Performance Improvement Using Receiver Node Selection in Receiver Cooperative Downlink Systems

Jeongkeun Lee*, Taekyoung Kwon*, Yanghee Choi*, Jaewook Shin† and Aesoon Park†

*School of Computer Science and Engineering, Seoul National University
jklee@mmlab.snu.ac.kr, tkkwon@snu.ac.kr, yhchoi@snu.ac.kr

†Electronics and Telecommunications Research Institute, Korea , {jwshin,aspark}@etri.re.kr

Abstract

We examine the downlink of wireless communication systems with receiver cooperation. The cooperative utilization among closely-located receiver nodes is referred to as cooperative receiving, which behaviors similar to multiple-antenna receiving. To realize this, a group of receiver nodes are first to form a cluster, which necessitates a node selection algorithm. The operation of such node selection is conceptually equal to antenna selection in multiple-input multiple-output (MIMO) systems, except that selecting longer distance nodes requires higher cost in cooperation. We propose a few node selection algorithms appropriate for receiver cooperative downlink systems. Simulation results indicate that the performance of the node selection algorithms is significantly dependent on the distances among receiver nodes.

I. INTRODUCTION

Recently the idea of the multiple-input multiple-output (MIMO) antenna system is extended in a distributed fashion where a group of closely-located but separate nodes, each of which has its own antenna, can cooperate together to utilize cooperative receiving, similar to multiple-antenna receiving, among themselves [1]? 4].

The co-existence of various wireless communication technologies and their complementary feature is likely to equip a mobile node with multiple wireless communication interfaces. For example, suppose a person carries two mobile equipments that are a cellular phone and a PDA, both of which employ CDMA and Bluetooth interfaces. They can form a wireless personal area network (WPAN) using their Bluetooth interfaces. Now consider how the CDMA cellular interface can be utilized cooperatively. Note that the distance between the CDMA base station (BS) and the group of these nodes is in general much longer than the distance between the cellular phone and the PDA. Then, this group of closely-located WPAN nodes can form a cooperating cluster using their CDMA cellular interfaces and Bluetooth interfaces as well. The intra-cluster channel uses Bluetooth communications, while the BS-to-cluster (between the BS and the cluster) channel uses CDMA cellular communications. That is, the nodes in this cluster can cooperate to utilize their antennas as if their antennas belong to the same node, resulting in advantages of MIMO [6]. Note that intra-cluster communication used for node cooperation allows much higher rate transmission compared to the long-distance BS-to-cluster communication since its relatively short distance. The traffic flows between the cluster of wireless nodes and the BS, although receiver nodes cooperate on their receptions.

References [1], [2] consider node-collaborative signal processing, but with only two cooperating nodes. In our preliminary work [5], we generalize this two-node cooperation model by introducing an intra-cluster multiple access channel (MAC), which is a key factor to realize a cluster of multiple (more than 2) nodes.

Numerous MIMO antenna selection schemes (e.g. [8], [9]) that optimally choose a subset of the available receiver antennas have been proposed in original MIMO systems (multiple antennas in single-node systems) to reduce implementation cost due to multiple RF chains. Node selection (antenna selection in the above case) in the case of receiver node cooperation is an even more crucial issue because relaying cost is significantly dependent on the number of receivers within intra-cluster. That is, the intra-channel is noisy, which affects to cooperation gains compared to the multiple antenna receiving in the above single-node system case, where every antenna is directly and noiselessly connected to each others. Taking lessons from these, we propose a few node selection schemes and investigate their applicability in terms of the BS-to-cluster distance.

II. DOWNLINK COOPERATION MODEL

Now we present the system model being analyzed and derive the cooperative downlink capacity bound based on our previous analysis work [5]. For the sake of illustration, we will consider the infrastructure-mode wireless communications

This work was supported in part by the Brain Korea 21 project of the Ministry of Education, in part by the National Research Laboratory project of the Ministry of Science and Technology, and in part by the Electronics Telecommunication Research Institute, 2004, Korea.