4G-LTE Smart Phones using Multi-Cell MIMO

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***Abstract*—This paper provides in-depth view on the technologies being considered for Long Term Evolution (LTE). In 4G-LTE Systems downlink soft handover scheme has developed for cell edge users. To avoid capacity loss this scheme has used multi-cell MIMO with multiple base stations. In the proposed scheme, different multi-cell MIMO transmissions are adaptively exploited based on the spatial correlation of a downlink channel and path loss of adjacent cells by comparing ergodic link level capacity. Unlike single-cell adaptive MIMO transmission, the proposed scheme optimizes the subset of antennas from two or more base stations to exploit the spatial decorrelation. Numerical results show that the proposed handover scheme significantly improves the cell edge capacity over the single-cell adaptation in the presence of spatial correlation particularly for handover regions.**

Keywords: 4G, LTE, Multi-Cell MIMO.

I. INTRODUCTION

In recent years a substantial increase in the development of broadband wireless access technologies for evolving wireless internet services and improved cellular systems has been observed. It is widely foreseen that in the future an enormous rise in traffic will be experienced for mobile and personal communication systems. This is due to an increase in number of users and introduction of new high bit rate data services. This trend is observed for second-generation systems as well and it will most certainly continue for third-generation systems. The rise in traffic will put a demand on both manufacturers and operators to provide sufficient capacity in the network, this becomes a major challenging problem for the service providers to solve. There are certain negative factors like co-channel interference and fading in the radiation environment contributing to the limit in the capacity. Smart antenna is one such development in this direction to full fill the feature requirements of mobile networks.

[1] Smart antenna: Smart antenna locates the direction of Signal of Interest (SOI) using Direction of Arrival (DOA) algorithm. The two basic functions of any smart antenna are:

(a) Direction of Arrival (DOA) Estimation and
(b) Adaptive Beamsteering (ABF).

DOA estimation is one of the most important techniques in both mobile communication systems and audio/speech processing systems. Direction of Arrival is defined as the direction along which the desired signals arrive. The function of the DOA algorithms is to work on the signal received at the antenna array elements and compute the direction of arrival of all incoming signals that include desired user signal, interfering signals and multipath signals.

ABF is a technique in which beam is steered along the direction of the desired signal, while a null is generated along the direction of the interfering signal. This is done by ABF by dynamically updating the complex weights with the help of adaptive algorithms.

[2] Problem Formulation: The mobile communication system at base stations should use spatial filtering techniques in order to increase the channel capacity. This can be achieved by using Adaptive antenna system at base station. Adaptive antenna system works on two algorithms DOA and ABF, these algorithms have to be optimized in order to achieve better performance.

Based on the objectives, the project problem is chosen as ***" Simulation of Beam forming for High Altitude Airborne Systems",*** which involves simulation of ABF, algorithms and comparing their performances.

[3] Previous Approach: In the previous 3G Networks the mobile user was detected by computing the power spectrum based on the value of Array correlation matrix and then finding the inverse of the array correlation matrix. As the number of antenna elements increases the magnitude of the array will become closer to zero and then the inverse of array correlation matrix will be infinity and also when the radiation is transmitted towards the mobile users the phase shifts will be applied to each of the individual elements. The phase shifts will depend upon on the inverse of the array correlation matrix and the radiation will be spread across entire space due to which even interference users will get the radiation.

[4] Current Approach: In the project 4G network based mobile user detection is performed using subspace computation of the array correlation matrix When the radiation pattern is formed it forms the main beam towards the desired mobile users and nulls or reduced radiation towards the interference users. The beamforming is done in such a way that the Mean Square error is very less in case of 4G LTE network. Also in order to improve the convergence and capacity of 4G networks variable step size algorithms are used for beamforming.

[5] Work of project: [1] Design & Simulation of Beamforming algorithm using 3G LTE for directing

radiation towards the desired mobile users and nulls or reduced radiation towards the undesired mobile users.

[2] Design & Simulation of Beamforming algorithm using 4G LTE for directing radiation towards the desired mobile users and nulls or reduced radiation towards the undesired mobile users which makes using a fixed step size such that the MSE is less.

[3] Design & Simulation of Beamforming algorithm using 4G LTE for directing radiation towards the desired mobile users and nulls or reduced radiation towards the undesired mobile users which makes using a variable step size such that the MSE is less and also the convergence is improved.

[4] Design & Simulation of Capacity computation for 4G LTE systems.

[5] Comparison of 3G LTE beam forming, 4G LTE fixed Step Size beam forming and 4G LTE variable step size beam forming algorithms**.**

II. SYSTEM MODEL AND LINK LEVEL CAPACITIES:

We consider the MC downlink MIMO system model with two base stations (BS's), each employing M transmit antennas. The results can be generalized in a straightforward manner to multiple BS's. It is assumed that a mobile station (MS) has N□M receive antennas and selects M transmit antennas from $2M$ BS antennas. We also assume equal transmit power from each BS and each antenna and consider a flat Rayleigh fading
channel. The channel correlation is assumed to have the Kronecker structure and the channel between different BS's is assumed to be uncorrelated since the BS's are geographically separated.

III. DOWNLINK SOFT HANDOVER USING MULTI-CELL MIMO:

Fig. 1 shows the basic concept of the proposed downlink soft handover scheme. The proposed scheme can be sorted into soft handover because a mobile station can keep a connection without discontinuance by MC MIMO in handover region. In the conventional hard handoff scheme, a handover user switches its connection from a serving BS to a target BS based on the received signal strength (RSS). However, the proposed handover scheme chooses an antenna set from a serving and neighbor BSs and adaptively applies MC MIMO modes to handover users based on the spatial correlation and path loss of serving BS and neighbor BSs. Note that these channel information required in the proposed handover scheme can be gathered through the simple extension of typical channel estimation procedure of the conventional handover scheme. Moreover, the proposed handover adopts a statistical switching in which the fast BS cooperation is not required among a serving BS and neighbor BSs. Therefore, the proposed handover scheme is efficient and feasible to apply into the current 4G-LTE systems with minor revision of standard. The overall handover procedure of the proposed scheme is almost same except a MC MIMO mode-switching procedure.

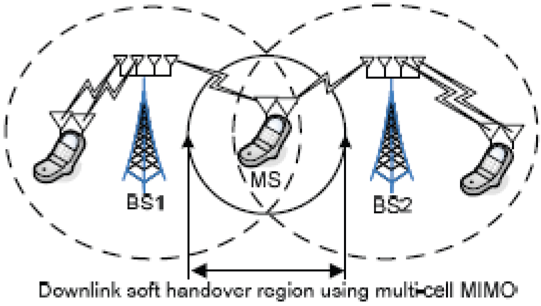

Fig. 1. Downlink soft handover using multi-cell MIMO

IV. BEAMSTEERING ALGORITHM:

Beamsteering is signal processing technique used in sensor arrays for directional signal transmission or reception. The spatial selectivity is achieved by using adaptive or fixed receive/transmit beamformer units. Beamsteering can be used for both radio or sound waves. It has found numerous applications in Radar, Sonar, Seismology, Wireless Communication, Radio Astronomy, Speech, Acoustics and Biomedicine. The main objective of this spatial signal pattern shaping is to simultaneously place a main beam toward the Signal-of-Interest (SOI) and ideally nulls toward directions of interfering signals or Signals Not of Interest (SNOIs). The goal of Beamsteering is to isolate the signal of the desired user from interference and noise. The weights of the filter are continuously changed and are adapted according to the received signal. Such adaptive filters attempt to filter out jammer signals, which are received by the sensors from directions other than the selected signal source.

V. SAMPLE MATRIX INVERSE (S.M.I):

SMI is used if the desired and interference signals are known before or have been estimated. This provides the direct and fastest solution to compute the optimal weights. However, if the signals are not known exactly, then signal environment undergoes frequent changes. Thus, the signal processing unit must continuously update the weight vector to meet the new requirements imposed by the varying conditions. The weight vector must be updated without a priori information which, leads to estimation of covariance matrix R_{xx} and cross-correlation vector r_{xs} in a finite observation interval given by equations.

$$R_{xx} = E[X\,X^H]$$
$$r_{xs} = E\left[XS^H\right]$$

1. SMI Algorithm

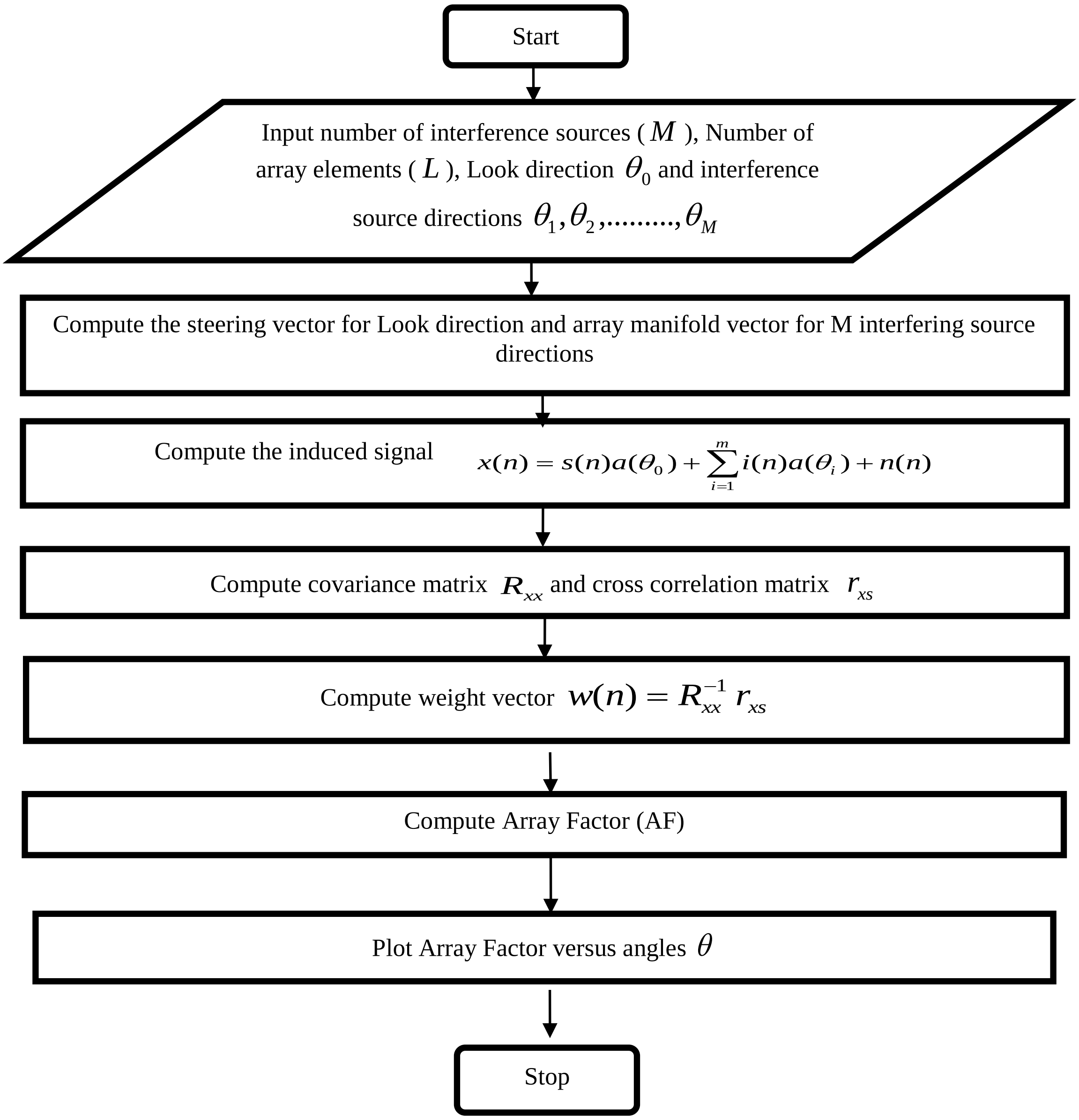

Fig 2: Simulation Methodology of SMI Algorithm

SMI algorithm is simpler because the array weights are computed by using well known Weiner-Hop equations. SMI algorithm involves finding the inverse of autocorrelation matrix which is subjected to errors. Hence it does not work for large number of antenna elements.

VI. PERFORMANCE EVALUATION:

To evaluate the performance of handover, we compare the capacities of the proposed and conventional schemes on cell edge area. Figure 2 plots the link level capacity of SC and MC MIMO switching according to the distance between a MS and BS's for 4X4 MIMO cases.

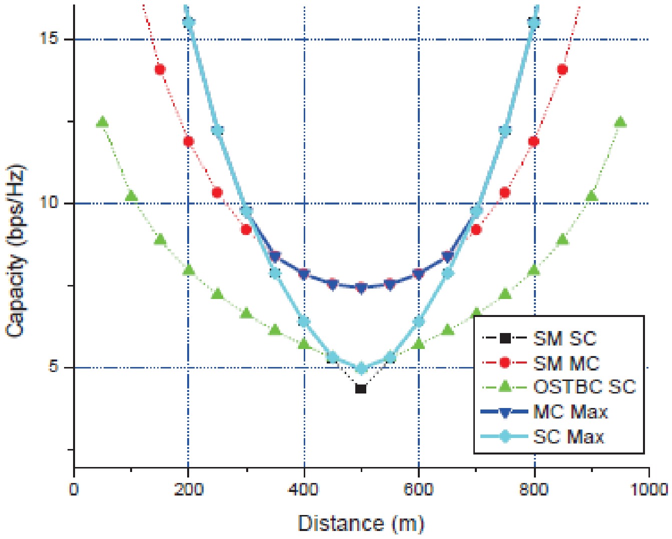

Fig 3: Handover Performance

VII. FUTURE SCOPE:

Beamsteering is a technology that provides wireless networks with less latency and high data rates. Some of the disadvantages of this project can be overcome by extension of this project work which are listed as

1. Square Array can be utilized to steer the beam over a wider range of angles for both azimuth and elevation.

2. Direction of Arrival algorithms like Root MUSIC (MUltiple SIgnal Classification) algorithms can be implemented to obtain high resolution.

3. The RF cost of Beamsteering can be reduced by utilizing Dielectric Lens in front of antenna array which increases directivity. The Directivity obtained by using dielectric lens can be achieved by using large amount of antenna elements in the array structure but large array increasing the complexity and cost.

4. Most of the noise considered for practical purposes is white noise. However, in nature we observe that additive white Gaussian noise is pre-dominant. Thus, measures have to be taken to take this constraint into account.

5. Other techniques like Neural Networks can be employed to reduce the computational burden on the existing Adaptive Beamsteering techniques.

VIII. CONCLUSION:

In the phase the Beam steering algorithms namely; SMI and SDLMS were simulated and compared. These algorithms were able to produce main beam towards desired direction and direct nulls towards interference directions. Each of the algorithms has their own advantages and disadvantages. The SDLMS provides faster convergence as compared to SMI. The weight calculation is performed by varying the step size with an upper limit on the step size so that the algorithm does not diverge from the optimum value .

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