

# Location Estimation of Mobile in GSM and CDMA Networks

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**Abstract.** In this Paper, we present the design and implementation of location estimation tool that provides the location of mobile for a known mobile number. During emergency, persons who are in deep trouble should be located concisely and accurately due to the critical importance. With any tracing mechanism of least delay, culprits could be caught by authorities. In such kind of scenarios, our location estimation tool detects the location of the person carrying the mobile. This tool works at either Base Station Controller (BSC) or Mobile Switching Centre (MSC) at mobile network side. Location estimation tool works based on neighbor BTS and serving cells signal strength information. At MSC, Signal strength values are to be collected from signal dump file of mobile number. Tool gives the location of a mobile as latitude, longitude values on Google maps in different cases.

**Keywords:** GSM architecture, CDMA architecture, Base Transceiver Station (BTS), Base Station Controller (BSC), Mobile Switching Centre (MSC).

## 1 Introduction

There are so many websites available to give the location of a mobile for a given mobile number. But the result of those websites are not up to the mark, at most they will give good result as location of serving BTS. Theoretically BTS can cover a maximum of 70 KM diameter range, but in practical it can cover up to 25 KM range based on remoteness of the area. Even we know the location of BTS, it is very difficult to find out correct location of mobile within that 25 KM diameter range of area. We have designed location estimation tool which gives the exact location of mobile in the wide range covered by BTS.

Location estimation tool gathers neighbour BTS signal strengths information, base station identity code (BSIC), location area identity (LAI), cell Id (CID) and frequency values from signal dump file of a given mobile number. Location estimation tool uses hata model to calculate distance (BTS to mobile) from signal strength. This tool uses Google map API to give location of mobile as point on Google map with longitude and latitude values. We present design and implementation of our tool in GSM environment [1], [2], [3], [4] here, but the same design and algorithms can be used for CDMA network [6], [7] also. Location estimation tool has been designed in three different cases based on information in input signal file [5], [13].

## 2 Literature Study

Mobile Networks have always been an area of research. Location finding of a mobile is an important issue under which so much research work is going on. The following are some of the related research work [8], [9], [10], [11] carried out to find the location of a mobile.

Karim Y. Kabalan, Jinane I. Mounsef addressed the problem of determining the position of GSM cellular mobiles in a cost- efficient way, i.e. without any change in the infrastructure or the handset [10]. It uses the signal strength technique as a major tool to solve the mobile location problem. James Caffery, Gordon Stuber investigated subscriber radio location techniques for code-division multiple-access (CDMA) cellular networks [11]. Two methods are considered for radio location: measured times of arrival (ToA) and angles of arrival (AoA). The ToA measurements are obtained from the code tracking loop in the CDMA receiver, and the AoA measurements at a base station (BS) are assumed to be made with an antenna array.

Christopher Drane, Malcolm Macnaughtan, and Craig Scott have proposed methods for positioning GSM telephones [8]. They have examined the ability to derive position information from GSM signals, based on their May 1996 achievement of accurate position measurements using GSM. They also explained about self-positioning, remote positioning and indirect positioning techniques.

From the above literature survey, we understood that we do not have any software that gives the location of mobile without adding any extra hardware either at network side or at mobile side. We have designed such software which is a network based positioning tool, to give the location of mobile.

## 3 Methodology

Location estimation tool has to work in three different cases based on the information in input signal file. In all the cases, we have used hata model empirical formulae to get the distance of mobile from BTS with the help of BTS BCCH signal strength (RxLev) and some other factors like tower height, antenna gain, transmission power etc. This model is being considered for use by ITU-R in the IMT-2000 standards activities.

According to Hata model [12], pathloss is given by

$$\Delta P \text{ (dB)} = 69.55 + 26.19 * \log_{10}fc - 13.82 * \log_{10}h_{\text{BTS}} - a(h_{\text{ms}}) + (44.9 - 6.55 * \log_{10}h_{\text{BTS}}) * \log_{10}d.$$

Where  $fc$  is carrier frequency,  $h_{\text{BTS}}$  is height of BTS in meters,  $d$  is distance between  $ms$  and BTS in km,  $a(h_{\text{ms}})$  is correction factor to compensates the antenna variations of the  $ms$ , and is given by

$$a(h_{\text{ms}}) = (1.1 * \log_{10}fc - 0.7) * h_{\text{ms}} - (1.56 * \log_{10}fc - 0.8) \text{ in small or medium sized cities,}$$

$$a(h_{\text{ms}}) = 3.2 * (\log_{10}(11.75 * h_{\text{ms}}))^2 - 4.97 \text{ in large cities.}$$

Generally path loss  $\Delta P$  can be obtained as follows,