CHAPTER 1

INTRODUCTION

1.1 Background

Modern communication systems require high data rate and high mobility communication which has good performance, good resistance to errors and good spectral efficiency. Multicarrier transmission technique is the most potential technology to realize high data rate communication system. Multicarrier technique can mitigate the frequency selective fading, make it possible to implement a broadband communication system. One of potential multicarrier transmission technique is MC-CDMA which combines OFDM and CDMA systems. The problem of the recent multicarrier techniques is the sharp decline of performance in high mobility condition compared to medium or low mobility case. To achieve good performance communication in high mobility, non-coherent transmission scheme will be explored.

Coherent transmission scheme that widely used nowadays need channel state information (CSI) to help receiver recovering the original transmitted. In very high mobility where channel condition is rapidly changing, the coherent scheme is practically useless because in this condition the channel estimation becomes inaccurate. The use of pilot for channel estimation in coherent transmission scheme also decreases the spectral efficiency of the system. To overcome this problems non coherent transmission scheme is expected to give a solution [1][2][3].

Many non-coherent transmission schemes for various communication systems have been proposed to transmit data without knowing the channel condition. For MIMO system several differential scheme has been proposed; for example Differential Space Time Block Code (DSTBC)[4][5][6], Differential Unitary Space Time Modulation (DUSTM)[7][8], Differential Unitary Space Time Frequency Modulation (DUSTFM)[1][3][9] and also Differential Unitary Space Time Modulation [10]. The performance of LTE with differential modulation also has been analysed in [2]. However, MC-CDMA performance combined with differential modulation scheme has not fully explored.

In this thesis combination of MIMO MC-CDMA system with DUSTFM is explored. MC-CDMA is selected because its robustness against fast fading condition. The combined methods exploit the advantage of each scheme (MIMO, MC-CDMA, differential modulation, STFC), result in a high data rate communication system which is robust against frequency selective fading, multipath fading, and fast fading. OFDM performance and conventional differential modulation performance are compared with the proposed system.

The DUSTFM scheme that is used in this thesis is the same as that is proposed in [1]. However, while in paper [1] the multicarrier technique is MB-OFDM, in this thesis MC-CDMA is used. A symbol detection technique to make the DUSTFM can be decoded without channel state information, when the transmission is using the same frequency band between antennas is proposed. The last, for the validation, the result of the proposed system is compared with other differential modulation techniques. A new DUSTFM scheme that modified the STBC in [6] in combining with MC-CDMA also proposed for 4x4 MIMO models to improve the system performance.

1.2 Problem Definition

Multicarrier transmission scheme is very good transmission technique to achieve high data rate communication system. The current multicarrier technique, although it can give good performance for high data rate, it still not good enough for very high mobility. For high data rate and high mobility communication system, channel estimation cannot be employed because channel condition change rapidly. In this condition channel estimation will become inaccurate. To overcome this problems a non-coherent transmission scheme without CSI and channel estimation can be a very potential candidate. In this thesis, non-coherent scheme for MIMO MC-CDMA to achieve high data rate and high mobility communication system will be explored.

1.3 Research Objective

The objective of this thesis is to design a non-coherent transmission scheme with DUSTFM scheme for MIMO MC-CDMA system to achieve high data rate and high mobility communication.

1.4 Hypothesis

MC-CDMA multicarrier scheme that sends a symbol into *n* different subcarriers can give better performance compared to OFDM multicarrier scheme because of the *n* transmitted

symbols can strengthen each other, result in more accurate symbol decoding especially in high mobility condition when the channel condition change rapidly.

The proposed symbol detection scheme is expected to separate the symbols that transmitted from different transmitter accurately. As the result the proposed scheme is expected to give close performance compared to the main reference from Tran [1] even though only half of the reference scheme bandwidth is used.

The combination between MC-CDMA and the proposed DUSTFM scheme is expected to give high performance communication scheme (good BER as function of SNR) that can give high data rate communication in high mobility condition.

1.5 Scope of Work

To make this research more focus, several limitations are implied:

1) This research focus on the design of the best combination of DUSTFM and MIMO MC-CDMA
2) The channel that used in simulation is Rayleigh fading channel
3) This research focus on downlink transmission side

Scientific results of this research are expected to give contribution to Telkom University, to the national development and in general to science and technology. The research benefits will be obtained by Telkom University and other education institutions. The research will encourage other research in non-coherent transmission scheme applications, especially for high data rate and high mobility communication system.

1.6 Description of Proposed Method

In this thesis MIMO MC-CDMA is combined with DUSTFM that proposed in [1]. In paper [1] has been explained that an STBC Alamouti scheme is modelled into Unitary STFC scheme to get more efficient differential modulation system than conventional differential modulation. In the receiver, a symbol detection scheme without channel estimation is employed to improve the decoding accuracy, especially if the transmission in all employed antennas uses the same frequency band. Maximum Likelihood detection is used for the decoding process to recovering original transmitted symbols. New DUSTFM scheme with is also proposed for 4x4 MIMO models to improve the performance. For 4x4 MIMO DUSTFM models, the STBC from [6] is modified into a unitary STFC. There are three possible models proposed for 4x4 MIMO. The first model uses one frequency band for each antenna, the second model uses one frequency band for each pair of antenna, and the third model only uses one frequency band for all antennas.

In this research differential modulation scheme (DUSTFM) will be implemented in MIMO MC-CDMA Scheme. The combined scheme is expected to provide:

a. Good BER Performance for high mobility (low SNR condition)
b. High Data Rate communication
c. Reliable transmission through Rayleigh fading channel
d. Good Spectral Efficiency