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Enhanced Performance for Dynamic Wireless Environment via Integrated Push System and Femtocell

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Abstract:
This paper provides a, new design topology for wireless data broadcasting. At the Broadcast server, the use of smart antennas with alterable beamwidth to client location based wireless push system. Where data from the broadcast sever (BS) is transmitted to the user location area with respect to geographical distribution of clients with the help of learning automata, where modification is done at the receiver side by integrating with the Femtocell. The proposed scheme increases the speed of data broadcasting in dynamic environment observed at the client side.

Key words*: Data broadcasting, push system, smart antenna femtocell, interference, Learning automata*

1. Introduction

Data broadcasting is the most efficient way of information dissemination in dynamic wireless networks. However, due to the increased population demands, in both outdoor and indoor networks, the QOS expected by the user, are not attained in many networks.

In many asymmetric networks, smart antenna is equipped at the transmitter side with the broadcast server, by that alterable beamwidth is provided to the client location area. But in such systems, even though locality of demand is exploited so that the geographical distribution of the client is known and learning automata is equipped at the broadcast server to estimate the demand probability, required data service is not achieved if the user or group of user is working into a closed region. Many wireless networks provide less indoor coverage due to high frequency that has more attenuation, path loss and fading effects. So to overcome such drawbacks, a modification is done at the receiver side. Where the technique used is alterable beamwidth with beamforming.

Beamforming is a technique, where there are demands, in that particular region only beamwidth is provided and in other places steer null, where locality of demands is exploited. By the use of array antennas and locality of demand the QOS to the user is still more increased.

This letter proposes to use smart antennas, at the transmitting side of the broadcast server and deploy of femtocell at the receiver end. By exploiting this property the beamwidth of the antenna is alterable according to the user location area and data is transmitted in a form of push architecture, so by this data transmission rate to user is increased. But in some case if the groups of user are operating in an indoor system means required quality of service is not attained due to multipath fading effects and path loss. So to combat the problem, the beamwidth from smart antenna is given to femtocell base station and from femtocell base station it's broadcasted to the users for that particular system area. In this system topology, high quality of service is attained, observed at the client side by overcoming multipath fading by the use of integrated wireless push system with smart antennas and deployment of femtocell.

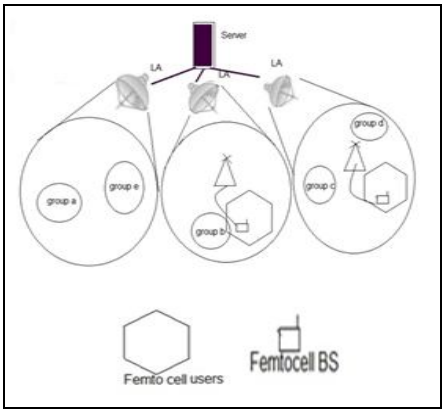

Figure 1: New network topology for wireless enhanced performance

2. Characteristics of System

In figure 1 the topology of new network for enhanced wireless system is shown. Which consists of a large number of users grouped according to their demands and an indoor users integrated with femtocell base station, where broadcast server equipped with number of smart antennas according to system design. Push systems provides good scalability and hardware simplicity at the client side. A pure-push system can't operate efficiently in dynamic environments. But adaptive wireless push system can operate efficient in dynamic environments with priori-unknown to client demands by the use of LA [8], which is used to estimate the demand. The system is of push means, the client need not ask for the demand item [10], every time the system architecture will provide the item in a high data rate to the user.

Where beamforming, methodology is employed by the smart antenna at the broadcast server, so that the beamwidth from the antenna is transmit to the particular client location area residue [1], and steering null in all other direction. By this way clients located in other regions will not receive any transmission from the broadcast server. This beamforming and user location tracking can be implemented in an efficient manner by the use of smart antenna technology [7], and it further supports space division multiple access. The system can work with any kind of smart antenna equipped with broadcast server, the antenna which is capable of providing alterable beamwidth [14], to the client location area with push architecture. Antennas such as switched beam, adaptive array ones, and MIMO antennas can be deployed depending upon the application. In switched beam antennas number of fixed beam radiation patterns are employed and depends upon the application which beam to access at a given point of time. Adaptive array antennas are able to steer the antenna beamwidth [1], to any point of direction to the user location.

In this wireless push system, with broadcast server and smart antenna the learning automata are equipped, for the estimation of the demand probability of the information item of the user according to the geographical distribution of the client. This LA improves the system opera-ability by involving with the random environment. And also this LA is applied in different areas of networks like wireless sensor networks, mobile ad-hoc networks, and in adaptive MAC protocols [1], [4], [5].

In the receiver side the users are grouped into groups according to their demands, where the user or users can has direct line of sight or an indoors, and the client groups exhibiting locality of demand and clients equipped with GPS receiver.

Femtocells are very small, low cost base stations and their maximum allowed transmit power level is low. Femtocells are even smaller than nanocells but the biggest difference is not the size of the cell. The devices are integrated to small desktop or wall mount cases and are installed to the customers' premises by the customers themselves. As the femtocells are installed indoors they will certainly help in achieving better indoor coverage at least in their close proximity. People living in rural areas can use them to gain better coverage. Femtocells will also give some additional network capacity due to the small cell size and reduce the load of the macro cells.

2.1. Broadcasting algorithm, cost function and stochastic dual control

In wireless push system the smart antennas are equipped with LA, [9] that contains the estimated value of server and demand probability. [1]

$$\sum_{i=1}^{N} p_i = \sum_{i=1}^{N} d_i = 1$$

Where p_i and d_i are the server estimate and demand probability of the data item i. Estimation of the cost function from the broadcast server to transmit the data item i to the user $G(i) = (T - R(i))^2 \frac{p_i}{l_i}\left(\frac{1+E(l_i)}{1-E(l_i)}\right)$, in this cost function T is the current time, R (i) is

the time when i was last broadcast, l_i is the length of the item i and E (l_i) is the probability that an item of length l_i is erroneously received. [1].

We observe that real-time and precise control of the femtocells in a highly dynamic and uncertain environment is not strictly possible, although near-optimal solutions may be found in practical situations, to find out a proper coordination of the system, we solve the optimization problem by using a wide-sense adaptive Dual Control approach, which has been shown to be very effective in rapidly solving highly stochastic processes with uncertain inputs and measurements. The problem of reducing interference can be considered as a reinforcement learning problem, whose goal is to moving toward solutions with the lowest interference

Taking a mobile phone user as an example, the user may think of a move in a particular direction or make a call in a particular place as being reinforced if the signal reception can be improved or when a call from that place is successful, thus leading the mobile user to increased probability via that direction or that place, by implementing the stochastic dual control so that the femtocell base station(FBS) increases the probability of scheduling channels with lower first-order and second-order interference characteristics.

3. Integrated Push, Femtocell and Array Antennas

The wireless push system with smart antennas at the broadcast server efficiency is not fully exploited due to the multipath fading in the system coverage area. So to overcome the problem, this paper proposes the use of femtocell at the receiver side, by this efficient coverage area of the system is attained. The operation of the system begins at the broadcast server, by sending a control packet to its coverage region. By sending a packet that triggers the group of user to send a feedback, depending upon the feedback the broadcast server decides whether to transmit the beam-form to that particular region or not within the system coverage area.

Here two cases exist, case-1 where the groups of users are grouped according to their demand directly to the broadcast server antenna. More over here, the quality of service will be good compared to older antenna system. Where in case-2 the group of users are located inside a closed region so multipath effects will be more, ensured QOS will not be achieved, hence to attain more QOS, beamforming is used. From the broadcast server the data is transmitting to the client location area. Compared to the multiple antenna system with learning automata this system performance has more QOS. By this high QOS service is attained with high data rate to the users.

3.1. Interference

The Femto have studied many femtocell to macro cell, macro cell to femtocell and femtocell to femtocell interference scenarios. These studies have been particularly focused on the co-channel operation because of its importance. The required adjacent channel selectivity of 33dB in terminals is enough to prevent the most extreme interference scenarios if the femtocells are on a dedicated carrier.

4. Performance Evaluation Using Interference Analysis

4.1. Performance of Smart Antennas

We consider the broadcast server equipped with three smart antennas each one having different coverage region.

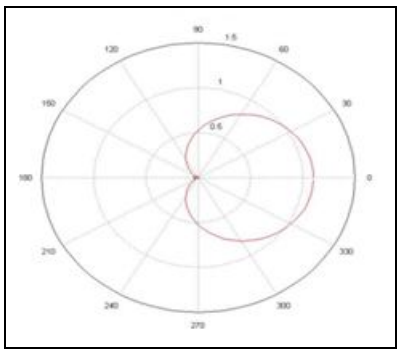

Figure 2: Radiation pattern of smart antennas

Figure 2 illustrates the beamforming technique of smart antennas where beam-form is created in a region where there is demand and steer nulls in other direction.

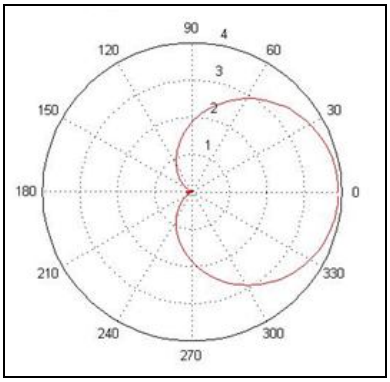

Figure 3: Radiation pattern of the smart antennas

Figure 3 illustrates, beamforming of array antennas where the beamwidth is given to desired region, where number of array antennas used are four with an operating frequency of 8MHZ, and angle of incidence of desired source signals are 90 degrees and 120 degrees. And steering nulls in other direction parallel.

4.2. Interference Analysis in Macrocell

Considering the users directly connected to broadcast server with input parameters, where cross polarization is 15dbs (XPD) In circular polarization the signal moves in a circular fashion (O) with either left-handed or right-handed rotation, if user moving in a speed of 60km/hour the connection establish to user is possible. And drops are considered with two attempted, that is the connection establishment to user trail takes place two times then it's dropped. In cluster transmission, nodes are grouped into clusters and one node which is cluster head is responsible of sending other nodes data to the sink like -wise here number of cluster path consider(N) is 6, with a carrier frequency of 2Ghz

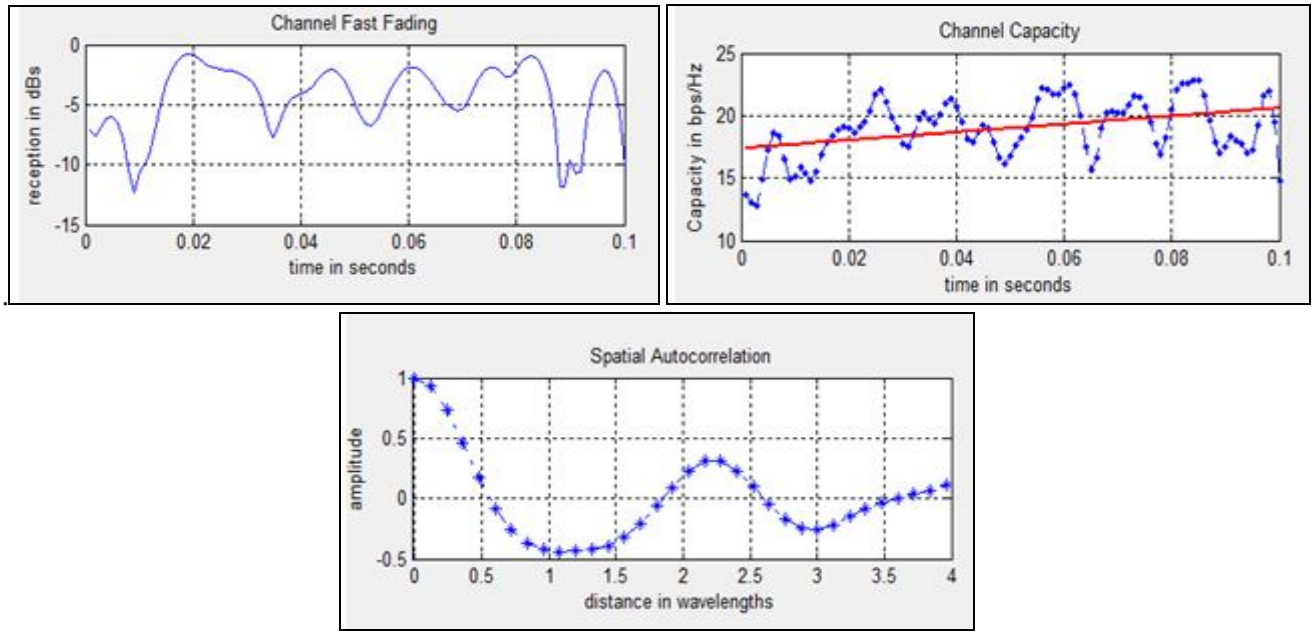

Figure 4: Interference Analyses for Macrocell Users

4.3. Interference Analysis in Femtocell

Consider the users in closed region are integrated with femtocell region to overcome the fading, but the main problem over here is interference. The interference between two user networks that is macrocell users and femtocell users, this problem have been overcome by the use of stochastic dual control. Now in figure consider the channel capacity the average value is in-betweens 20 to 25, an improvement in channel capacity. And the channel fast fading average value is in-betweens -5 to -15, and the spatial autocorrelation process shown with respect to amplitude and distance in wavelength. So the analysis of user's performance is improved by the use of femtocell.

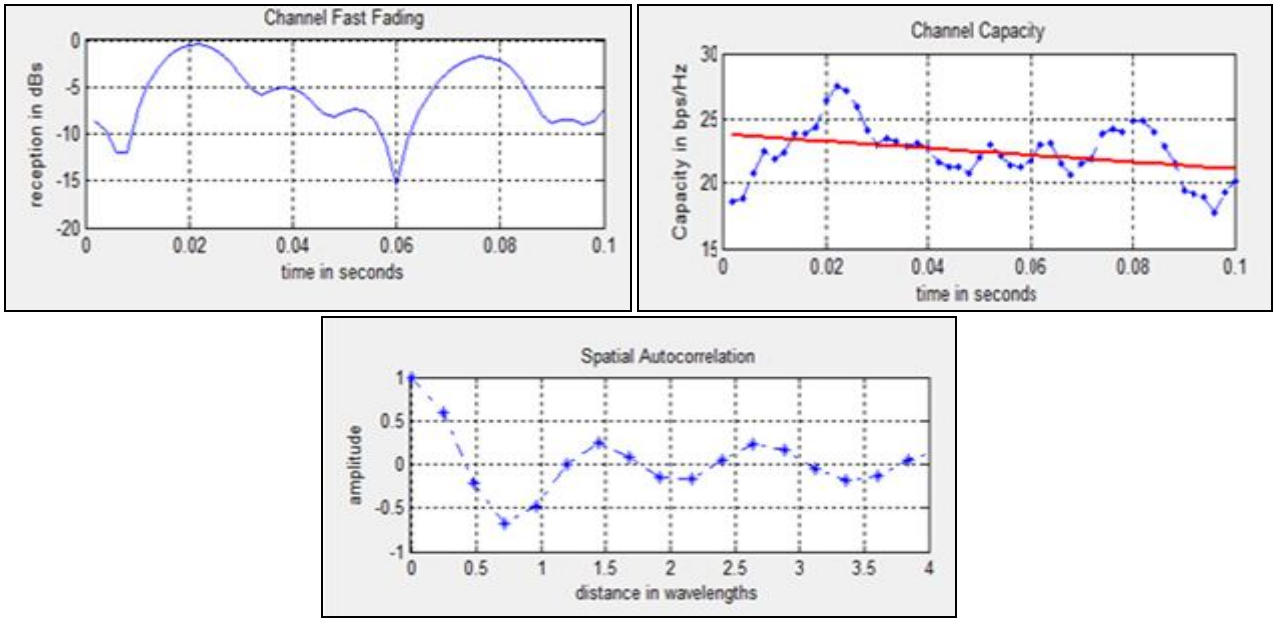

Figure 5: Interference Analysis of Femtocell Users

4.4. Interference Analysis with Interference Added in Femtocell Region.

In figure 6 the result shown analysis of interference added in femtocell region that is if interference occurs in femtocell region also the performance will be good. The channel capacity is in-between 20 to 25 and its peak value is reaching 30bps/Hz. And similarly the channel fast fading value reaches more than -15dbs with respect to time. The power delay profile performance is good and autocorrelation of a process also, so performance of the femtocell region with interference also good by the use of stochastic dual control.

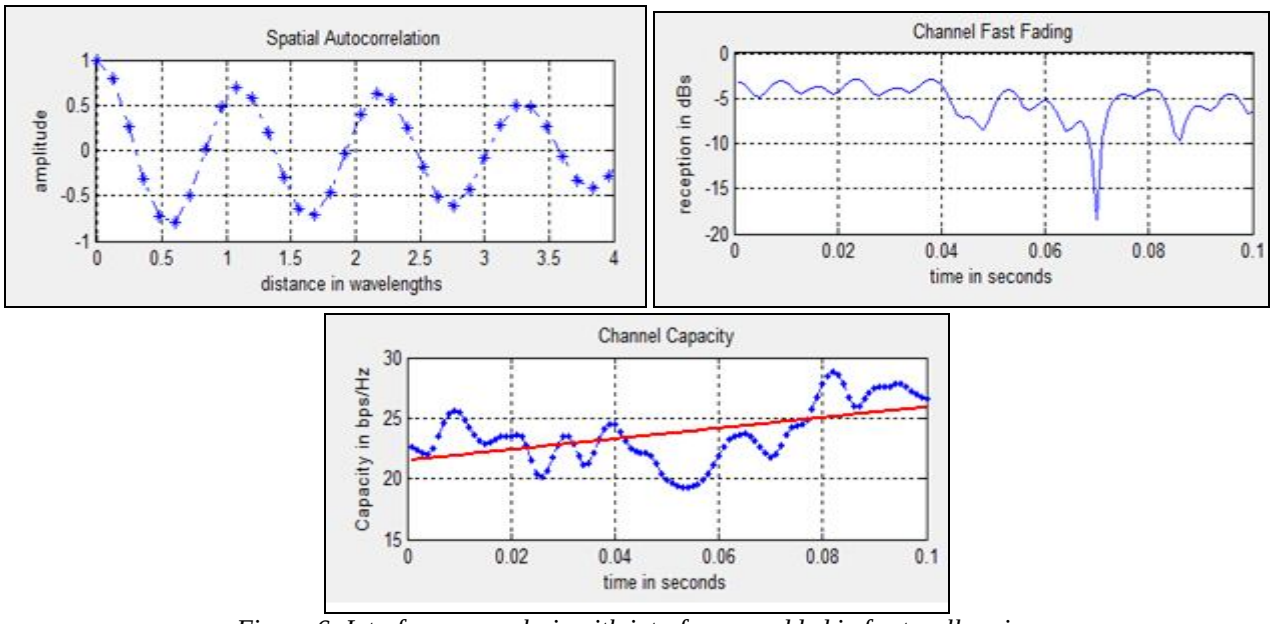

Figure 6: Interference analysis with interference added in femtocell region

5. Conclusion

This letter proposed An enhanced performance for dynamic wireless environment through integrated push system and femtocell, where alterable beamwidth from smart antenna is given to the femtocell base station, from their it's transmitted to the users in indoor with the help of stochastic dual control. So the system coverage area will be in an efficient manner to attain the required quality of service. Simulation result proves that the proposed system provide more QOS when compared to the system of [1] that employs smart antennas without femtocell coverage.

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