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Smart Antennas for Wireless Communications for CDMA

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Abstract

Abstract— Smart antennas are the systems which are useful for wireless environment. Smart antenna systems may revolutionize future communication systems. So far, only the spectrum, the time and the code domain are exploited for communications systems. In the fast, from a signal processing perspective, most Wireless networks have been Single Input and Single Output (SISO), with the sequential nature of SISO signal processing serving as a bottleneck that limits performance. However, processing multiple signals simultaneously through smart antennas could lead to substantial performance improvement. Using this new approach, researchers are exploring multiple Input and Multiple Output (MIMO) wireless technologies to improve end-to-end network throughput of multiple flows relative to SISO antennas. Smart antennas are widely used in wireless mobile communications as they can increase the channel capacity and coverage range. The proposed research suggests solutions for wireless communications an example of mobile environment into consideration.

1. Introduction

The early days of wireless communications, there has been the simple dipole antenna, which radiates and receives equally well in all directions. To find its users, this single element design broadcasts omnidirectional in a pattern resembling ripples radiation outward in a pool of water. Smart antennas offer substantial benefits to the design of wireless mobile communications systems, which can be summarized as follows:

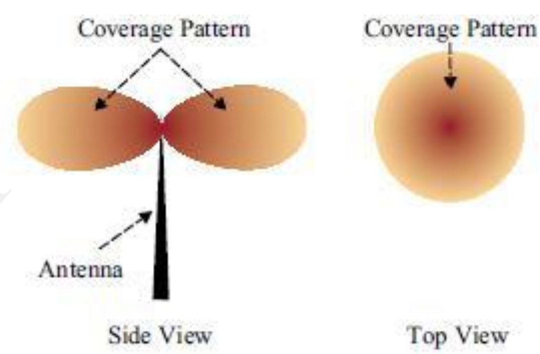

Fig.1: Sectorized Antenna System and Coverage Pattern

- **Interference Rejection:** Antenna pattern nulls can be generated toward interference sources. On the reverse link or uplink this reduces the interference seen by the base station. It also reduces the amount of interference spread in the system on the forward link or downlink. Such improvements in the carrier to interference ratio C/I lead to increased capacity.
- **Diversity:** composite information from the array can be used to minimize fading and other undesirable effects of multipath propagation. In addition to spatial and

polarization diversity, antenna arrays also allow the use of angular diversity.

- A smart antenna system combines multiple antenna elements with a signal processing capability to optimize its radiation and reception pattern automatically in response to the signal environment. Smart antenna systems are customarily categorized as either switched beam or adaptive array systems.

On most wireless networks today, all of the antennas are of the Single Input and Single Output (SISO) variety. However, since these antennas transmit and receive data omnidirectionally, in all directions simultaneously, a node causes interference among the nodes around it while it is trying to transmit data an experience interference from other nodes as it attempts to receive data. This interference is caused by the node's blocking of all other transmission in its range to prevent other nodes from causing interference while the data packets are being sent. Smart antennas would alleviate this problem, due to the fact that they can listen and send directionally. There is an extended range of transmission with smart antennas. With Multiple Input and Multiple Output antennas, there is also the additional functionality of high throughput, or the ability to send multiple packets at once. There are multiple antennas on a particular node, and each antenna can send a packet to the receiving node, increasing the amount data that can be sent.

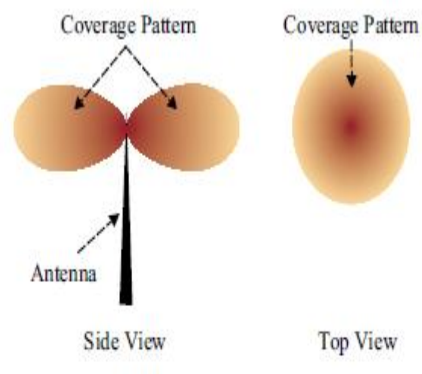

Fig.2: Omni directional Antenna and coverage pattern

2. SMART ANTENNA EVOLUTION

The advent of low cost digital signal and general-purpose processors and innovative algorithms have made smart antenna systems practical at a time where spectrally efficient solutions are in imperative. In the domain of personal and mobile communications, an evolutionary path in the utilization of smart antennas towards gradually more advanced solution can be established. The evolution can be divided into three phases:

- Smart antennas are used on uplink only. By using a smart antenna to increase the gain at the base station, both the sensitivity and range are increased. This concept is called high sensitivity receiver and is in principle not different from the diversity techniques implemented in mobile communication systems.
- In the second phase, directed antenna beams are used on the downlink direction. In this way, the antenna gain is increased both on uplink and downlink, which implies a spatial filtering in both directions. The method is called spatial filtering for interference reduction. It is possible to introduce this in second generation systems. In

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GSM, which is a TDMA/FDMA system this interference reduction results in an increase of the capacity or the quality in the system. In CDMA based systems, due to non-orthogonality between the codes at the receiver, the different users will interfere with each other.

- The last stage in the development is the full space division multiple access (SDMA). This implies that more than one user can be allocated to the same physical communications channel simultaneously in the same cell separated by angle. It is a separate multiple access method, but is usually combined with other multiple access methods (FDMA,TDMA,CDMA). This flexibility inherent in CDMA systems allows the interference reduction to be translated into either more users in the system, higher bit rates for the existing users, improved quality for the existing users at the same bit-rates, extend cell range for the same number of users at the same bit-rates.

3. PERFORMENCE EVOLUTION

In environments with locality of client demands, the use of multiple directional antennas at the broadcast server (BS) splits the client propagation to groups of clients that exhibit higher demand skewness. In such a system each antenna is equipped with a Learning Automation (LA) whose probability distribution vector determines the popularity of each information item among the clients in the service area of the antenna.

The topology of the proposed wireless push system is show in Figure 3, Consists of a large number of clients and BS equipped with a number of smart antennas.

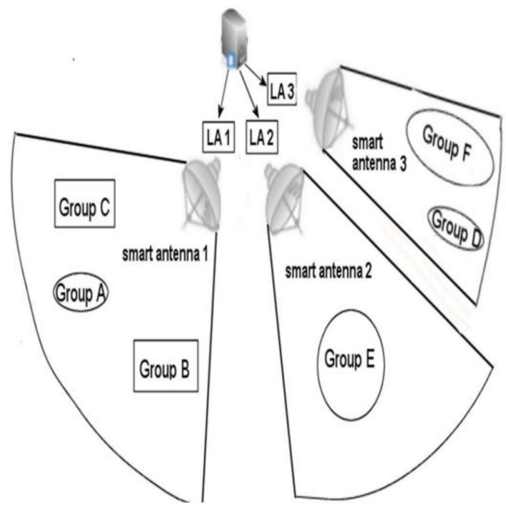

Fig. 3: Proposed Topology

The fact that the system is of a push nature means that the system clients do not possess the ability to explicitly submit requests for data items, thus each client will wait for the item it demands to appear in the broadcast program constructed by the broadcast server. In the proposed system, each antenna is equipped with a Learning Automation (LA) for the estimation of the demand probability of the information items that are broadcast to the clients under its coverage. A LA is an automation that improves its performance by interacting with the random environment in which it operates. LA have been applied to several problems in the area of wireless networks.

3.1 SYSTEM CONSIDERATIONS

The BS employs three smart antennas and the client population comprises groups A,B,C,D,E,F consisting of 100,150,150,100,300 and 200 clients respectively. The beam width of the three antennas and assigns groups to antennas in such a way that number of assigned clients per antenna is close to each other. The simulation runs until each antenna broadcasts M

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data items. The simulation results are obtained the following system parameters:

Numcl=5000, M=200000, L=0.15, alpha=10^-4,Num=20,lamda=0.1,Theta=0.5,l=10, mu=10,sigma=sqrt(5).

3.1.1 SIMULATION RESULTS

Observation 1:

In this we are discussing about some graphical representation of the system performance. Mean response time for various numbers of fixed antennas is compared with the smart antennas. As compared to fixed antennas, smart antennas are providing uniform distribution among the group of clients.

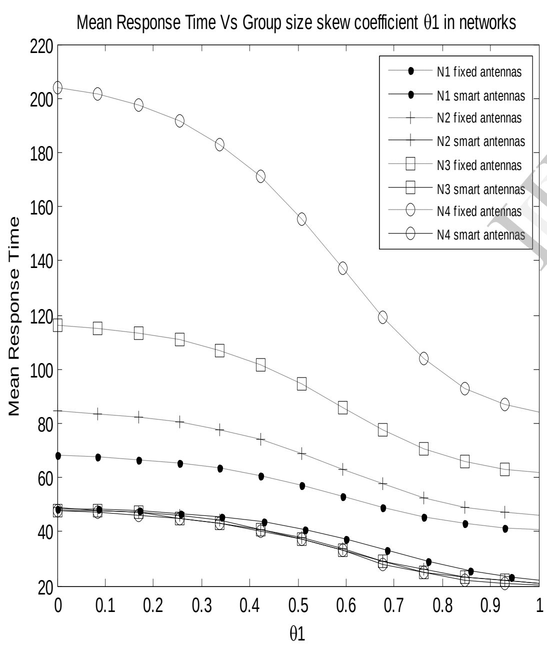

Fig.4: Fixed Antenna Vs Smart Antenna

Observation 2:

Next to comparison we can change the number of networks present in the system and we can check the system performance by calculating their corresponding mean response time. Here we consider five networks that use fixed antennas or smart antennas for its transmission. We compare the simulation results by using both antennas.

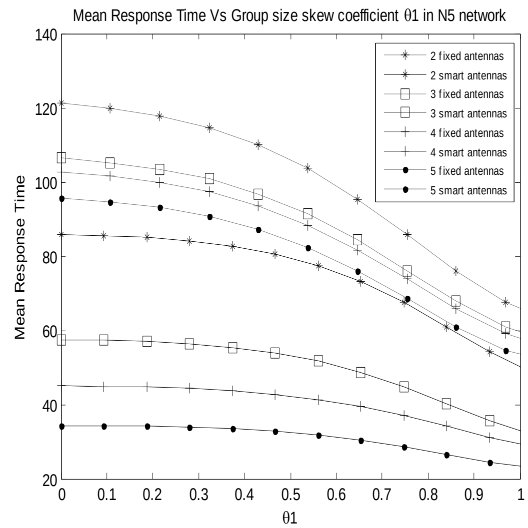

Fig.5: Fixed Antennas Vs Smart Antennas (Five Networks)

Observation 3:

we are discussing about the six networks that are using the smart antennas or fixed antennas for its transmission. And we compare the results by calculating the corresponding mean response time.

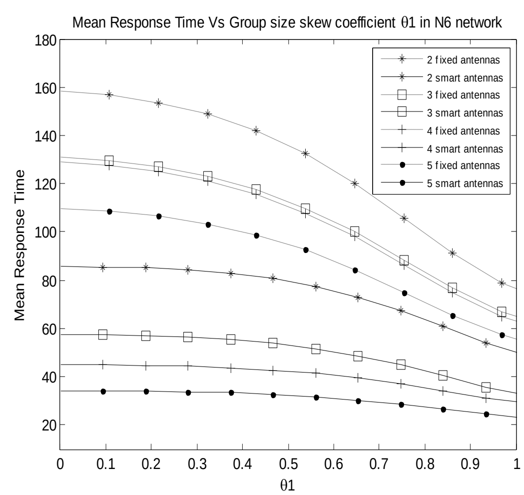

Fig.6: Fixed Antenna Vs Smart Antenna With Particular Network

Observation 4:

we are check the performance for various types of distributions. We use three different types of distribution techniques; they are uniform distribution, Poisson distribution, Gaussian distribution and Zipf distribution. And make this calculation we can check the performance of the entire system.

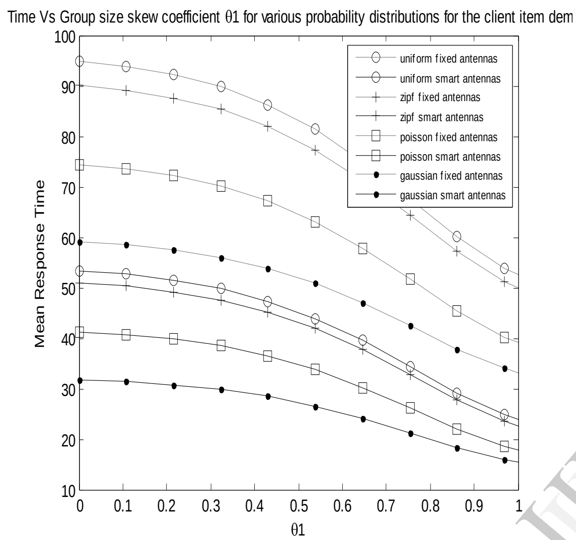

Fig.7: Fixed Antenna Vs Smart Antenna with Different Distributions

Observation 5:

we are check the performance for mobile clients. In this literature we are mainly discussing about both the fixed and the mobile users. So in this section we are discussing about the mobile clients.

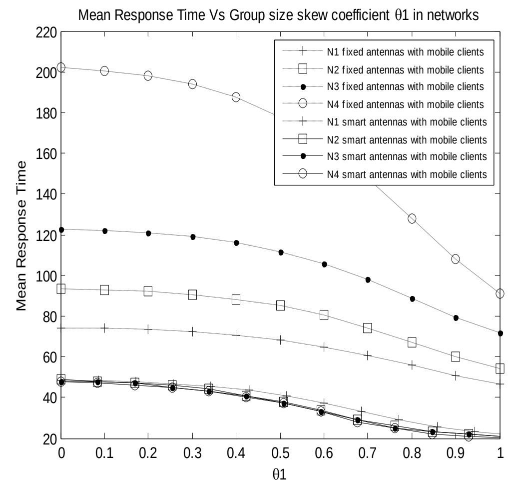

Fig.8: Fixed Antenna Vs Smart Antenna with Mobile Clients

Observation 6:

we are check the performance for different number of clients. In this literature we are mainly discussing about both the fixed and the number of users. So in this section we are discussing about the different number of users in fixed and smart antenna condition.

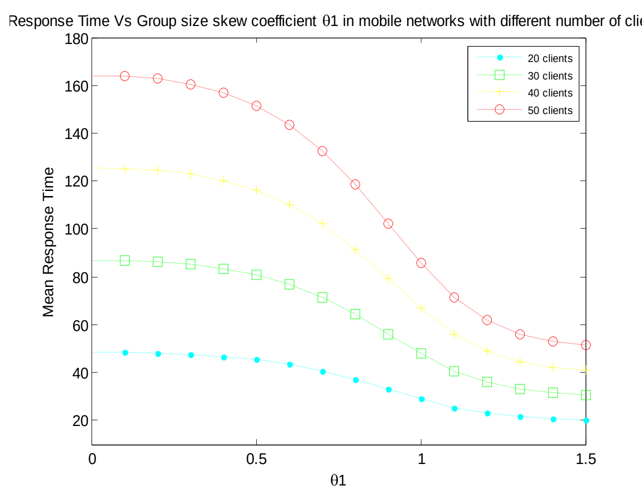

Fig.9: Fixed Antenna Vs Smart Antenna with Different number of Clients

4. CONCLUSION

Smart antenna and MIMO technologies have emerged as the most promising area of research and development in wireless communications, promising to resolve the traffic capacity bottlenecks in future high- speed broadband wireless access networks. A simple analytical model has been proposed, the results obtained using this analytical model had given good simulation results. Thus the analytical model can be used to rapidly calculate the smart antenna system performance under a variety of user and channel scenarios and is of value in the planning of smart antenna for urban and suburban areas.

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