ABSTRACT

Communication has visited various trends and stages over the past few decades. Global system for mobile communication (GSM) a second generation (2G) technology, which was introduced in early 1990’s, is running out of bandwidth. This has led to its evolution into third generation (3G) networks with general packet radio service (GPRS) and EDGE based networks as milestones. Although cellular phones and pagers revolutionised communication, the next few years promise the deployment of enhanced wireless communication devices. These future technologies are targeted at providing very high-rate communication anywhere and anytime. Researchers now realise the need to develop a technology to handle very high rate multimedia traffic, which will not only be able to support the traffic, but also provide this service for a mobile user moving at a high speed. This technology is certainly beyond 3G and can be classified as a fourth generation (4G) technology.

The field of mobile radio communications aspires to support high data rate applications such as image and video. However, the ability to achieve high bit rates at low error rates over wireless channels is severely restricted by the frequency selectivity of channels used by multiple propagation paths with different time delays. With conventional code division multiple access (CDMA), resistance to fading is achieved by spreading the signal energy over a larger bandwidth than necessary, to contain the user signal. However, in the process of providing resistance to deep fades, the signal is affected by delay spreads to a greater extent, and experiences considerable inter chip interference (ICI). Recently, wide-band CDMA systems have been proposed as a 3G contender to increase data rates in wireless communications networks. However, since signal propagates in multi-path, phenomena like fading, shadowing, inter symbol interference (ISI), multi-cell interference and co-channel interference occurs.
Multi-carrier code division multiple access (MC-CDMA) system has gained significant interest as a multiple access method and has emerged as a potential aspirant for 4G cellular systems. This is mainly due to its capability of simultaneously exploiting the advantages of CDMA, combined with orthogonal frequency division multiplexing (OFDM), a multi-carrier modulation scheme, to cope with frequency selective fading encountered in large bandwidths apart from ensuring high data rates required for systems beyond 3G. Therefore, a number of multi-carrier CDMA (MC-CDMA) schemes have been suggested to improve performance over frequency-selective channels. Nonetheless, as like any CDMA system MC-CDMA system is also interference limited.

Multi-cell interference is generally mitigated through diversity techniques. Commonly used diversity technique includes temporal diversity, frequency diversity and antenna or spatial diversity. Antenna or spatial diversity technique employs multiple antennas at the transmitter and/or receiver and is very promising, since it does not increase the transmit power and the signal bandwidth. This can be efficiently utilised through multiple-input multiple-output (MIMO) systems, i.e. systems with multiple transmit and multiple receive antennas. MIMO can be easily realised through space time coding which transmits multiple copies of a data stream across number of antennas. Copies of the signal received through multiple antennas are combined in an optimal way to extract as much information from each of them. This ensures optimal reception of data in a potentially difficult environment with scattering, reflection, refraction and indeed with multi-path problem associated with wireless scenario. This dissertation deals with the study of site diversity techniques based on various space time codes for the MC-CDMA system to enhance its performance.

Space time block code (STBC) based site diversity technique is proposed to reduce multi-cell interference by exploiting the diversity gain of number of antennas. Site diversity technique is extended to differential space time block code (D-STBC) based site diversity which works without the knowledge of channel state information (CSI). However, these two techniques offer diversity gain alone. To improve the system performance further, space time trellis code (STTC) which provides coding gain in addition to diversity gain is put forward. With the
introduction of balanced space time trellis code (B-STTC) formed with equal probability of constellation points, site diversity technique based on B-STTC is propounded for the MC-CDMA system.

To further suppress the multi-cell interference and to improve the performance of MC-CDMA, space time codes formed with the blend of STBC and STTC are used. These codes jointly hold the advantages of both STBC and STTC codes and site diversity technique employing STTC based STBC and STBC based STTC site diversity techniques is proposed for MC-CDMA system. The effectiveness in mitigating the multi-cell interference using STTC based STBC and STBC based STTC site diversity techniques can be further improved by replacing the STTC blocks by B-STTC. This decreases the error rate in addition to diversity gain and efficiency of the channel without aggravating the bandwidth expansion. Site diversity techniques involving B-STTC based STBC and STBC based B-STTC is proposed for MC-CDMA system. All the proposed site diversity techniques are evaluated with two, three, four and five transmit and receive antennas.

To summarise, in this work site diversity technique for MC-CDMA system based on different space time codes have been evaluated and is found to enhance the performance which in turn increases the capacity. Of all the site diversity techniques for the system studied, optimum performance is achieved by STBC based B-STTC site diversity technique in improving the system performance. Moreover, increase in receive antennas yields better performance than with the increase in transmit antennas. There can be further research to implement site diversity techniques along with power control and can be extended to other types of multi-carrier systems.