ABSTRACT

The backbone of much of today's technology is the landmark invention of transistors and integrated circuits. The evolution of the integrated circuits technology enabled the explosion of the personal computer industry in the late 80s, which catered the pervasive demand for more computing power. More recently still, after the advancement in the very large scale integrated circuits and semiconductor technology, it has paved way for the development of the wireless personal communication industry to feed the insatiable need for communicating capability, anytime anywhere. The personal communication service industry's goal is to expand the capabilities of the current cellular system to provide enhanced services like wireless facsimile, e-mail, wireless video services, bank transactions etc. Looking further ahead, the fourth generation personal communication system, which is under research now, will afford the capability of communicating, with anyone, anywhere and at anytime across the globe. While there is still some distance to cover before reaching this point, many developing personal communication service technologies are key in achieving ultimate fourth generation goals.

International telecommunication union has identified Multi carrier code division multiple access (MC CDMA) as the access choice to cater the requirements of fourth generation, since it combines the advantages of both orthogonal frequency division multiplexing (OFDM) and code division multiple access and has superior performance while transmitting high speed data in wireless fading channels. Future wireless links are to support enormous number of multimedia subscribers, which is possible only if some sort of capacity enhancement techniques is invoked in code division multiple access system. Capacity of CDMA systems is not hard limited like FDMA (bandwidth limited) or TDMA (time slot limited). It is soft and can be increased by reducing the bit error rate (BER). Lesser the amount of interference offered by the coexisting users lesser will be the BER and more will be the number of users sharing the spectrum. Hence, by adapting proper BER reduction techniques, it is possible to increase the capacity to the extent possible.
The BER performance of the MC CDMA system is reduced by multi-user interference, due to the users sharing the bandwidth. Interference cancellation techniques are applied to the receiver to tackle this interference. Different flavours of interference cancellation schemes are available. Parallel interference cancellation is faster, more complex and unreliable. Successive interference cancellation scheme is slow, highly reliable and less complex. A tradeoff is made between the parallel interference cancellation (PIC) and successive interference cancellation (SIC) schemes and a new method hybrid interference cancellation (HIC) is arrived at combining the advantages of these two schemes. This hybrid scheme is a simple, faster and reliable method. The performance of the receiver is studied as compared to a detector without interference cancellation. Improvements in performance of parallel interference cancellation can be achieved by using multiple stages of the cancellation unit. Similarly performance of HIC receiver can also be improved. The PIC part of HIC is made iterative. As a further analysis the performance of iterative PIC and iterative HIC are compared in terms of computational complexity and error performance and an optimum receiver is arrived at.

Apart from canceling the interference through interference cancellation receiver, interference can be effectively reduced through power control techniques. Power control algorithms can be implemented both in the forward link and reverse link. Target QoS driven subcarrier allocation and power control algorithm is proposed for the forward link. This algorithm ensures minimum utilization of the subcarriers and their power which ultimately reduces the interference in air in the forward link to a greater extent. To reduce the interference in the reverse link a dynamic and precise SIR based reverse link power control algorithm is followed. Both the algorithms ensure reduction in interference, increment in capacity inspite of maintaining target QoS.

The BER of MC CDMA system can still be reduced by proper synchronization schemes. The different levels of synchronization in digital communication are carrier synchronization, symbol synchronization, frame synchronization and network synchronization. Data aided synchronization and non data aided synchronization are the two fundamental ways in which these different levels can be implemented. In data aided synchronization, a preamble, containing the
information about the carrier and symbol timing, is transmitted along with the data bearing signal. In non data aided synchronization, the receiver has the task of establishing synchronization by extracting the necessary information from the modulated signal. Non data aided scheme is quite attractive as bandwidth is not wasted for synchronization. Due to the use of large number of carriers, MC CDMA systems are sensitive to synchronization errors. Hence carrier synchronization is very much essential. The algorithm proposed for synchronization in MC CDMA systems in this thesis is of non data aided type and synchronization is achieved through virtual subcarriers which are not utilized by any users. The next level of synchronization in an OFDM based system is the identification of the OFDM symbol boundary which is normally referred as frame synchronization. By employing the frame marker encoding concept in the non data aided technique, the modified frame synchronization algorithm proposed, reduces the transmission overhead and provides a reduced frame error rate. This algorithm also helps to incorporate variable frame sizes for each user so that it efficiently integrates the multimedia services with a single unit and also provides efficient bandwidth utilisation.

In summary, this work studies different techniques to enhance the capacity of MC CDMA system through BER reduction so that apart from increasing the capacity quality is also ensured.