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QoS improvement for indoor high speed data traffic deploying collaborative agent based smart uplinking LTE algorithm

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Abstract: *In recent years, femtocells play important role in providing better spectral efficiency to meet out growing wireless communication traffic. The system proposed in this work attempts to provide higher QoS at heavy traffic condition using WiMax uplinking and smart antenna system. The reference signal for steering nulls towards interference and channel state information are provided by an external middleware based mobile agent. Suitable simulation is carried out to provide higher quality of service in terms of throughput, Bit Error rate (BER) and spectral efficiency. Simulation experiments indicate that an effective isolation of indoor traffic is carried out using femto cells and intelligent WiMax uplinking with the required quality of service.*
Wireless uplinking, agent based uplinking – smart antenna wimax, indoor qos improvement

I. Introduction

The popularity of radio access technologies resulted in fast growing service demands among mobile users. Ubiquitous mobile broad band coverage is the current requirement for service operators [1]. The heavy traffic load with limited resources with higher demand environment given birth for new techniques in the present generation systems. In cellular mobile communication, the evolution of separating indoor services from that of outdoor ones is becoming important. This is because indoor traffic has grown beyond 75% of the total traffic in fourth generation mobile personnel communication as well as in mobile computing [2]. The growing demand for higher rate and heavy traffic, demands maximization in spectral efficiency. Femto cell configuration has appeared as the timely solution for high rate and high QoS to indoor traffic. In recent years, researchers have established that multiple femto cells can cooperate and improve system performance to a greater extent [3].

Femto cell topology reduces the distance between sender and ASP leading to capacity improvement. Low signal power adapted results in decrease in the interference to neighbouring cells. It also can devote large portion of resource for fewer users and frequency reuse within small range. Developing an intelligent network management with fast resource optimization in macro cell and femto cell topology is the talk of today's cellular concept. The access points for femto cells need to be arranged to match the broadband operation of femto cell channels. In this work a WiMax link is proposed with transmitter and receiver diversity along with feedback control mechanism for reducing BER. Adaptive techniques by deploying smart antenna have matched the adverse communication characteristics of linking femto cells to operators entering control stations. Collaborative middleware incorporated mobile agents provide intelligent network operation in radio resource management. Mobile user within a residential location gets connected through a Femto cell Access Point (FAP). The operators resource managing station is connected by a suitable WiMax wireless connection with Femto cell Access Point for switching.

Recently query languages have been developed for signalling between middleware and the main communication system [4]. Employing this technique, collaborative receiver functioning is achieved. This kind of system management enhances the error rate performance along with the minimization of power consumption and delay in the hardware used in the Wimax linking.

II. Proposed System

To meet out the growing needs of heavy capacity based reliable uplinking, a new communication configuration is proposed in this paper. The system configuration is presented in Fig1. It consists of small cell topology within a building [5]. It reuses the whole cellular mobile communication system spectrum and adopts WCDMA for multiplexing the multimedia information of the user inside a building. Such a linking system is shown in fig 2, where WiMax linking with the operator's control station is employed. As femto cells reuse the outdoor spectrum, there is a possibility of co channel interference from adjacent femto cells. To avoid this happening, Smart antenna is deployed (Fig 3). These antenna systems are supported by a mobile agent, which collaborates with it in providing channel state information in terms of reference signal for adaptive beam forming.

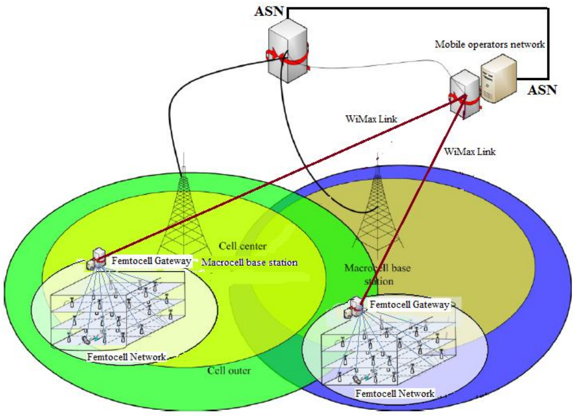

Fig 1. Proposed System

The referenced signal consists of information regarding i) Direction of Base Station, ii) Channel fading Information, iii) Noise Level Status, and iv) Distance of Travel Information. Using these parameters, the multivariable adaptive processor maximises the radiation towards desired direction while avoiding the side lobes and back lobes. The multivariable antenna element vector is controlled in real time to achieve the desired functions. The diversity based on Almouti Principle inbuilt in the MIMO topology of smart antenna system provides the fading free reception at the femto cell access points (FAP) [7].

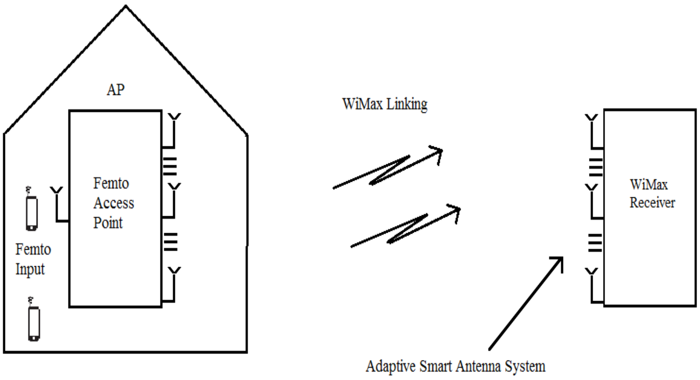

Fig 2. WiMax Linking

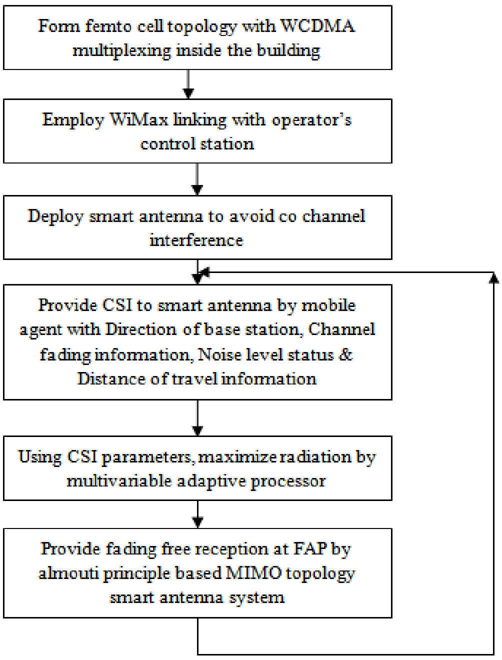

Fig 3. Process involved in the proposed model

III. Smart Antenna Algorithm

Pseudo gradient algorithm is of the form

$$W_{k+1}=W_k+\frac{a_k}{b_k}\sum_{i=1}^{l}\{\varepsilon_l(w_k+b_k u_k)^i-\varepsilon_l(w_k)\}w_k^i \qquad (1)$$

where ε_l (k) is finite time estimate value of mean square error at a weight vector. The difference between the estimated and the actual value of ε_l is called the undesired signal component. The numerical coefficient b_k is the length of the trial step where a_k is the length of the working steps. This coefficient tends to zero from large value of k as per the adaptation algorithm. l is the number of random vectors used per iteration. It is arranged that U_k^i is oriented such that for each hyper plane, there exists a non-zero probability that U_k^i will appear outside it or equivalently, the covariance matrix of U_k^i is non-singular. This particular condition holds good in space, if U_k^i has a positive dissipation density on some bounded convex surface for which zero is an interior or a surface point. Another example in which the condition holds in the random coordinate descent, in which unit vectors with probabilities greater than zero taken as U_k^i. Other conditions to be satisfied for convergence are i) The undesired signal component estimates of mean square error has zero mean value and is not correlated with U_k^i during all iterations ii) The distribution of U_k^i have finite j^{th} moments for j=1,2,….6. This condition ensures that U_k^i remains a finite vector without excessively large values of its components, iii) the undesired signal in the estimate of mean square error has a bounded variance for all iterations. Random search adaptive processor (Fig 4) which happens to be a microcontroller with suitable operating system generates and injects required vectors at the appropriate time instants [8].

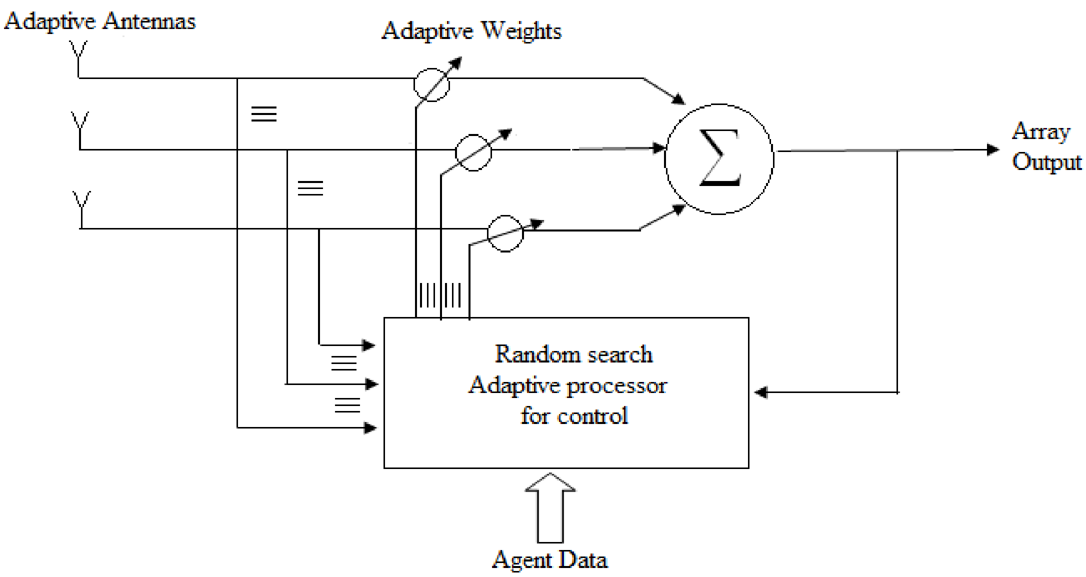

Fig 4. Proposed System – Adaptive Smart Antenna Configuration

The algorithm deployed matches the femto cell environment is using the WiMax (LTE) linking. The Rayleigh density distributed undesired information matches the statistical nature of the pseudo gradient algorithm.

Table 3.1. Parameters used for simulation

Multiple access method	OFDMA, Synchronous TDMA combined with FDMA
Duplex method	Time Division Duplexing
Number of TDMA channel	4
Number of OFDMA channel	16
Operating channel bandwidth	20 MHz
Subcarrier frequency spacing	37.5KHz
Number of FFT points	512
Frame duration	5ms
Number of slots	8 slots, Downlink & Uplink simultaneously
Modulation method	QPSK / 16 QAM, Autonomous decentralized channel
Peak channel	9.85 Mbps
Transmission rate	10 Mbps

IV. Middleware Architecture

The middleware in the uplinking (Fig 5) is providing three services for i) Security, ii) Routing, iii) Channel State Indication. In this particular application, channel state information in terms of angle of arrival for desired and undesired signal are sensed and details sent to the adaptive processor along with channel state condition[9]. At the agent layer, essential perceptions are carried out to provide information for various services. Multifunctional embedded layer converts the information to a suitable form for the cellular protocol using real time manager. This function is achieved with the help of the required hardware at the physical layer [10].

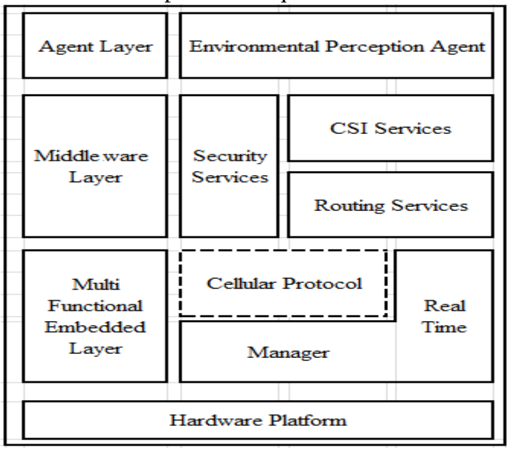

Fig 5. Middleware Architecture

V. Simulation Results

To evaluate the performance of the proposed system, simulation experiments were carried out. The channels adopted WCDMA, OFDMA and IS 95 standards along with the proposed algorithm improvements. Parameters used for simulation are shown in table 3.1. The simulation results are presented in fig 6 to 11. Fig 6 depicts the effectiveness of the pseudo gradient algorithm adopted in steering the nulls towards undesired interferences and maxima towards the desired signal. Fig 7 illustrates the minimization of fading with multiple antenna array system at the transmitter and at receiver. From the figure, it is evident that the dynamic variation in the signal strength with time gets reduced with the multiple antenna system used at the transmitter and at the receiver. In fig 8, the effect of throughput reduction due to the increase in the simultaneous use of the link is established. Here it can be noticed that decreasing nature of throughput with number of users, is less with the proposed algorithm. This is due to the spectral reuse with the indoor user of the femto cell topology where broad band CDMA is deployed along with OFDMA.

The proposed system performs well with high data rate compared to the existing one as shown in fig 9. This is due to the performance of WCDMA along with OFDMA and smart antenna system. The adaptive system with smart radiation resulted in higher signal to noise ratio which provides higher bit rate with the help of higher capacity WCDMA and OFDMA techniques. Fig 10 illustrates the performance of the proposed algorithm with the improvement of throughput with increase in the number of elements of the smart antenna system. This behaviour is noticed at the higher bit rate and traffic conditions. Fig 11 indicates the improvement on BER and fig 12 provides the improvement in the voice spectral efficiency with the fraction of satisfied mobile stations in %. Θ

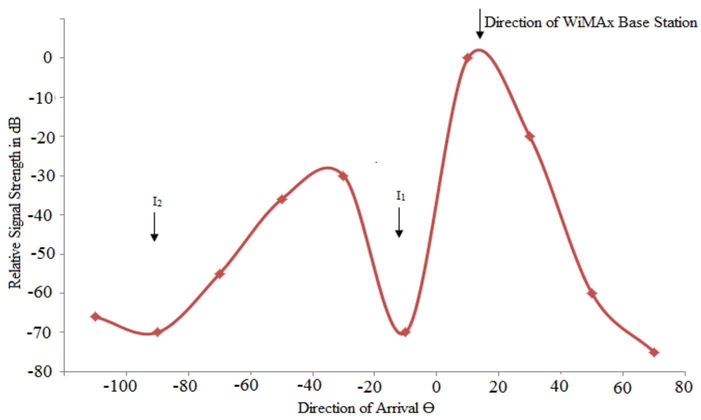

Fig 6. Effectiveness of Pseudo gradient adaptive algorithm in maximizing the desired information

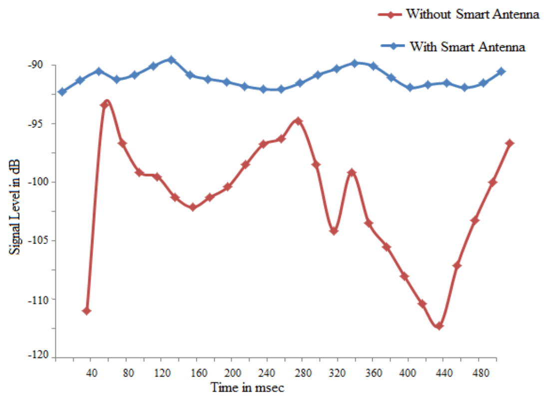

Fig 7. Minimization of the effects of Fading

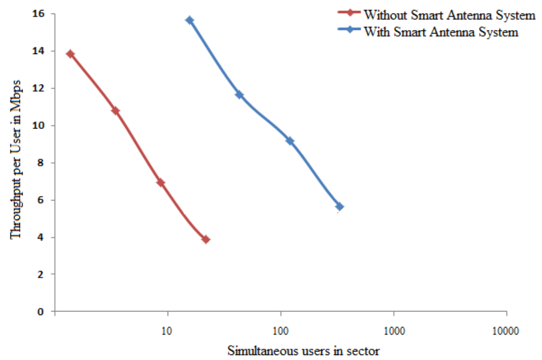

Fig 8. Improvement of throughput in the proposed uplinking

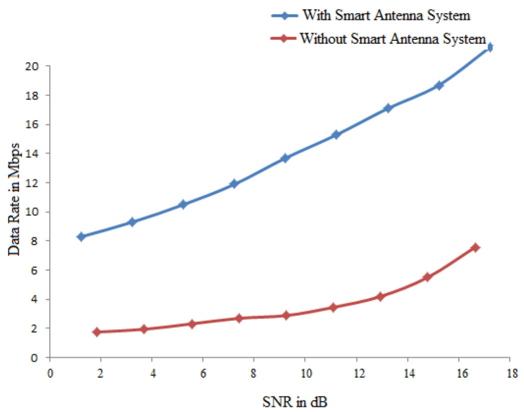

Fig 9. Improvement of Data rate performance

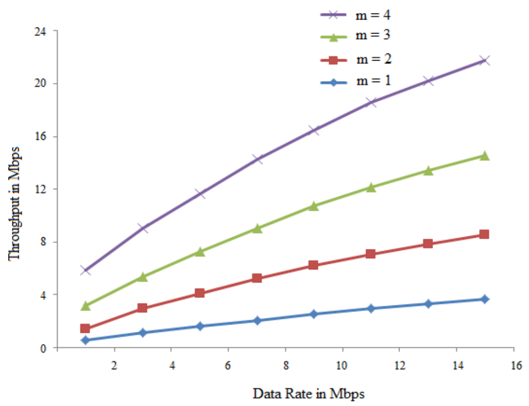

Fig 10. Improvement of throughput with higher data rate

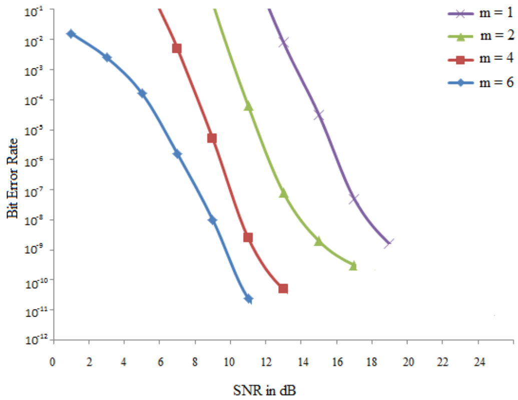

Fig 11. BER improvement with the proposed uplinking

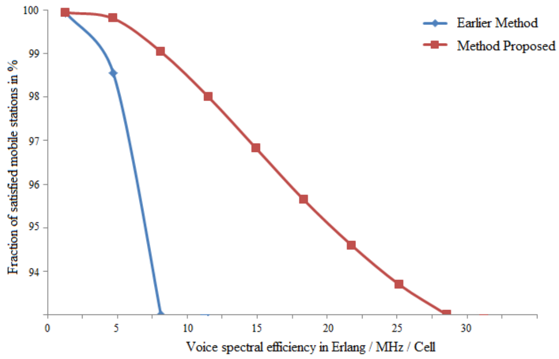

Fig 12. Improvement of voice spectral efficiency with the proposed uplinking

VI. Conclusion

The proposed collaborative agent based WiMax (LTE) uplinking with pseudo gradient adaptive smart antenna system has been discussed in detail for its performance at heavy traffic condition. The simulation results have proved that due to reduction in outage higher throughput with enhanced SNR was noticed with the proposed algorithm. The effectiveness of the pseudo gradient algorithm in maximising the desired information, minimizing the effect of fading, improvement of throughput, data rate and BER are proved through the simulation results. In future works, the use of mobile agents both for femto cell and macro cell can be tried along with load balancing techniques.

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