CHAPTER 7

CONCLUSION

This chapter concludes the present work with a summary of research contributions and highlights the development of an efficient subchannel power controlled scheme to enhance the capacity of multicarrier code division multiple access (MC-CDMA) systems of wireless communications with guaranteed quality of service (QoS). This also enlightens on the utilization of power control along with adaptive beamforming to further improve the capacity.

The increasing number of users and the requirement for multimedia services with high quality has resulted in the emergence of successive generations of cellular systems from the first-generation (1G) to the fourth generation (4G). But this has certain unresolved problems affecting the quality, and inability to increase the capacity beyond certain limits. This led the researchers to look for better schemes and application of many techniques either singly or in combinations.

In this direction a lot of developments have occurred. Many multicarrier techniques have been investigated to cope with the high data rate transmission with guaranteed QoS. OFDM and CDMA techniques are being used with a lot of limitations. This led to the development of MC-CDMA systems to reduce the interference which transmits the same data symbol over all the subcarriers simultaneously. MC-CDMA systems can effectively combine the energy of the received signal scattered in the frequency domain and eliminate the use of Rake combiner intended for CDMA systems. However processing each of these subcarriers is both time consuming and complex. Instead a subchannel consisting of group of subcarriers, can be used to reduce the time consumption and the complexity.
7.1 RESEARCH CONTRIBUTIONS

A subchannel transmission power control scheme for MC-CDMA systems has been proposed and described in chapter 2. The BER performance and the capacity have been evaluated under time invariant multipath channel. Significant reduction in BER is achieved through subchannel power control. This scheme has been found to offer an improved system capacity while transmitting the same amount of data, power and bandwidth with guaranteed QoS compared to conventional MC-CDMA systems without power control.

A new adaptive algorithm for SINR estimation at the base station of MC-CDMA cellular systems developed and tested by simulation is given in chapter 3. The useful role of the proposed Kalman filter based SINR estimator in improving the performance of power control algorithms has been evaluated by simulation, particularly at higher mobile speeds, when the Doppler spread increases in a high velocity slow fading environment. This innovative approach can pave the way for the development of better power control strategies.

A reverse link power control technique using intelligent controllers for MC-CDMA radio interfacing has been proposed. The simulation study has shown that the adaptability of threshold SINR is crucial to the SINR based power controllers. The power control and adaptive adjustment of threshold SINR of each subchannel according to the time varying conditions of the channel utilizing the FGA controller has contributed to reduction in BER with guaranteed QoS. Also it has been shown to enhance the system capacity and reduce the outage probability significantly.

A beamforming algorithm has been proposed for MC-CDMA systems under the flat fading and frequency selective fading channel environments to suppress the interference in the presence of strong interferers. Out of many performance criteria available, the MVDR algorithm has been found to be more suitable in view of its fast convergence and ability to handle complex multicellular environment. This
interference suppression technique has been utilized to enhance the capacity maintaining the QoS. Mathematical analysis of the frequency domain e and the time domain beamforming schemes using MVDR algorithm has been described. The simulation results of the new scheme for the MC-CDMA systems under the flat fading and frequency-selective fading channels with the presence of interferers at different spatial locations has been analyzed. Comparison of the simulation results of frequency domain and the time domain beamforming in terms of complexity and performance has also been observed.

MC-CDMA systems realized using advanced processing techniques and implemented through the fast and more sophisticated digital signal processors provide high data rate services. Though for the same amount of bandwidth with required QoS, the power control and adaptive beamforming independently mitigate the interference and increase the capacity, the joint scheme proposed in the chapter 6 achieves the same target with less amount of total network power. The performance of the joint power control and beamforming iterative algorithm for MC-CDMA systems on both frequency and time domain beamforming separately has been studied. It is revealed that the received SINR of all subchannels are at least equal to the threshold SINR value while minimizing the total network power of the system. The algorithm has been investigated under flat fading and frequency selective channel environments. The integrated frequency domain beamforming and adaptive power control has been found to yield 5 dB less total network power compared to single antenna case for the same threshold SINR, while it is only 3 dB less for the integrated time domain case. Thus the joint scheme using frequency domain beamforming reduces the interference and enhances the capacity of the MC-CDMA systems by more than 5 times compared to the conventional scheme with guaranteed QoS for the same amount of transmitted power. But the frequency domain beamforming is relatively a complex one. Therefore there is a trade-off between the two schemes in terms of performance and complexity. It is important to note that joint power control and beamforming approaches will go a long way in realizing an optimum radiated power, user-friendly mobile environment.
7.2 SCOPE FOR FURTHER WORK

This study can be explored further by means of implementing the intelligent power controller through neural networks known as artificial neural fuzzy inference system (ANFIS). The utilization of ANFIS model may provide better performance than other intelligent controllers. The hardware implementation of neural networks and ANFIS model is also a challenging task.

Another direction from this work may be to improve the capacity further through base station assignment. In this field a user is assigned with the best base station according to the load constraint. If a particular base station is congested, control of some of the users in that base station may be transferred to the neighbouring less congested base stations. Thus this base station algorithm is capable of dynamically modifying the shape and size of the base station. Base station assignment may be combined with joint power control and beamforming techniques to further improve the capacity of MC-CDMA systems.

Employing various other technologies such as multiuser detection (MUD), interference cancellation schemes, call admission control schemes, adaptive modulation and synchronization techniques in the reverse link transmission in MC-CDMA systems may improve signal reception and capacity enhancement.

The real time implementation of the MC-CDMA systems with power control and adaptive beamforming schemes using hardware components like field programmable gate arrays (FPGAs) and firmware digital signal processors can be worth exploring.

The proposed work can be further applied to wavelet packet based multicarrier CDMA (WP-MC-CDMA), vertical Bell laboratories layered space-time (V-BLAST) and multiuser OFDM systems.