SITE SELECTION FOR BASE STATIONS BASED ON A NEW METHOD

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ABSTRACT

In mobile telecommunication systems (GSM/2G, EDGE/2.5G, UMTS/3G, LTE/4G ...), the planning of the location of the base station is key for uninterrupted communication. The major problem in achieving ideal signaling between mobile phones and base stations is inaccurate site selection due to the altitude of the region. In addition to altitude, there are many important parameters such as height of buildings and population density. If site selection is inaccurate and determined without reference to any previous parameters, the connection between mobile phones and base stations can be often interrupted and calls can drop. If old or new communication technologies have lots of problems such as inaccurate site selection, these should be fixed and regularly checked by optimization engineers. When a new technology is developed, firstly it should be applied to a trial area. After a period of study, results will indicate its suitability. After the region is determined, the next stage is determination of base station location depending on legal and expert opinion and carried out with site selection tools. When calculations are made to determine site locations, radio wave propagation (Okumura-Hata, Erceg-Greenstein, SUI, etc…) should be simulated using by RF tools to make a coverage map. In this study we created a site selection tool to select sites before calculating the LTE coverage map in built up area for the Beykoz district of Istanbul.

KEYWORDS: site selection, base station, LTE coverage map, tool for site selection

INTRODUCTION

The study of site selection is used to determine the location of solar panels, wind turbines, base stations and solid waste dumps (*Bennui et al., 2007*). Furthermore, there are lots of methods for site selection which are used according to the particular purpose for which the site will be used. Many models are considered, but three of them are very important and support this study. The models in which we are interested are: the elimination with criteria, map partitioning and Longley-Rice models. The map partitioning model can work on very small areas and place a great number of arrays on a map. When it is compared to the other models, it exposes too much processing for calculation but gives a clear result for comparison (*Liansun et al., 2008*). The other model which is the Longley-Rice model is useful for small areas such as rural districts, railways and highways (*Lu et al., 2010).* This model works with DEM maps to calculate path loss for RF signals in the GSM network. The model in this study is based on the elimination with criteria model which can be configured as required (*Dolney et al., 2013; Hurley et al., 2000*). In this study a technique that reduces unnecessary samples during the calculations has been developed and depends on sample numbers and sample choice method in the database. An available prediction model is then selected for LTE technology and finally we expect that an all built up area will provide good signal levels for the LTE coverage map.

STUDY AREA

The study area must be a district or city which includes lots of buildings such as schools, hospitals, universities, houses, hotels, offices and public buildings because realistic results depend on a database which includes all the built up districts in the study area. Altitude is the key parameter for the site selection tool because it selects the site location as a building location with the center coordinate of the building and all buildings have their altitude recorded. The site selection tool starts to find available roof tops of buildings from the highest elevation which is the sum of the altitude and building height. If most of the study area has a fixed altitude then the site selection tool can work, but it is not too hard to select site without the site selection tool when the study area has a fixed altitude across most of its area. Engineers can work for days to determine site locations without any site selection tools. If the study area has a varying altitude measurement, the site selection tool can prove that it is able to calculate the best site location for coverage in a region with any elevation value. Therefore we decided to study the Beykoz province which is on the Anatolian side of Istanbul in North-West Turkey (Figure 1). Beykoz has an important geographic condition that includes a long coast line, and varying altitude and a crowded population (*Musaoglu et al., 2005*). The total area of the Beykoz province together with its villages is 19.627 ha and has a population of 246,352 according to the latest census (www.tuik.gov.tr).

Figure 1. Map of the position of Beykoz province in Istanbul-Turkey.

Database for Study Area

In this study, the algorithm used to prepare the database is shown in Figure 2. First of all, the region/study area selected and the database of the built up area in Beykoz was prepared in vector format.

Each polygon in the database represents a building in the built up area (Figure 3). Moreover, the database includes all building heights, names, altitudes and total elevations which give the sum of the altitude of buildings and building heights. In Turkey, the installation of base stations near to schools and hospitals is forbidden by the

Informatics and Communication Technologies Authority (BTK) (http://www.btk.gov.tr/). The approximated "safety distance" from these locations depends on the electromagnetic field from the base station. In Turkey, operator firms give reports about the safety distance to the BTK according to the most recent BTK guide which was published in the official newspaper on 21.04.2011. (http://eng.btk.gov.tr/mevzuat/yonetmelikler/).

In this study we chose circles with a maximum radius of 0.35 km placed at the center of forbidden locations as shown in Figure 3. Therefore buildings which intersected with these circles were deleted from database. Moreover public buildings such as police stations, courthouses, public housing and military buildings were deleted from database because it is also forbidden to install antenna on their roofs. Finally, we chose one building from each set of 10 at intervals from the highest to the lowest elevation. Thus we avoided calculating of lots of buildings which have the same elevation.

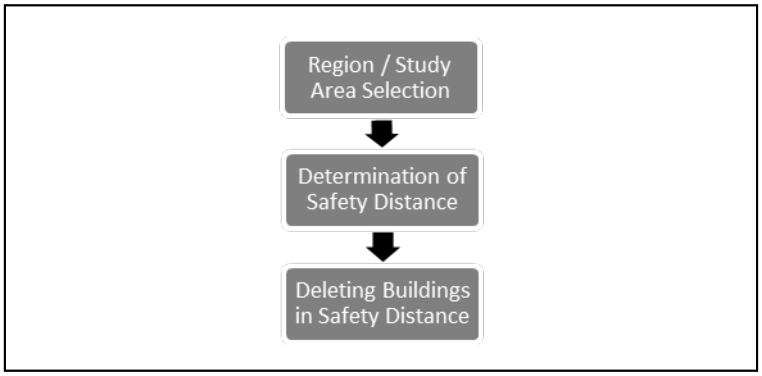

Figure 2. Algorithm for preparing database.

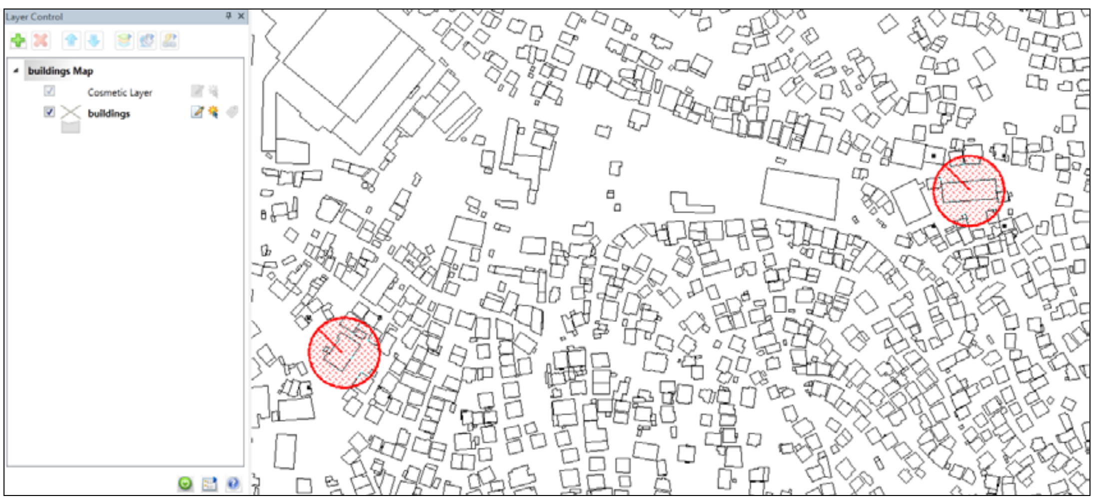

Figure 3. Screenshot from database that includes a hospital and a school with 0.35 km radius.

WORKING WITH SITE SELECTION TOOL

The programmed site selection tool works with the database which was created from the built up area in Beykoz. Because base stations have serious costs, and communication firms do not want to invest in the analysis of non built up area in rural or regions with no population (*Nawrocki et al., 2006*). The tool starts to select sites from the highest elevation and each object in the database is compared to every other with regard to elevation and distance parameters. The distance parameter is defined as a circle with a 0.3 km radius in a district or city center for each base station which will be selected by the tool. Therefore the distance between the two closest selected base stations will be 0.6 km, and this is appropriate for city centers or districts because of the availability of population and crowded buildings to produce good signal levels in the LTE coverage map. In the tool, the building which has the highest elevation is the first available base station location. Then tool starts to find the second base station location outside of 0.3 km radius of the first selected base station. The algorithm continues to find other available sites until the built up area is covered with 0.3 km radius circles as shown in Figure 4.

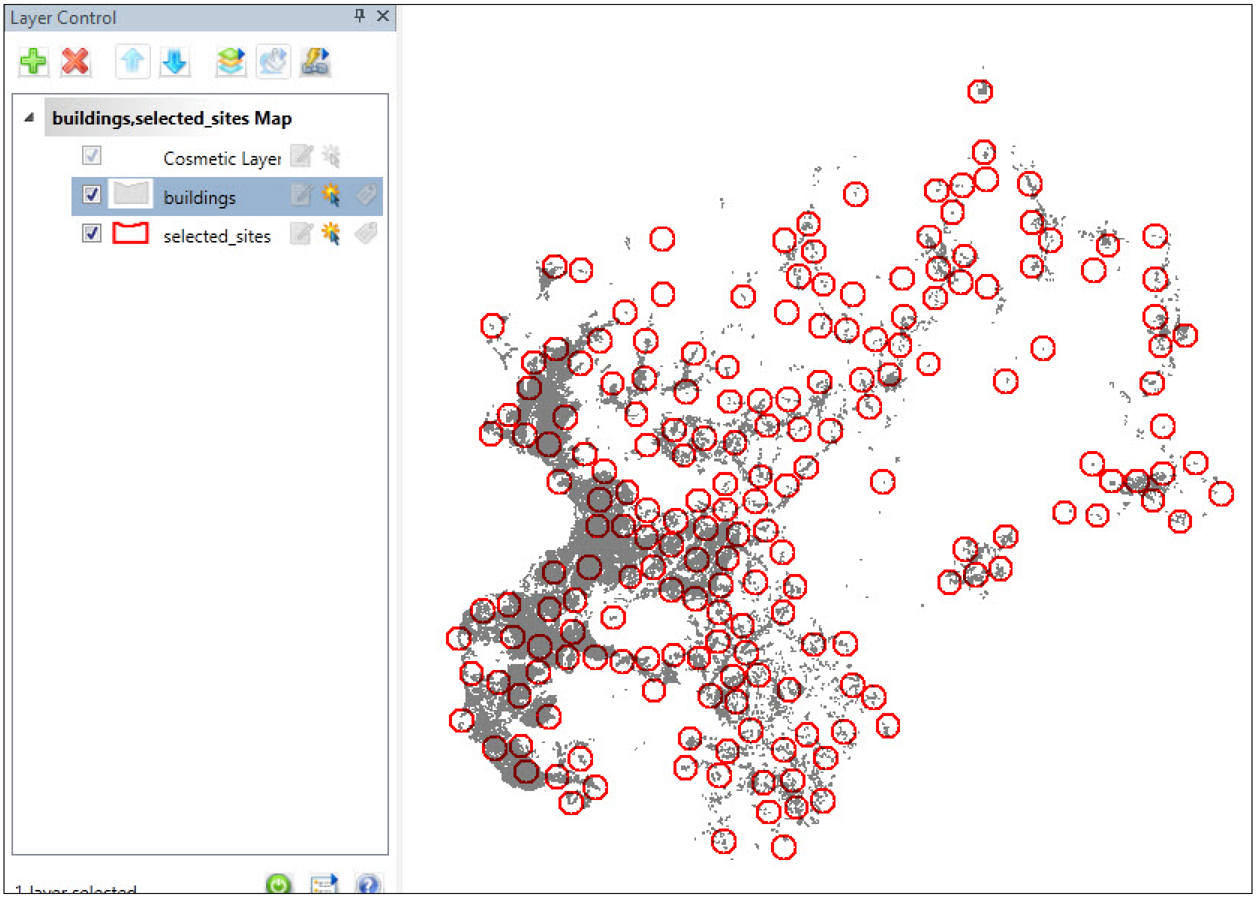

Figure 4. Screenshot from selected sites with 0.3 km radius in Beykoz.

LTE COVERAGE MAP

There are lots of tools to show the coverage of mobile communication technologies. In this paper we focused on the LTE coverage map with the Atoll program (*Shabbir et al., 2011*). Before signal calculation in Atoll can be made, a digital elevation model (DEM) and a clutter elevation of the region must be considered. In Beykoz, the geographical data for DEM and clutter with 35 m resolution are imported in the UTM zone 35. After the determination of the propagation model, each base station transmitter (antenna) can be calculated for signal levels on the map. We focused on the Stanford University Interim (SUI) radio propagation model in this paper because it can be used for 1900 MHz systems and it is an effective model for urban areas and city centers (*Sharma et al., 2010; Shabbir et al., 2011; Rani et al., 2012; Sachin et al., 2013*). Signal levels are defined in Figure 5 and the Beykoz coverage map and a magnified view of the southern part of Beykoz are shown in Figure 6 and Figure 7.

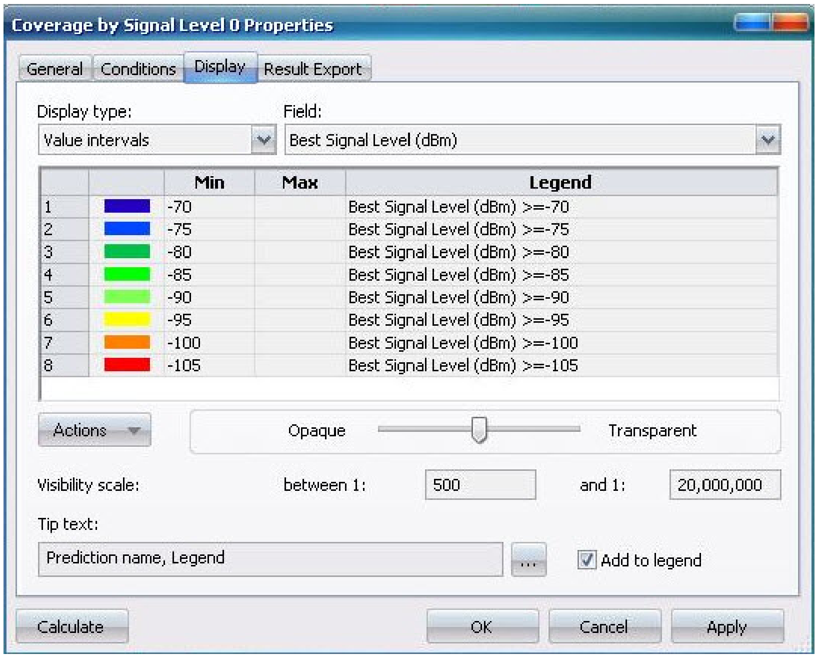

Figure 5. Best signal levels and colors.

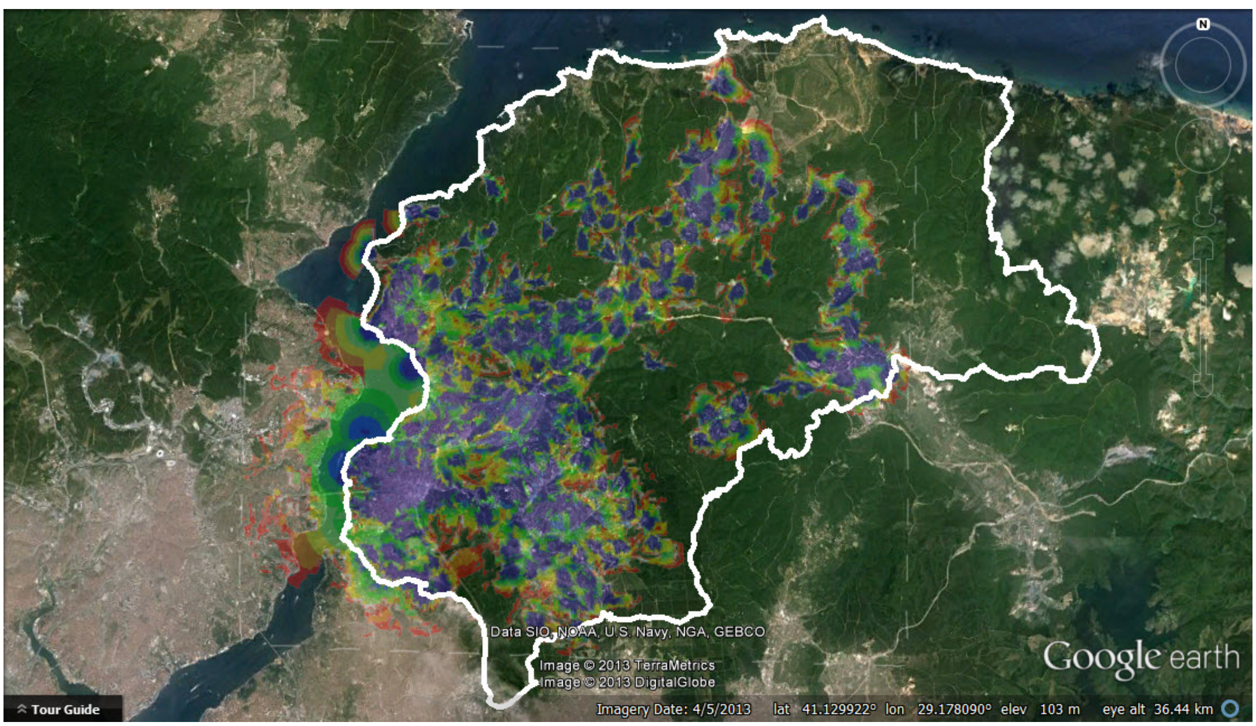

Figure 6. LTE coverage map of Beykoz.

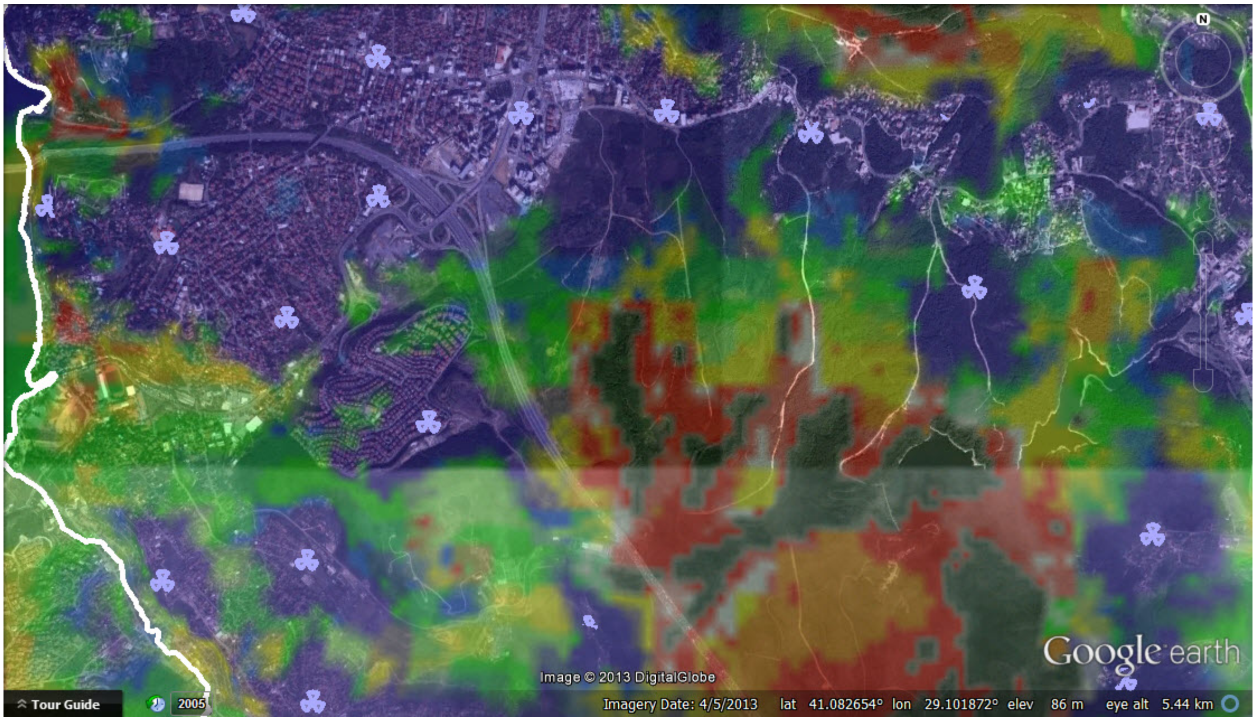

Figure 7. Magnified LTE coverage map showing the southern part of Beykoz.

RESULTS AND CONCLUSION

Finally, the result of the radio prediction showed that the coverage of a region that has all built up areas has effective radio signal levels between -40 dBm and -105 dBm. This result allows engineers to spend less time surveying the area to find available base station locations. Moreover, they can spend their time dealing with issues such as subscriber complaints and network optimization. If an incorrect site is selected, it becomes necessary to replace it, and the time taken to do this, as well as the costs, can be reduced by using the site selection tool. Therefore, operator firms can use their investments more effectively in the region.

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