

POSITIONING METHODS FOR GSM NETWORKS

Communication networks are very popular and useful nowadays. Almost all people in the world use it. Therefore it is rapidly developing. In our country GSM networks are very popular. A national GSM operator provides its services on the whole territory of Ukraine. This communication network is possible to use for navigation and positioning.

GSM is placed in the base of cell structure. Every call in the network contains Base Station (BS) which provides radio communication with mobile stations (MS) located in the work zone BS. Location of each BS has been known. Three dimensional coordinates contain in the special data base.

The positioning methods in GSM network use three or more receiving sites to monitor a call and compare signal strength, time of arrival, and distance or angle of arrival of a signal from a handset. These location techniques are independent of external systems. The most important of them are described briefly below.

Cell of Origin. This method of determining covers delivering the BS signal zone. The antenna density is big therefore the accuracy of this method little.

Signal Strength. Applying a mathematical model for the relation between the distance and the signal strength the distance between the MS and BS can be estimated measuring the signal strength at the BS.

Angle of Arrival. Using antenna arrays, the direction where the signal originates from can be determined. With at least to BS, an interception point of two lines can be determined.

Time of Arrival method is based on the measurement of the time that a signal needs to travel from the BS to the MS. In two dimensions the distance of the MS from the BS marks on a circle. The interception of two circles results in two possible position solutions.

Time Difference of Arrival is a hyperbolic position determination technique. MS measures the time difference of the arrival of the signals of two BS. The possible solutions where the time difference is constant lie on a hyperbola. In order to get an unambiguous position solution at least 2 hyperbolas, i.e. three BS are necessary.

Enhanced Observed Time Difference. The signal send by BS is received by the MS and a reference measurement station with known coordinates. The time difference, and therefore the distance, between the BS and the MS, is determined by correlating the two received signals. Therefore distance contains the clock error.

The methods above have in common that the accuracy depends on the number of measurements and on the geometry of positions of the MS and BS. If the measurements are redundant least square techniques can be applied to get a better accuracy. On the other hand an unfavorable geometry degrades the accuracy. In the common way mix of represented methods provides very high accuracy.

GSM positioning techniques can be used for satellite navigation systems complementary. Because in the open sky area the using of satellite navigation is good, but in the urban area the GSM navigation will be better.