

Research on the Scheme and Performance of Linear SA in CDMA Application

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Abstract—Firstly, this paper researches on the scheme of amplitude weighting(AW) for smart antenna(SA) beam-forming in linear array. With the proposed mathematical model in this paper, QPSK base-band AW is an effective method for linear SA to realize multi-user and multi-direction transmission, by which the perfect directional beam-forming can be realized with low complexity and low cost. Secondly, this paper analyses the performance of linear SA with 6 array elements(AEs) in different application scenarios. Compared with carrier phase-shifting, the implementation scheme of beam-forming by AW has the feature of easy to implement and high reliability, so that the popularization and application of SA is possible.

Keyword-smart antenna (SA); beam-forming; amplitude weighting (AW); QPSK;6 array elements(AEs)

I. INTRODUCTION

Recently, smart antenna(SA) application in CDMA mobile communication system is a very important research direction as well as the basis of future multiple-input multiple-output(MIMO) system. Consequently, the application research of SA has great practical value. SA, based on the phase-controlled antenna array(PCA) technique, is an effective method to increase the frequency and power efficiencies for mobile communication systems. With the directional beam-forming of SA, we can realize the instant tracking and orientation for mobile terminals in a cellular mobile communication system. In CDMA mobile communications system, generally, due to the complexity of realization, SA is mainly employed in base station transceiver. To perform the perfect directional beam-forming, the direction of arrival (DOA) of mobile station (MS) signal should be acquired firstly from uplink, and then with this DOA the directional beam-forming of downlink is possible.

The effect of space division multi access (SDMA) formed by SA directional receiving and transmission is expected to be utilized to separate multi access interference (MAI) and multi path interference (MPI) in CDMA system, which can improve system spectrum utilization greatly and increase the number of users in a given channel bandwidth or CDMA code-channel. The effect of SA SDMA is originated

from the directional reception and transmission principle of phase controlled array antenna. If directional reception and transmission is to be realized in base station (BS), DOA of MS must be known.

Reference [1] states that it could realize downlink beam-forming in base-band after the direction of arrival (DOA) estimation in the uplink, but it has not given the implementation scheme of beam-forming with QPSK base-band signal. Reference [2] presents the block diagram of downlink beam-forming, which is base-band weighting and can form k-beam. Pointing out in [3, 4, 5, 6], the directional transmission of SA can be achieved with the method of beam-forming by base-band weighting, but the specific implementation principle and implementation method has not been shown. Many authoritative monographs [7, 8, 9, 10] on SA only give the principle of PCA, i.e. the basic method of directional transmission by carrier phase-shifting weighting. Literatures [11, 12, 13, 14] on downlink beam-forming only give the interrelated matrix solutions of downlink beam-forming, and have not given the relation among the interrelated matrix solutions, DOA and the direction vector of SA or the related processing. Many patents [15, 16, 17, 18] related to TD-SCDMA system also remain at the level of matrix solutions. One chief engineer of ZTE R&D center has said in [19] "In addition, comparing to extensive research of uplink adaptive beam-forming technique, the downlink performance has become the 'bottle-neck' for the systems performance, so that there is an urgent need for the method of effective downlink adaptive beam-forming." The top authority [20] of TD technique said "The current application of SA technique is an initial state of multi-antenna technique. In the future it will become more powerful multi-antenna technique, which would have the functions of beam-forming, space-time multiplexing (i.e. MIMO) and SDMA." Therefore, it has been shown in those patents and articles that the research on SA in CDMA basically remains at the stage of theoretical research by mathematics, which sharply does not match the conclusion that SA has been widely used in mobile communication system for TD-SCDMA.

Owing to the difficulty in realizing the accurate phase-shifting in the radio frequency and the large output of side

