CHAPTER 4

CONCLUSION

Effective radio resource management schemes, including dynamic radio resource estimation (RRE) and call admission control (CAC), based on the concept of Signal to Interference ratio margin and interference guard margin (IGM) for Wideband CDMA systems are presented and its performance is analysed. The resource reservation schemes used in this work, to improve the connection level QoS performance such as new call blocking probability and handoff dropping probability of the Call Admission Control is based on the mobility models, parameter measurement model and fuzzy model.

Based on the mobility prediction of where and when the mobile will handoff to the next cell, type of traffic and also based on the user distribution, call admission control and SIR margin reservation schemes have been developed. The performance of the schemes have been analysed using computer simulations. The results show that these schemes can achieve a better balance of guaranteeing handoff dropping probability while maximizing resource utilization, and they outperform the static-reservation. From the analysis it is found that , the performance improvement of the call admission control algorithm achieved with the dynamic reservation is about 11% over static reservation of 7 dB and the improvement is only 3% with the static reservation 10 dB under heavy load. The performance improvement of this scheme with dynamic reservation is not very much significant when the static reservation is very high under lightly loaded condition.
In the CAC scheme with the mobility model based on the user’s speed and direction of the movement, a service model with mobile terminals’ service rate, priority, rate adaptivity as well as their mobility is considered. The dynamic IGM scheme developed in this work, reserves a certain amount of interference margin for high priority handoff calls by referencing the traffic condition and mobile users’ traffic profile in neighbouring cells. From the simulation results, it is observed that, the fixed and dynamic IGM schemes outperform the non-priority scheme in giving a smaller blocking and dropping probabilities under light as well as heavy traffic conditions.

In the parameters measurement based algorithm, the target value for the handoff dropping probability of Class-2 traffic is fixed and to maintain this target value the resource reservation is adjusted dynamically. This algorithm also improves the performance of the Call admission control algorithm significantly. The new-call-blocking probability of both the real-time service classes(Class-1 and Class-2 traffic) increases with increasing real-time traffic, whereas the handoff dropping probabilities of Class-2 and Class-1 service classes remain at the target level. The variations in the traffic load of the non real-time service class does not degrade connection-level QoS parameters of real-time service classes.

The uncertainty in the measurements due to the mobility of the users, varying QoS requirements of the applications in 3G systems and dynamic characteristics of the channel leads to poor performance of the Call admission control algorithm. The fuzzy based CAC algorithm provides the solution for this and it improves the performance by about 5% over the algorithm without using fuzzy logic especially at heavy load. The performance variations of the fuzzy based system with respect to the mobility of the users is also analysed. It is found that, when the mobility of the users is low, most of the calls are accepted and hence the blocking probability is less.
For the medium and high mobility users, the blocking probability is high due to the high SIR requirement for eliminating the effect of fading and other multi path effects.

As a future work, the performance of the Call Admission Control with resource reservation schemes based on the service profile, call request rate of the user may be analysed. The effect of power control errors, inefficiency in the code allocation schemes on the performance of the admission control algorithm in WCDMA may also be analysed. For an efficient resource utilisation, the amount of interference guard margin or SIR guard margin is to be optimum. Hence for optimization, the genetic algorithm approach or neural network based approach can be adapted to improve the overall performance of the Call Admission Control schemes.
APPENDIX - I

The likeliness (probability) that the mobile in the cell ‘i’ visit the cell ‘j’ in the time slot ‘\( T_k \)’ is calculated as,

\[
P_{i,j}(T_k) = w_1 \cdot [1 - \frac{d_j}{(2a + R)}] + w_2 \cdot [1 - \left| \frac{\theta_1 - \theta_2}{\pi} \right|]
\]

where
- \( d_j \) - is the distance between the mobile and cell ‘j’
- \( R \) - Radius of the cell.
- \( w_1 \) - is the weight associated with the mobile-cell center distance.
- \( w_2 \) - is the weight associated with the location of the cell center with respect to the direction of the mobile. (Both \( w_1 \) and \( w_2 \) are equal to \( \frac{1}{2} \)).
- \( \theta_1 \) - is the angle between the line that connects the mobile to the cell center and x-axis.
- \( \theta_2 \) - is the direction of the mobile and \( |\theta_1 - \theta_2| < \pi \).
- \( a \) - is the semi-major axis (half of the length) of the ellipse representing the reservation area.

In the above equation the likeliness value (probability) of the mobile moving from cell ‘i’ into cell ‘j’ depends on the following.

- Distance of the mobile from the center of the cell ‘j’ and speed of the movement. (1\textsuperscript{st} term).
- Direction of movement of the mobile. (2\textsuperscript{nd} term).
\[ P_{i,j}(T_k) \propto \left[ 1 - \frac{d_j}{(2a + R)} \right], \] with maximum \( d_j = 3R \), i.e., \( 2a_{\text{max}} = 2R \) and
minimum \( d_j = R \)

\[ P_{i,j}(T_k) \propto \left[ 1 - \frac{\theta_1 - \theta_2}{\pi} \right], \] with maximum difference in the angle = \( \pi \) and
minimum = 0.

The equation formulated for the likeliness value can be justified by considering the following cases.

Case (i): Mobile moving in the direction exactly towards the center of the cell ‘j’. i.e., \( \theta_1 = \theta_2 \), the distance ‘\( d_j \)’ = 3R and the length of the major axis of the ellipse is 2R.

Case (ii): Mobile moving in the direction exactly towards the center of the cell ‘j’. i.e., \( \theta_1 = \theta_2 \), the distance ‘\( d_j \)’ = R and the length of the major axis of the ellipse is 2R.
In case (i) and case(ii), the likeliness value due to the $2^{nd}$ term is maximum and the likeliness value due to the first term depends on the distance and the value of ‘a’

Case (iii): Mobile moving in the direction exactly opposite to the center of the cell ‘j’. i.e., $\theta_1 - \theta_2 = \pi$, the distance ‘dj’ = 3R and the length of the major axis of the ellipse is 2R.
Case (iv): Mobile moving in the direction exactly opposite to the center of the cell ‘j’. i.e., $\theta_1 - \theta_2 = \pi$, the distance ‘dj’ = R and the length of the major axis of the ellipse is 2R.

In case (iii) and case(iv), the likeliness value due to the 2nd term is zero and the likeliness value due to the first term depends on the distance and the value of ‘a’.