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Subject: **Paper Abstract.**

- Title of the paper: **Relative-Locative system for a GSM Environment.**
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Relative-Locative system for a GSM Environment.

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The Brief:

To locate the position of any mobile handset/PDA or Cell-phone (O) in a region we should have at-least two reference points from which it's distances are known; as in a rectangular co-ordinate system. In a GSM Cell (Base Station region) there are no such fixed points of reference and being a Polar Co-ordinate environment- where points are known by (Radius, Theta) convention; though the radius can be ascertained, the bearing (Theta) cannot be known. The radius or 'nominal' distance of the mobile handset can be calculated from the strength of the received signal, where the word 'nominal' accounts for the non-linear and uncertain variation in the signal strength due to various factors.

In this paper I propose an method to establish a stable Reference System for the GSM-Cell, which records location of any mobile handset with Relative to the other handsets in it's vicinity.

The scenario:

In GSM technology mobile handsets communicate with the Base Station, which lies in the center of it's signal territory called a Cell. Pictorially, the Cell is a hexagonal area whose size increases or decreases depending on number of mobile handsets in it. More the handsets, the shorter the Cell's span and vice-versa.

When any mobile enters the Cell, it registers itself with the Base Station by a process called Handoff. While the mobile is in the Cell, the Base Station is aware of its presence but does not know about where exactly it must be located at a particular time.

The problem

A Base Station can find how far a mobile is (nominally) by measuring the received signal strength. The 'nominal' distance is inversely proportional to the signal strength and can be obtained by using advanced equations, say for example

If,
Do= Distance of mobile (o) from it's Base Station.
D'o= Nominal of mobile (o) from it's Base Station
Po= Power strength received by Base Station from the mobile o.
K= Loss factors due to climate
T= Gain Factor

$$D'o \propto K\{1/Po\ )+ T \qquad \text{(Equation E-1.0)}$$

Nominal distance is inversely proportional to the Strength of the signal multiplied by the loss factor. Higher the signal strength means closer the mobile(o) is to the Base Station. By increasing it's resolution, the Base station can more accurately judge the nominal distance.

Knowing radius, the bearing of the mobile with respect to the Base Station can be vaguely ascertained from a reference from the neighboring Cell's Base Station, which will measure the nominal distance of the mobile(o) in question. Now since the distance between the two stations are already known, the position of mobile can be vaguely determined. This method is however unreliable because the signal strength of the mobile(o) will be too weak and at times inaudible to the neighboring base station. Though, it can used to further strengthen the innovation presented in this paper.

Basics of Location Determination

To locate the position of any mobile handset/PDA or Cell-phone(o) in a region we should have a large number of reference points from which it's 'nominal' distances are known. These can be mobile(o's) surrounding handsets which can act as temporary reference points. Once nominal distances of mobile(o) are known from (all surrounding handsets) all directions, their *logical summation* will give a fair position of the mobile(o) at the given time since the variations (represented by factor K and T in equation E-1.0) will cancel out.

The Method:

Any mobile(o) in the cell (Cell1) having it's Base Station (BS1) will identify who all are it's immediate 'nominal' neighbors, called Peers (Pi) and bearing agents called Fixers(Fi)?

Peers (Pi) are in the closest proximity of the mobile(o) having the signal strength greater than a pre-established cut-off value. Hence all signals stronger than the cut-off strength are said to belong to Peers.

P(i)= ID of mobile(i), Name of parent Cell *(Name-1.0)*

Fixers(Fi) are mobiles lying on the neighboring cell whose signal is audible and clear. Fixers establish cross-connections across two adjacent cells, making all the mobiles geographically determinate.

F(j)=ID of mobile(j), Name of parent Cell, Strength of Audible signal *(Name-1.1)*

This information about Peers and Fixers is maintained and stored by each mobile in a table called as **Relative Location Table (RLT).**

The conclusion:

When ever the location of the mobile(o) needs to be determined by it's Base Station (BS1), it query's it's RLT and finds out the Fixers and Peers listed. Then it queries all the Fixers and Peers for their RLTs. From all the RTLs thus obtained, the BS1 makes a 'nominal' *Map of all mobiles* in all the RTLs. In this nominal map, the nominal distances between ***most*** mobiles are present.

Then, through a suitable equation, the bearing of mobile(o) is obtained with respect to the line joining the two neighboring base stations, incorporating as many possible factors to maximize the accuracy of the location.