areas. Every cell system is setup within particular logical geographical areas depends on cell frequency coverage capacity. Geographical areas are defined as particular regions are covered by cell system. The mobile devices are connected with cell sites. The cell

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shape can be square, circular and hexagonal or some other regular shapes. In real life it is seen that the cell shapes are not perfect as the shape of hexagonal. Furthermore cell shapes are not perfect in shape within a particular region according to cell planning definition. Thus the coordination within mobile devices is not performed in the correct way due to the inaccurate cell data. As a result the position of users are not defined perfectly as well as the users position are not located. User positioning problem is one of the major issues due to wrong co-ordination of the cell data. The telecommunication companies are facing these difficulties. A good cell data means that it can cover a geographical area where the users are located perfectly on basis of proper value of longitude and latitude of the cell data. The longitude and latitude of any two points of cell data are used around 70 km depends on the cell size for different telecommunication company. On the contrary if the longitude and latitude are out of the range then the user location cannot be found properly. This type of cells is defined as irregular cell which cause the difficulties to locate the user position. The GSM and CDMA service providers are normally facing the same issues. However the existing systems have some problems to recover the accuracy of cell data to locate user position. The proposed system contributes to recover the issue by providing a novel approach.

The remainder of this article is structured as follows: Section 2 surveys related work, while Section 3 presents our proposed solution. Section 4 then describes the experimental environment, while Section 5 presents our results. Finally, Section 6 concludes the article and indicates future work.

## 2 Related Work

A mobile cellular network compensates large geographical area. A cell system is constructed by a base station, Base station controller, mobile switching center, visitor location register etc. [1]. The base station controls the cell system between user and network interface. However there are few problems have been discovered regarding irregular cell shape which can occur the unexpected user missing in a cellular network. To recover the irregular cell data characteristics there are few researches are carried out. Every mobile device is constructed by transmitter, receiver, control circuitry and antenna. The base stations control the mobile device connecting simultaneous mobile calls. It has several transmitters and receivers for controlling full duplex communications via switching center. The activity of base stations and the cellular system are interacted with this switching centre. A cellular network [2] system provides a wireless connection which can provide large number of mobile units depending on the area and frequency spectrum. However the cellular communication is developed using GSM, D-AMPS, and CDMA etc. The author has focused on connection interaction within cellular network.

The network can transfer data in wider geographical places and ensures high quality of radio communication services [3]. Cellular networks are used to provide communication within mobile users. It is also used for positioning purposes [4]. Cell based positioning system are considered where cell can transmit frequency from base station within a network to locate mobile devices position. Laasonen et al [5-original] used cell based positioning in GSM network to recognize users' important places from their daily task. In their research, they have described regarding GSM cells where user visited places have been included into their database with the time and location. The data have been utilized for identifying places and time and also recorded while the users have passed the most time in different places. The system can also determine user's relative position with respect to location. The proposed systems describes regarding location of users with changes time using GSM cell system. But the systems don't concern about the cell particularly which cells are irregular.

LaMarca et [6] al have used wireless radio networks for tracking and mapping them to the GPS coordinate system. A GPS enabled mobile terminal has been discovered using calibration process. It is used for logging identifier to discover wireless networks with GPS coordinates to the server. Thus, the co-ordinate system can track user location without GPS device. In their system when other users are

found in the calibrated area then the co-ordinate system can locate those users using landmarks. This paper motivates regarding tracking the user location using GPS co-ordinate system but it doesn't suggest for the development of proper location of users.

GSM [7] network can cover a large physical area which is up to 20 kilometers for a single cell in diameter due to positioning purposes. The operators are identified by the unique numbers in this network within cell system. The GSM network works as network based, network oriented and GPS based methods. All methods can identify and recognize id number of GSM cell which is used for user location purposes. The location of user are estimated by the known cell size and known physical location of base station. The accuracy of user location estimation is linearly related with the cell size which is varied by the distance. The data in GSM network are utilized for accurate estimation of user location in the cell-id based positioning. To enable high accuracy of positioning the infrastructure of GSM network can be updated with location measurement units. On the contrary CellSpotting[8] is a tool that is used only in cellular network for positioning purposes. It is mobile software. It can check the id number of GSM cell provided by the central register. For the new cell the user is identified to locate with generic name. Moreover user can associate the cell found by Global Positioning System (GPS) co-ordinates using online tool. This is how GSM cell are associated with some fixed point of user location. Furthermore [9] GPS is used in urban environments for geo-location. The taller buildings are the reasons for losing reliability of radio signal. Thus the cell co-ordinate problems are occurred where the mobile operators are facing the unreasonable cell shape. Some methods [10] have been proposed to locate the original position of user, location change and user view respect to time. A new approach [9] has been proposed regarding the signal strength patterns of geo-location. These patterns are generated by samples of signal strength. The signal strengths are collected from different base stations within different cell sites. The patterns show two characteristics. Firstly, the signal strengths are measured by the high reflection and the other hand large fading are observed while it is reflected in scattering manner by the reflectors as buildings and trees. The author has proposed a visualization tool which can check the GSM cell id number and track the new cell as well but the system is unable to fix the irregular cell shape for better accuracy of user position.

The cell structures are compromised using [11] the latitude and longitude are counted by decimal number and converted and displayed as degrees-minutes-seconds values. The seconds are calculated within 0.00002 of an integer value thus the percentage of accuracy become higher and the impacts goes to the nearest second. More over the effects of north-south accuracy become by 31 meters, east-west accuracy of 19 meters and at latitude of 52°N. However the two types of antenna are available in the cell network system. Those are directional and omni directional which average position of all handsets are communicated with cell. Furthermore an arc is covered by directional antennae between 120 and 180 degrees within a tower. In addition to the pattern of omni directional antennae is hexagonal as the cell are designed as hexagonal in the same network coverage area. Moreover the directional antenna is designed by diamond shaped in some cases. [12] A cell configuration management is considered to monitor operation state of cell. The data determinations for operation are organized by this management. BtsManager, btsCell, radiocarrier, and channelElement object classes are defined and controlled by the cell configuration management. In addition the data defines cell identification and location area of cell. Moreover channel element configurations, radio frequency allocated to the cell, etc. are also manipulated. The system configurations are controlled by the static data and state variables are managed by the dynamic data. The data operations and management are performed by the cell fault management whereas the faulty data and performances are tested. The same working principles are conducted for the bsEquipment, bsTest object classes. All the proposed systems described regarding the construction of cell system that is used by mobile operators globally and how the data are communicated in the cell system hardware. However the systems don't indicate the improvement of cell data for positioning purposes [13]. The XML data storage was used as conventional database management system but recently the XML document storage

is the source of core data management. The XML data works as internet standard for representing data. It can also exchange the data efficiently. The mapping and transmission between XML and underlying database structure are performed by the system as well. The Query processing [14] performed for large XML data by partitioning the XML data according to partition size. The partition structure depends on algorithm based on data size and structure. Control nodes manage the query management. It also handles path information mapping of XML data. The control node is used for analyzing and dispatching data to another node for computation. The tasks are performed by sending XML data queries to computation node for compiling and getting output from each node. Thus the control node sends data query to computation node to calculate any issue. The data relocation is another important part. According to data distribution the use of computation nodes is essential. Due to the balance the cost query processing the partitioned and distribution data are relocated while the query processing cost is unbalanced. The main important part is to select the data which are required for query processing. It is used for large XML data. Moreover the query processing are considered based on data distribution, distributed query processing, dynamic data relocation and data partitioning for the large XML data. However the systems provide the XML data format for controlling and analyzing cell data in real life purposes but the system can read the data from the XML data file which is not feasible to manipulate and interchange the structure of cell data. Propagation causes the changes of the cell shape which interrupts the regular cell data. Thus user locations are not identified accurately. In a cellular system propagation techniques are used to determine exact path, ray tracing model, predict signal strength in a non-line of sight region etc. Cellular radio systems can communicate between transmitter and receiver avoiding direct line-of sight path while signal are scattered by trees, moving objects and buildings. [15]

To conclude it is found the researchers are still working on cellular mobile communication to improve the cell data for positioning purposes. However, there are lots of difficulties using cell data are discovered while it is being used by the telecommunication operator in real life for user location accuracy. As examples shadowing type, network planning, irregular cell shape etc.

### **3 Proposed Solution**

#### **3.1 System design**

The first phase of the system is run on Google map supported by any web browser. The cell data has been showed on Google map to display a specific region after drawing a polygon. This system contains few tools in upper left Corner. The left Conner has zoom in and zoom out scrollbar that can be possible zoom in and zoom out of map and there are few options beside this scrollbar defined as Add a marker, draw a line, draw a rectangle, draw circle, draw a shape. Those tools are used various purposes except the tool Stop drawing. The main goal is to draw a polygon using a shape tool. The tool is activated and changed the pointer to (+) while it is clicked inside the tool and that confirms the activity of that tool. A polygon can be drawn to see a cell in a specific area on Google map. This polygon will be drawn starting from first point will be back again the first point after connecting another points on that region. The color of polygon will displayed as blue as it is default color. But the color can be changed using a tool box on the upper right Conner on the map. Afterwards it can be possible to reach at the process button by clicking on the area of click points. After clicking process button all click points will be set on cookies. Afterwards clicking on show cell button the good cell and bad cell can be seen on the Google map. Actually browser has captured the click point into the cookies and that capture click point area are matched with latitude longitude. On the contrary some bad and good cells are displayed using some algorithms. Finally after clicking the repair cell button, the bad cell can be converted into good cell mostly.

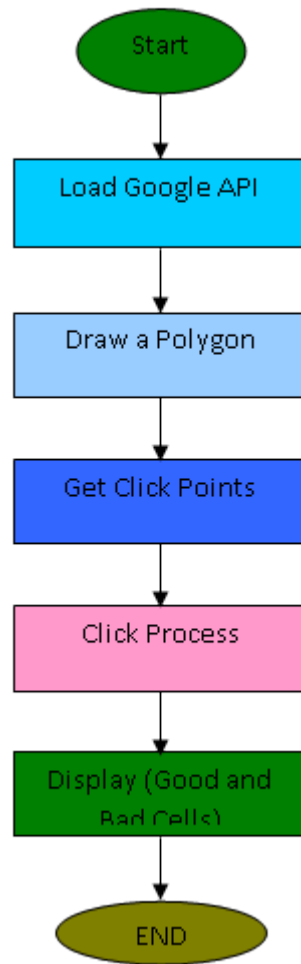


Figure 1: Prototype system architecture for monitoring vehicle speed

### 3.2 Cell Data Configuration

The data in the log file have been analyzed by considering different aspect. Firstly the tab is removed to maintain standardized of the log file to make accuracy and feasible for drawing polygon on Google map. The UtranCell is used as a root element of the log file. There are lots of elements (child of root element) in this file. The most important element is <UN: UtranCell id>. The cell data has been considered with the value of longitude, latitude. The cell id is considered as unique ID. Furthermore, longitude, latitude and cell id has been inserted in MySQL data base and the coordinate of cell data have been inserted against those fields by maintaining a confidential mathematical calculation are normally used by Telecom Company. The physical existences of those cells are found while it is drawn on Google map. The whole cell data have been configured as the following steps.

- Analysis the log file to make data as standard format
- Data are inserted into the database for visualizing data
- The tool is run
- Polygons are drawn on Google map to visualize the data

- Polygons click points are stored in cookies
- Cookies points are checked from database
- Cell id with cell shapes are displayed on Google map

## 4 Experimental Environment

The target of the project is to fix the bad cell data into good cell data. At first a database has been created using PHP. Few tables are created under the database to distinguish the data characteristics. Those are cell, cell data, fix and good cell. The following tables are displayed as individual data table. Every table contains four fields such as latitude, altitude, longitude and id.

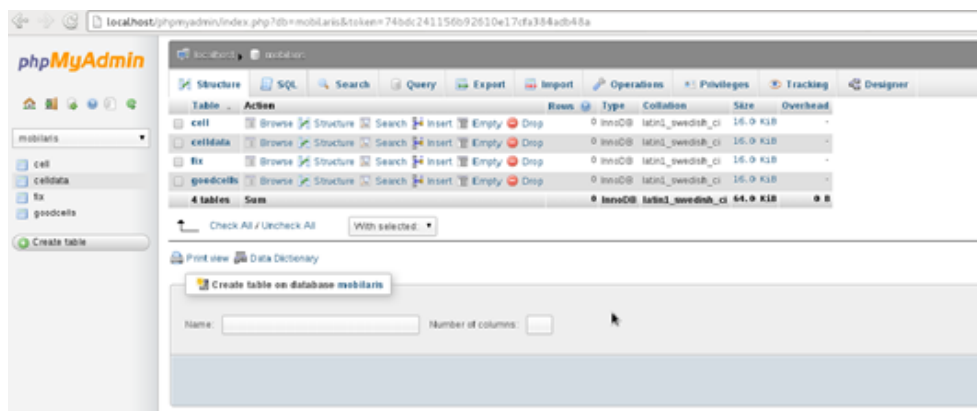


Figure 2: The database considering four tables!

A database creation and insertion data are completed. Furthermore users can run the visualize tool to visualize data from the database. The tool contains few buttons such as “delete select shape” to delete the drawings of previous polygon. The “process” button processes the polygon points. On the other hand the “show cell” button can show the data accordingly. Furthermore the “repair cell” can repair the bad cell data. There is few color options are set up. On the contrary the “zoom button” in the left hand side of the tool has been setup. Moreover few drawing tools are visible where polygon is use mostly.

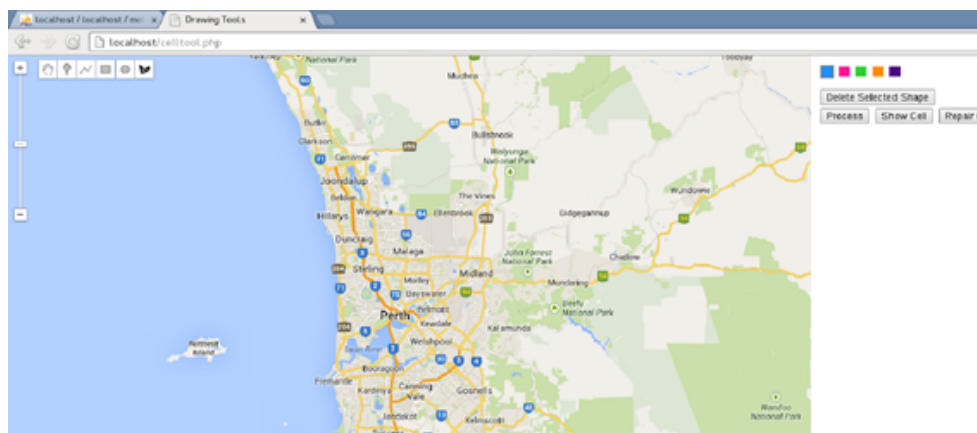


Figure 3: Visualization tool initialization

In the above figure has showed the first run visualize tool. When users can run the visualize tool to visualize data from the database.

## 5 Results

### 5.1 Working procedure of cell data

The data Diagram is named as Mobilaris by consisting four steps cell data, cell, good cell and fix cell. The diagram is created as Mobilaris by consisting there are some own fields of the each table every table is contained by their own fields. Every table contains some different fields such as cell data contains id, latitude, altitude and longitude. Afterwards CID is in cell while good cell contains id. Furthermore Cid, latitude, and longitude are position under fix cell and a structured way is followed for restoring in the data from database the different fields under the diagram. The actually latitude, longitude are found when polygon are drawn in Google map by capturing the click point of lat long the searching criteria of lat long in cell data table is carried on while polygon are drawn in the Google map the cell data table are searched based on the existence of the latitude, longitude of cell id around the actual lat long. The lat long of cell data table are identified as id and they are placed in cell table as CID. Good Cell content only ID because of the whole cell are good cell. Furthermore, fix cell content the latitude and longitude due to convert the good cell if possible.

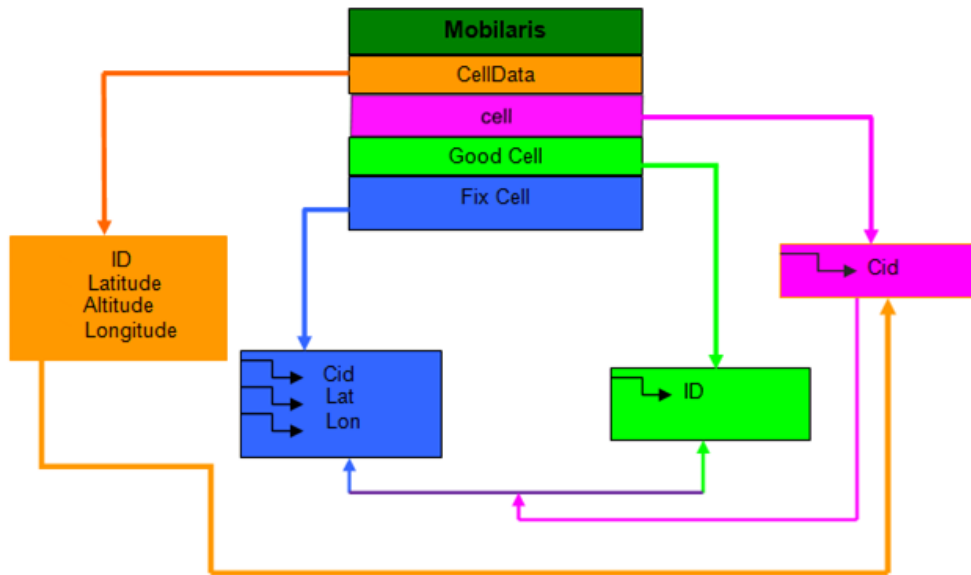


Figure 4: Data diagram of cell

### 5.2 Identify bad and good cell data

Latitudes and longitudes have been considered to draw polygon against a cell on Google map. After considering close observation for the following cell it can be said that it is not a good cell according to the definition of good cell. The following figure 5 shows the cell size. We have also considered for reflecting the characteristics of different bad cell.



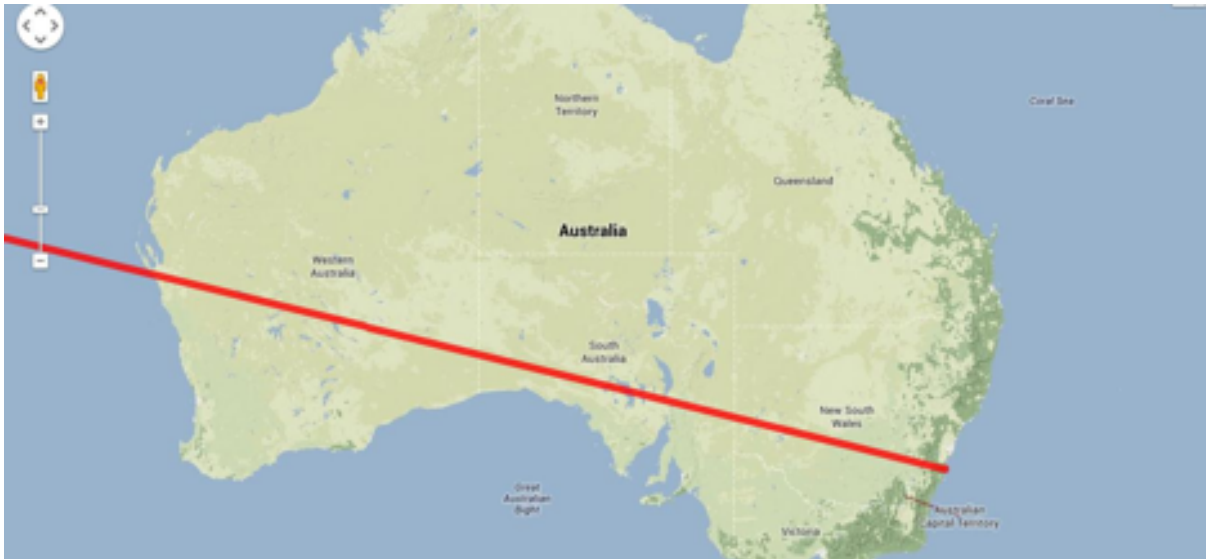


Figure 5: The bad cell shape is showed the coverage area on Google map

Furthermore, latitudes and longitudes have been considered from the realistic data to draw polygon against another cell on Google map. The characteristics of the following cell considered as a good cell according to the definition of good cell. The following figure shows the cell size. Few figures are also showed below for reflecting the characteristics of different good cell.



Figure 6: The good cell shape is displayed as zoom on Google map

### 5.3 Repair cell data

Users can click a specific area on Google map by the mouse or use a keyboard. After drawing polygon on google map the good cell and bed cell are displayed. Furthermore, Visualization tool can also fix bad cell into the good cell. The process button processes the clicking value that is latitude longitude. Show

Cell Button is used to see good cell id and bad cell id on Google map. The data are displayed on the right side below the using button and cell shapes are displayed on the clicking point area of google map. The result has showed the quantity of bad cell data is higher than good cell data. A formula has been used for getting good cell data by PHP code considering 70km distance between two points. The following figure 7 displays the cell shape with cell id. The figure 8 displays the repaired cell data which has been converted from bad cell data into good cell data. Different points of cell data containing different values. As an example there are four points consisting in a cell data. The distances are assumed of each point as 10.2, 10.3, 10.4 and 200.4 km. First three values among four values has been considered which are keeping regular sequential distance where the last distance looks in different from others and higher than other values. This is the perfect example of bad cell data. The developed mathematical equation has been used to keep consistency with all distances of different points. Considering the equation, the error points of cell data are repaired. Such as 10 km have been inserted instead of 200 km of last distance then all values are looking similar and the bad cell has been converted into good cell. This technique has been considered to convert all bad cell data into good cell data. However some bad cell would have not possible to fix completely but most of them have been fixed as good cell.

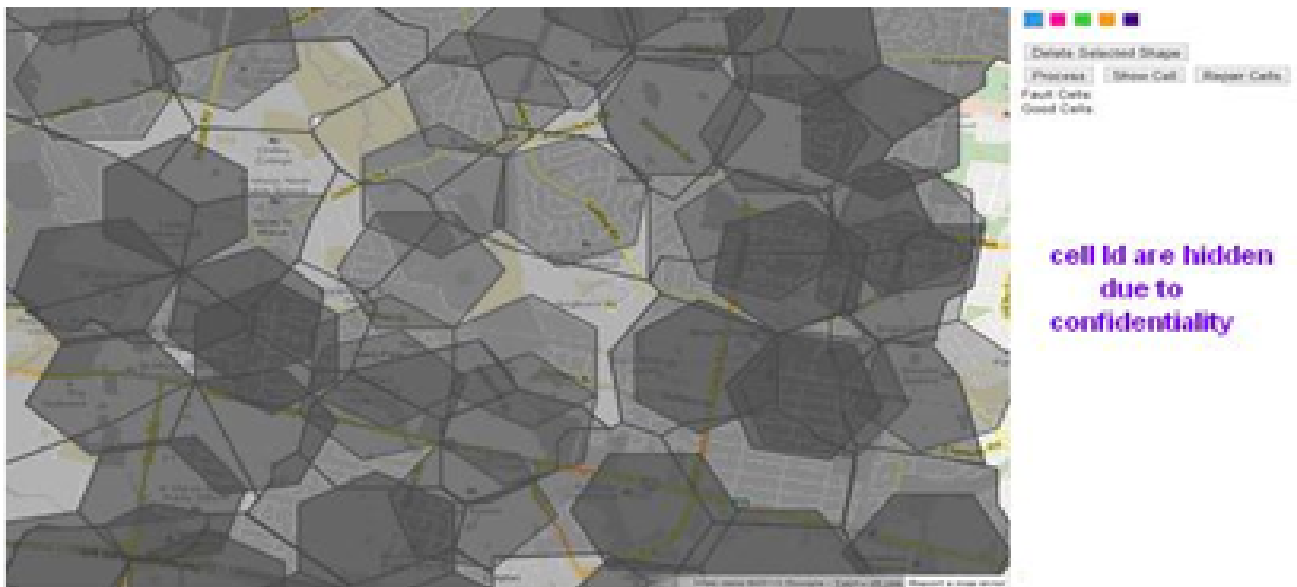


Figure 7: The figure displays good cell data using

## 6 Conclusions and Future Work

The cell data infrastructure has been analyzed and identified good cell data and bad cell data. All the data are stored in the database created by MySQL. Afterwards, a visualization tool identifies the characteristics both good and bad cell data. Different geographical areas have been considered to apply the procedure for displaying bad cell data and good cell data characteristics on the Google map

The area of bad cell data and good cell data have been identified and highlighted on the Google map. On the contrary the distance between two data points have been considered as 70 km to draw the polygon which is defined as good cell. Furthermore, few Polygons have been drawn using the tool where the distance between any two points is greater than 70 km which is then considered as bad cell. Moreover, this bad cell data have been repaired into good cell data. Occasionally it takes long time to



Figure 8: The repaired cell data

display the cell data on the Google map at the time of drawing in a large region. To solve this problem intelligent algorithm and time frame are needed to extend for ensuring the high accuracy of cell data as future work

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**Prof. Dr. Karl Andersson** received his M.Sc. degree in Computer Science and Technology from Royal Institute of Technology, Stockholm, Sweden, in 1993. After spending more than 10 years as an IT consultant working mainly with telecom clients he returned to academia and earned his Ph.D. degree from Luleå University of Technology (LTU) in 2010 in Mobile Systems. Following his Ph.D. degree and a postdoctoral stay at Internet Real-Time Laboratory, Columbia University, New York, USA, Karl was appointed Senior Lecturer and Associate Professor of Pervasive and Mobile Computing at LTU in 2011 and 2014 respectively. During Fall 2013 he was also a JSPS Fellow at National Institute of Information and Communications Technology, Tokyo, Japan. His research interests are centered around mobility management in heterogeneous networking environments, mobile e-services, and location-based services. Karl is a senior member of the IEEE and a member of ACM.