4. SELECTION OF NEW BASE STATION

4.1 INTRODUCTION

The handover can be done smoothly, only if the next BS to which the signal is to be handed over is known well in advance. This is used to pre-allocate the TCH in advance. In general during handover a new BS selection is done based on the signal strength received by MN from the nearer BSs. This process is suitable if the MN is in intra MSC because the MSC itself takes care of new BS. Due to signal ray scattering, shadowing and multipath reflections the signal strength measurements may not be accurate, which leads to wrong prediction of new BS. This may in turn lead to multiple handovers. Similarly in inter MSC handover the signal strength based new BS prediction leads to multiple handover and multiple authentications. This may result in break off of communication which has to be further re-established. To avoid these drawbacks, in the proposed study the exact MN location is identified based on hybrid location prediction algorithm and the new BS is selected based on direction of movement of MN for Inter-MSC handover.

4.2 REVIEW OF RELATED WORK

The conventional method of location prediction includes RSSI (Received Signal Strength Indicator) [91][92][93][94], AOA (Angle of Arrival) [95], TOA (Time of Arrival) [95][91], TDOA (Time Difference of Arrival) [96] and GPS (Global Positioning System) based[97]. RSSI, AOA, TOA and TDOA methods are used in wireless sensor network and Ad-hoc networks.

RSSI based location prediction is done by applying ray theory with the assumption that there is no ray scattering in between the MN and the BS. But in reality due to ray scattering, the accuracy of the localization is reduced. In AOA method, the angle measurements need to be accurate to identify the exact location of MN. Hence AOA method requires relatively large and complex receiving antenna arrays and Direction of Arrival (DOA)[98]
estimation algorithms at the BS. Also, network shadowing and multipath reflections have to be reduced to make AOA method more accurate. To perform TOA method, the BS regularly broadcast its own identification numbers as LAI, CI and BTS-Id along with the sending time of every signal through BCCH. In TDOA [96], the differences in time stamps are combined to locate the exact location of MN. But multipath distorts the shape of the signal, which makes it difficult to accurately determine the location.

For a large area wireless network GPS based location prediction is applied, but the method is considered to be too expensive. Also to find the geographical location based on the GPS receiver at least four satellites visible at all times are needed, which is difficult in covered rural environments.

For sensor network an RSS (Received Signal Strength) based localization algorithm in non line-of-sight environment is suggested by YanWang[92]. Kalman filter is employed to mitigate the process noise. In this work a large number of sample beacons are taken for localization which consumes more computational time. In the work done by Yungho Leu[93], a predefined set of training locations, the RSS values from several access points are recorded in a database called the radio map. RADAR performs pattern matching of the collected RSS values against the RSS values in the radio map. A location-dependent received signal strength vector, called the RSS location signature is used for pattern matching in online location prediction. This location prediction is suitable only for indoor environment. For every location prediction pattern matching is done in online which creates congestion in network. In the work suggested by Ae-cheoun Eun [94] localization is done based on sensor nodes which is addressed only for indoor wireless sensor network environments. Mohamed Zhaounia [95] proposed hybrid time-of-arrival/angle-of-arrival (TOA/AOA) location prediction algorithm. To perform TOA the time synchronization is required between BS and MN, which is highly impossible with BSs under different MSCs.
4.3 LOCATION PREDICTION OF MN

A novel hybrid location prediction algorithm is proposed in this work to determine the location of MN in inter-MSC area based on received signal strength indicator, angle of arrival and time difference of arrival. From the consecutive locations the direction of movement is identified. Furthermore in the effective proposed method is improved high accuracy.

MIC maintains a database \( \{X_i, Y_i, r_i\} \) of BSs located in the borders of the MSCs, where \( \{X_i, Y_i\} \) is the latitude and longitude value of BS\( _i \) and \( r_i \) is the maximum coverage range of BS\( _i \) in kms, \( i \) varies from 1 to \( n \) (\( n \) refers to total number of BSs in inter MSC zone). This is used for direction prediction of MN to find the best new BS to be handed over.

4.3.1 Identification of MN which are in inter MSC area

MN receives the beacon (BCCH) packets from various surrounding BSs in every 420 ms. While communication is going on, MN measures the signal strength (RXLEV) of current communication and BCCH’s signal strength of neighbouring BSs. This information is passed to BSC via SACCH in every 480 ms once. From the MN’s SACCH information, BSC identifies those MN which are about to be handed over (which are having the received signal strength of current communication is below -97 dBm) and neighbouring BSs are under different MSC (inter MSC). BSC sends location parameter request to selected MNs which are in the inter MSC area through SDCCH without disturbing other nodes. Based on the facility available in the MN the location prediction is categorized into two. The first one is GPS based direction prediction procedure and the second is non GPS based direction prediction procedure.

4.3.2 GPS based direction prediction procedure

Nowadays due to advanced technology, GPS facility is introduced in wireless communication. But due to additional cost, some of the MNs only have GPS facility. As per GPS based direction prediction, the GPS satelite
continuously broadcasts the beacon packets with almanac data [99][100] (starting time, its latitude and longitude) for specified intervals. Each GPS based mobile device receives beacons from at least four GPS satellites. If MN receives less than four GPS satellite’s beacons then it will not be considered for location prediction. With increase in number of identified GPS satellites, the accuracy in location prediction also increases. After receiving location parameter request from BSC, MN determines its distance $d_1, d_2,..d_i$ from GPS$_1$, GPS$_2$,... GPS$_i$ (where $i<=4$) respectively based on the time difference between starting time and receiving time of the beacon packets. From this MN determines its latitude and longitude values. Figure 4.1 gives the location of MN by intersection of four GPS satellites.

![Figure 4.1: GPS based location prediction of MN](image)

MN adds its GPS location (latitude and longitude) information along with SACCH and sends it to BSC via BS. Since MIC takes care of inter MSC handover, BSC forwards this information to MIC as shown in Figure 4.2. The same process is repeated until MN finds the BS’s current communication received signal strength to be -102 dBm (handover threshold). MIC stores these consecutive GPS locations. From the obtained consecutive locations MIC decides the direction of movement of MN and it’s speed.
4.3.3 Non-GPS based location prediction procedure

When MN receives the location parameter request from BSC, it has to collect the starting time of each neighbouring BS’s BCCH beacon packet and also finds the receiving time. If the mobile device has angle sensor then it identifies the neighbouring BS’s received signal angle [101][102]. MN sends this information with SACCH to BSC. For inter MSC handover BSC forwards this to MIC as handover indication message, to find the direction of movement of MN, Figure 4.3 gives the sequence of steps for handover indication.

4.3.3.1 Intersection area between BSs

From the handover indication message MIC identifies the neighbouring BSs. Since the location and the range of these BSs are known to MIC, it determines intersection area of the BSs are shown in Table 4.1. The intersection area refers the area in which the MN lies. The below table and figure shows the location of MN and the intersection area obtained in matlab (m-file) software (ANNEXURE III)
Table 4.1: Location and Intersection area of MN

<table>
<thead>
<tr>
<th>S.No</th>
<th>Number of BSs detected beacon signal by MN</th>
<th>BS x coordinates in km</th>
<th>BS y coordinates in km</th>
<th>Maximum signal coverage distance in km</th>
<th>Figure number</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>6.2</td>
<td>5.5</td>
<td>5</td>
<td>Figure 4.4</td>
</tr>
<tr>
<td></td>
<td></td>
<td>14.4</td>
<td>9.8</td>
<td>6.5</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>3</td>
<td>7.7</td>
<td>14</td>
<td>6.1</td>
<td>Figure 4.5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>9.4</td>
<td>5.9</td>
<td>5.1</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>13.3</td>
<td>11.1</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>4</td>
<td>10.3</td>
<td>9.8</td>
<td>7.4</td>
<td>Figure 4.6</td>
</tr>
<tr>
<td></td>
<td></td>
<td>19.7</td>
<td>10.1</td>
<td>6.9</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>15</td>
<td>16</td>
<td>7.2</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>14.7</td>
<td>4.3</td>
<td>5.8</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>6</td>
<td>6</td>
<td>7</td>
<td>6</td>
<td>Figure 4.7</td>
</tr>
<tr>
<td></td>
<td></td>
<td>11</td>
<td>7</td>
<td>7</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>13</td>
<td>14</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>6</td>
<td>15</td>
<td>7</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>10</td>
<td>9</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>8</td>
<td>5</td>
<td>5</td>
<td></td>
</tr>
</tbody>
</table>

Figure 4.4 Intersection for 2 BSs.
Figure 4.5 Intersection for 3 BSs.

Figure 4.6 Intersection for 4 BSs.

Figure 4.7 Intersection for 5 BSs.
The MIC then predicts the location of MN based on RSSI, AOA and TDOA which is discussed in detail in section 4.3.3.2, 4.3.3.3, 4.3.3.4 respectively. The exact location of MN is found based on the hybrid location prediction method discussed in section 4.3.3.5.

### 4.3.3.2 Location based on RSSI

To perform the RSSI based location prediction procedure MIC requires the distance between MN and each neighbouring BSs. The MIC calculates the distance of MN from each BS from the received location parameters based on free space path loss model [103] as,

$$\text{Distance} = (10^{\text{path\_loss}-32.45-20\log10(\text{frequency})/20}) \times 200$$

where, \( \text{path\_loss} = \text{transmitted\_power} + \text{total\_gain} - \text{received\_power} \)

With each BS location as a center point and the distance corresponding to that BS as radius, MIC finds the intersection of circles for the entire surrounding BS. The intersection point refers to the MN location as shown in Figure 4.8. The intersection points based on Heron’s formula is given below.

\[
\begin{align*}
mx_i &= \frac{x_i + x_{i+1}}{2} + \frac{(x_{i+1} - x_i)(r_i^2 - r_{i+1}^2)}{2D^2} + 2\frac{(y_i - y_{i+1})}{D^2} \\
my_i &= \frac{y_i + y_{i+1}}{2} + \frac{(y_{i+1} - y_i)(r_i^2 - r_{i+1}^2)}{2D^2} - 2\frac{(x_i - x_{i+1})}{D^2} \\
mx_{i+1} &= \frac{x_i + x_{i+1}}{2} + \frac{(x_{i+1} - x_i)(r_i^2 - r_{i+1}^2)}{2D^2} - 2\frac{(y_i - y_{i+1})}{D^2} \\
my_{i+1} &= \frac{y_i + y_{i+1}}{2} + \frac{(y_{i+1} - y_i)(r_i^2 - r_{i+1}^2)}{2D^2} + 2\frac{(x_i - x_{i+1})}{D^2}
\end{align*}
\]
\[ \text{where} \quad \partial \quad \text{is the area of triangle } \text{BS}_1, \text{BS}_2, \text{E} \]

\[ \partial = \sqrt{p(p-D)(p-r_i)(p-r_{i+1})} \quad (4.5) \]

\[ \text{distance} \quad D = \sqrt{(x_{i+1} - x_i)^2 + (y_{i+1} - y_i)^2} \quad (4.6) \]

\( p \) is half the perimeter of triangle

\[ p = \frac{D + r_i + r_{i+1}}{2} \quad (4.7) \]

Figure 4.8: Location prediction using RSSI

But due to reflection, diffraction and scattering the intersection points differ. Hence the average of the intersection points lying inside the intersection area is taken as the location of MN based on RSSI.

The various steps in location identification based on RSSI are

i. The MIC converts the signal strength of each BS into distance.

ii. With each BS as centre and its distance as radius the circle equation is obtained. For each pair of BS two intersection points will be obtained.

iii. The intersection points within the intersection area are stored in the MIC.

iv. The average of the x and y co-ordinates of intersection points within the intersection area is considered as the MN location based on RSSI.
4.3.3.3 Angle of Arrival (AOA) based MN location

Angle-of-arrival is another location prediction method which is described and used for location estimation in many research works [95][104]. The position of the MN can be found with at least two straight line equations from the BSs to the MN. From the location parameters MIC collects angle information. If \( \alpha_i \) and \( \alpha_{i+1} \) denotes angle corresponding to the signal received by MN from BS\(_i\), BS\(_{i+1}\) respectively. Then

\[
\Theta_i = 180 + \alpha_i \mod 360 \tag{4.8}
\]

\[
\Theta_{i+1} = 180 + \alpha_{i+1} \mod 360 \tag{4.9}
\]

Where \( \Theta_i, \Theta_{i+1} \) denotes the angle mapped with respect to the BS.

Then MIC generates straight lines (i and i+1) according to these angles \( \Theta_i, \Theta_{i+1} \) with ending point of straight line as

\[
x_i = x_i + \cos (\Theta_i) \times r_i \tag{4.10}
\]

\[
y_i = y_i + \sin (\Theta_i) \times r_i \tag{4.11}
\]

where \((x_i, y_i)\) are the location of \(i^{th}\) BS and \(r_i\) is the maximum coverage range of BS\(_i\) in kms.

\[
x_{i+1} = x_{i+1} + \cos (\Theta_{i+1}) \times r_{i+1} \tag{4.12}
\]

\[
y_{i+1} = y_{i+1} + \sin (\Theta_{i+1}) \times r_{i+1} \tag{4.13}
\]

where \((x_{i+1}, y_{i+1})\) are the location of \((i+1)^{th}\) BS and \(r_{i+1}\) is the maximum coverage range of BS\(_{i+1}\) in kms.

The intersection point of these two lines based on triangulation method is calculated by MIC (Figure 4.9) as
\[ x = \frac{x_{i+1} \tan \theta_{i+1} - x_i \tan \theta_i + y_i - y_{i+1}}{\tan \theta_{i+1} - \tan \theta_i} \tag{4.14} \]

\[ y = \frac{(x_{i+1} - x_i) \tan \theta_i \tan \theta_{i+1} + y_i \tan \theta_{i+1} - y_{i+1} \tan \theta_i}{\tan \theta_{i+1} - \tan \theta_i} \tag{4.15} \]

where \( \tan \theta_i = \frac{y - y_i}{x - x_i} \) and \( \tan \theta_2 = \frac{y - y_2}{x - x_2} \)

\( \theta_1 \) and \( \theta_2 \) denote the angles of BS1 and BS2 to the same axis.

\( (x,y) \) represents the location of MN in km,

\( (x_1,y_1) \) represents the location of BS1 in km,

\( (x_2,y_2) \) represents the location of BS2 in km.

Figure 4.9: Location prediction using AOA

Similarly the intersection point of all combinations of the BS pair is done by the MIC. The average of (x and y co-ordinates) intersection points lying inside the intersection area is considered as the location of MN by the MIC based on AOA.
The various steps involved in location identification based on AOA are

i. The MIC receives angle for each BS from MN

ii. For each angle, straight line equation from each BS to MN is being framed.

iii. The intersection points within the intersection area is stored in the MIC.

iv. The average of the x and y co-ordinates of intersection points within the intersection area is considered as the MN location based on AOA

4.3.3.4 Time Difference of Arrival (TDOA) based MN location

TDOA is used to determine the relative position of the MN, by observing the difference in time at which the beacon signal of BSs arrives at MN [96]. Each TDOA measurement defines a hyperbolic locus on which the MN lie and the position estimation is given by the intersection of two or more hyperbolas [91]. So, an unknown location of MN can be estimated from the intersections of two or more TDOA measurements. When MN receives propagation signal of BSs it measures the signal received time. There will be variation in signal receiving time by the MN from each BS due to variation in distance of each BS. MN sends the signal received time of each BS to MIC through location parameters.

Keeping one BS as reference (starting BS), MIC determines the straight line equation from the reference BS to all the remaining BSs. In this method, all BSs are considered as foci points and the time difference between reference BS and the respective remaining BSs is considered as ‘a’ [a is the distance from the center of the hyperbola to each vertex of the hyperbola] for the construction of hyperbola as shown in Figure 4.10. The distance (D) between these two BSs is found as equation (4.6).
The MIC then calculates c as

\[ c = \frac{D}{2} \]  \hspace{1cm} (4.16)

\[ b = \sqrt{c^2 - a^2} \]  \hspace{1cm} (4.17)

where

- c is the distance between each foci of the hyperbola and the center of the hyperbola.
- b is half the height of invisible box

These calculated values are used to determine the hyperbolic equation

\[ \frac{x^2}{a^2} - \frac{y^2}{b^2} = 1 \]  \hspace{1cm} (4.18)

Similar procedure is adopted by MIC to find the hyperbolic equation for all the BSs. The intersection of these hyperbolas represents the MN location based on long range navigation. The average of (x and y coordinates) intersection points lying inside the intersection area is considered as the location of MN based on TDOA.

![Figure 4.10: Location prediction using TDOA](image)
The various steps during location identification based on TDOA are

i. For each pair of BS, MIC determines the difference in time in the arrival of beacon packets interval.

ii. For each pair of BS, with each base station as foci point MIC determines the hyperbolic equation.

iii. The intersection points of these hyperbolas within the intersection area is stored in the MIC.

iv. The average of the x and y co-ordinates of intersection points within the intersection area is considered as the MN location based on TDOA.

4.3.3.5 Hybrid location prediction algorithm

As mentioned earlier, small variations are observed in the MN location in each method. The optimal solution is given by MIC, by taking the average value obtained from the various methods. The detailed steps involved are given below.

step i) The location obtained from RSSI method (section 4.3.3.2)

step ii) The location obtained from AOA method (section 4.3.3.3)

step iii) The location obtained from TDOA method (section 4.3.3.4)

step iv) The average of the x and y co-ordinates of location obtained from step i to step iii is considered as the exact location of MN.

4.3.3.6 Simulation Results

The hybrid location prediction of MN based on RSSI, AOA, TDOA simulation which helps for the new BS identification during handover is done using MATLAB mfile. For experimental purpose three BSs are taken. BS1 is
located at 8 kms in x axis and 7 kms in y axis and its coverage area is upto 6.1 kms. BS2 is located at 16 kms in x axis and 9 kms in y axis and its coverage area is upto 7.3 kms. Similarly BS3 is at 9 kms in x axis and 14 kms in y axis and its coverage area is upto 5.4 kms. These 3 BSs are in the inter MSC zone so MIC has their information as shown in Figure 4.11. The input values for RSSI is obtained from Yellowjacket Sting Simulation Editor. The results are shown in Table 4.2. The MN location obtained based on AOA, TDOA and hybrid location prediction method is shown in Table 4.3, 4.4 and 4.5 respectively.

Table 4.2: Simulation Results for RSSI

<table>
<thead>
<tr>
<th>RSSI</th>
<th>Interception points (x in km, y in km)</th>
<th>MN location based on RSSI (x in km, y in km)</th>
<th>Figure number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Signal strength received by MN from BS in dBm</td>
<td>11.384, 11.090</td>
<td>10.016, 11.922</td>
<td>9.488, 10.257</td>
</tr>
<tr>
<td>-20</td>
<td>-22</td>
<td>-17</td>
<td></td>
</tr>
</tbody>
</table>

Table 4.3: Simulation Results for AOA

<table>
<thead>
<tr>
<th>AOA</th>
<th>Interception points (x in km, y in km)</th>
<th>MN location based on AOA (x in km, y in km)</th>
<th>Figure number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Received angle in degree</td>
<td>10.216, 10.592</td>
<td>9.730, 9.802</td>
<td>9.562, 10.769</td>
</tr>
<tr>
<td>58</td>
<td>165</td>
<td>280</td>
<td></td>
</tr>
</tbody>
</table>

Table 4.4: Simulation Results for TDOA

<table>
<thead>
<tr>
<th>TDOA</th>
<th>Interception points (x in km, y in km)</th>
<th>MN location based on TDOA (x in km, y in km)</th>
<th>Figure number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time difference between BSs</td>
<td>11.189, 9.467</td>
<td>11.813, 10.716</td>
<td>11.501, 10.092</td>
</tr>
<tr>
<td>40 ms (BS1 &amp;BS2)</td>
<td>50 ms (BS1 &amp;BS3)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Figure 4.11 Intersection area of 3 BSs

Figure 4.12 MN Location based on RSSI

Figure 4.13 MN Location based on AoA
Table 4.5: Simulation Results for MN location based on hybrid method

<table>
<thead>
<tr>
<th>Method</th>
<th>MN location based on (x in km, y in km)</th>
<th>MN location based on hybrid location prediction algorithm (x in km, y in km)</th>
<th>Figure number</th>
</tr>
</thead>
<tbody>
<tr>
<td>RSSI</td>
<td>10.296, 11.090</td>
<td>10.544, 10.523</td>
<td>Figure 4.15</td>
</tr>
<tr>
<td>AOA</td>
<td>9.836, 10.388</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TDOA</td>
<td>11.501, 10.092</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
‘x’- represents intersection points inside the intersection area.

‘.’- represents the location of MN based on the respective methods.

‘+’- Location of MN.

The program execution time taken for new BS identification using matlab is 246.471 milliseconds. In practice the processor at MIC would be more powerful and time consumption in real time will be lesser.

4.4 APPLICATIONS OF LOCATION PREDICTION

Prediction of the exact location of the MN is helpful in selecting the new BS during handover, monitoring an environment in dangerous regions, patient monitoring, personnel management in rescue operations, E-911 wireless emergency services [105], location-based billing, fleet management and Intelligent Transportation System (ITS) etc., [106][107].

4.5 DIRECTION PREDICTION OF MN

Even though the new BS is identified based on optimal location of MN it may lead to multiple handover and authentication when MN is moving. To overcome such kind of drawback, in the proposed method a slight modification is suggested. That is, the new BS is identified not only based on MN location but also based on the direction of movement of MN.

For every 480ms MN sends the location parameters to BSC. BSC forwards this information to MIC in every $\Delta t$ time interval. MIC finds the location of MN during every $\Delta t$ time interval based on hybrid location prediction algorithm which was discussed in section 4.3.3.5. The MIC continuously updates the next locations and predicts the direction, the parameters of which are shown in Table 4.6.
Table 4.6: Direction prediction table

<table>
<thead>
<tr>
<th>Movement</th>
<th>Location</th>
<th>Result Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>north west</td>
<td>$x, y + \Delta y$</td>
<td>$x + \Delta x, y + \Delta y$ (north east)</td>
</tr>
<tr>
<td>west</td>
<td>$x, y$</td>
<td>$x + \Delta x, y$ (east)</td>
</tr>
<tr>
<td>south west</td>
<td>$x, y - \Delta y$</td>
<td>$x + \Delta x, y - \Delta y$ (south east)</td>
</tr>
</tbody>
</table>

Assume $(x, y)$ is the first location calculated by MIC. The second and third location is updated in the MIC. From these locations, the direction of movement of the MN is predicted by MIC. With more number of location updates more accurate results for direction is obtained as given in Figure 4.16.

From the location of MN and its direction of movement, MIC exactly predicts the new BS to which the signal is to be handed over. This procedure is suitable to 2G, 3G and 4G inter MSC handovers.

Figure 4.16: Direction prediction
The algorithm for direction Prediction is given below.

Step 1: When the signal strength received by the MN from the existing BS reaches a value below -97 dBm (a) MN calculates location parameters (Signal strength, angle and time difference) of all its surrounding BS from the received beacon packets.

Step 2: MN sends the location parameter report to the MIC via existing BS and BSC

Step 3: MIC predicts the location of MN (location1) based on hybrid location prediction algorithm, which is discussed in section 4.3.3.5.

Step 4: After at time interval, MN again perform step1 (a), step2 and step3 to predict new location (location2) from the new beacon packets.

Step 5: MIC calculates the direction of movement of the MN from the two set of locations (location1, location2)

Step 6: Step1 to step 5 is repeated until a set of locations are obtained to determine the direction.

Step 7: From the location and direction of MN, MIC finds the exact new BS to which the signal is to be handed over.

Step 8: MIC sends the handover request to the new BS.

4.6   DELAY DUE TO NEW BS SELECTION

Exact location prediction of MN and New BS selection based on direction of movements starts, when the communication channel’s signal strength becomes -97dBm in inter MSC handover area. But handover process starts when signal strength becomes -102 dBm (threshold value). New BS selection process is completed when the signal strength becomes below the threshold value. Due to this there is no delay in the handover. This process improves the quality of service and avoids multiple handovers. The
only difference is that instead of MN sending signal strength of neighbouring BSs, MN sends location parameters. Since MIC is an agent in the MSC this process will not affect the other performance of MSC, thereby it improves the efficiency of inter-MSC handover.

4.7 CONCLUSION

In this chapter the exact location of MN is identified based on hybrid location prediction algorithm and also the direction of MN is identified. From this the exact next BS is selected for inter MSC handover. The experimental results are also shown in this chapter. It improves the quality of service and efficient handover process. This process will not affect the handover delay also. The next chapter deals with the procedure involved in reducing the delay in case of abrupt termination. BS services become inoperable for various reasons. Once the connection is terminated abruptly, the MN has to register with new BS as a new user and also it has to go through the entire authentication process as a new connection. To avoid re-registration a new mechanism is proposed in the next chapter.