Chapter 7

Conclusion and Future Work

This chapter presents the contributions of the proposed techniques for CFO estimation, CFO compensation, timing synchronization, channel estimation and detection at the base station for mobile WiMAX. Suggestions for future work have been outlined. Before proceeding with the review of the work done, the objectives stated earlier in the introductory chapter are recalled.

Synchronization remains a critical problem in OFDMA for uplink mobile WiMAX. Many criteria have to be taken into consideration while designing synchronization techniques. Important criteria include: perfect frequency and timing offset, perfect channel estimation, good detection probability, reduced MSE, and reduced BER. Current techniques achieve synchronization only by compromising some of the essential factors mentioned above. Hence, the main objectives of the research work can be stated as an efficient frequency and timing offset estimation technique in uplink OFDMA for mobile WiMAX that reduce MSE and BER with further increase in the probability of timing estimation and a novel Multi User Detection (MUD) for uplink mobile WiMAX with better Timing Offset estimation and reduces MAI at the base station.

7.1 CONCLUSION

The primary contribution of this thesis is the introduction of new methodologies for synchronization of OFDMA in uplink mobile WiMAX. The synchronization of OFDMA in uplink mobile WiMAX is desirable in order to obtain perfect frequency and timing offset, perfect channel estimation, good detection probability, improved MSE and BER performance.

An efficient CFO estimation technique in uplink OFDMA for Mobile WiMAX has been proposed. Simulation results show that the MSE performance of the proposed MDA-PIT estimator is 17% better than DA-PIT estimator. MDA-PIT
estimator employing GCAS and SCAS have been analyzed with Pedestrian-A and Vehicular-A channel models. MSE and BER performance of MDA-PIT estimator employing GCAS are 8% and 13% better than MDA-PIT estimator employing SCAS with Pedestrian-A channel. MSE and BER performance of MDA-PIT estimator employing GCAS are 21% and 19% better than MDA-PIT estimator employing SCAS with Vehicular-A channel. Under Pedestrian-A channel, the performance of MDA-PIT estimator with GCAS is better than MDA-PIT estimator with SCAS. But, MDA-PIT estimator with GCAS outperforms MDA-PIT estimator with SCAS with Vehicular-A channel. Also, the estimation accuracy is better in MDA-PIT estimator employing GCAS than SCAS under Pedestrian-A channel. It can be concluded that GCAS is more robust in Vehicular-A channel and well suited for mobile user. Hence, MDA-PIT estimator employing GCAS is better suited in uplink OFDMA for mobile WiMAX.

An efficient CFO compensation technique in uplink OFDMA for Mobile WiMAX has been proposed. Simulation results show that BER performance of the proposed Modified IEC compensation technique with MDA-PIT estimator is 11%, 27% and 5% better than SI-MUIC, DC-SC and IEC compensation techniques with MDA-PIT estimators respectively. Modified IEC compensation has better BER performance due to the efficient suppression of ICI and MUI. It compensates the residual CFO after performing FFT operation. It can be concluded that the proposed Modified IEC compensation technique with MDA-PIT estimator has better performance in estimating CFO.

An efficient technique for timing synchronization and channel estimation using perfect sequence in uplink TDS-OFDMA is proposed. Simulation results show that the timing synchronization is achieved and channel estimation performance using perfect sequence is 12% and 18% better than CAZAC and PN Sequences under Urban, 8% and 18% better than CAZAC and PN Sequences under Indoor Office-B and 8% and 12.5% better than CAZAC and PN Sequences under HIPER LAN-A channels due to accurate autocorrelation of perfect sequence. Also, the results show that the detection probability is good at SNR of 5 dB under AWGN and Rayleigh multipath channel.
In the initial ranging process, estimating the subscriber with precise timing offset is very important. If there is an error in the timing offset of a particular subscriber station, then that subscriber station may interfere with other ranging subscriber or data subscriber or it may be completely taken as a different subscriber resulting in system degradation. So, the system has more adverse effect with an error in timing offset than a misdetection. A Multiuser Detection algorithm for mobile WiMAX is proposed for perfect timing offset estimation. The timing offset estimation performance of MUD algorithm is 45% better than IRA for a maximum RSS of 12 since its ability to reduce the MAI is higher resulting in better detection and parameter estimation. The proposed Multiuser Detection, with a little computational complexity is able to detect the active ranging subscriber with minimum timing offset estimation error since an error in timing offset has got more adverse effect than a misdetection.

7.3 SCOPE FOR FUTURE WORK

The proposed schemes for CFO estimation and compensation, timing synchronization, channel estimation and multiuser detection can be implemented in an operational hardware environment. These developed schemes can be implemented in Field Programmable Gate Array (FPGA) platform. This type of system design can be used to make a better assessment of the computational complexity of the algorithm.

Multiple Input Multiple Output OFDM (MIMO OFDM) is an air interface that combines both MIMO and OFDM for wideband transmission. The concept of MIMO is that each receiving antenna combines the transmitted signal from all the transmit antennas in a way where the BER is reduced or the data rate of transmission is enhanced.

Diversity mechanisms can be implemented in Timing Synchronization and Channel Estimation for combating fading and co-channel interference and avoiding error bursts to increase the capacity of the system. Forward Error Correction (FEC) codes like Turbo codes and LDPC codes can be applied to make the system more efficient.