Pilot Reuse Pattern Optimization in Massive MIMO for Spectral Efficiency Enhancement using GA

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Abstract: **The area data throughput of wireless network becomes an important parameter which needs to be improved to manage the growing wireless data traffic requirement. MIMO techniques have already proven to improve the spectral efficiency hence improvement in area data throughput. In this direction, the concept of Massive MIMO technologyhas shown significant improvements in area throughput by increasing the spectral efficiency (bit/s/Hz/cell) with same bandwidth and basestations density. In spite of the big advantage of massive MIMO system, it suffers by the problem of pilot contamination which increases the effective interference. In this paper, the concept of pilot reuse is shown for reducing the pilot contamination. Further the reuse pattern is optimized by GA for enhancing the spectral efficiency.**

***Keywords: MIMO, Massive MIMO, Pilot contamination, 5G communication etc*.**

I.INTRODUCTION

As per Martin Cooper at Array Comm, the wireless data traffic has almost doubled in every 2.5 years after start of wireless communications. Now days, wireless data traffic in cellular and local area networks are exponential increase. This required the increase in area throughput of wireless network. The area throughput of awireless network is measured in bit/s/km^{2}and can be modelled as follows:

Area throughput (bit/s/km^2) =Bandwidth (Hz) Cell density (cells/km^2)*Spectral efficiency (bit/s/Hz/cell):*

The goal is to increase the area throughput for meeting the future data traffic requirement of wireless network. The bandwidth and cell density cannot be extent to high. Then this goal can be achieved if the spectral efficiency is enhanced. The Massive MIMO (multiple-input multiple-output) communication technology, wheremultiple antenna base stations with spatially multiplex amplitude of user terminals is well-suited. [1-8]

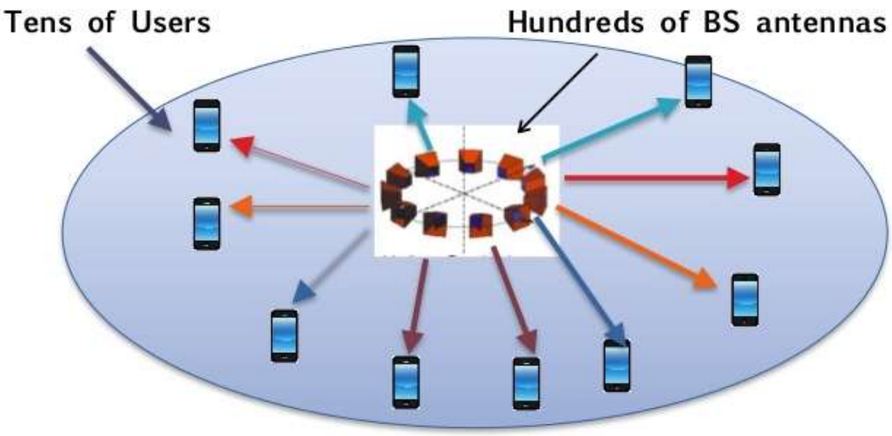

Figure 1: Massive MIMO scheme [9]

Massive MIMO is a multi-user MIMO system with M antennas and K users per BS. The system is characterized by M, K and operates in TDD mode using linear uplink and downlink processing. Figure 1 shows the typical scheme of massive MIMO.

A. Pilot contamination

In this paper we have focus on a specific problem of massive MIMO is pilot contamination. Coherent pilot contamination is amplified along with the desired signals due to unable to use the same pilot sequence by nearby base station. This pilot contamination problem degradesthe effective SINR by adding extra interference. However, pilot contamination in the network can be suppressed byincreasing the pilot reuse by designing the cell groups appropriately. Since the attenuation of the interference is higher with distance, the interfering cells must be as far away from cell.[2]

The GA based the modified pattern of pilot reuse for base stations are presented here to enhance the Spectral efficiency.

B. Simulation scheme

During the simulation, the interference of each base station are identified for the following simulation parameters.

- Pathloss exponent =3.7
- SNRvalues=0 to 20
- coverage area =1 km x 1 km
- Maximal number of users per cell =100
- number of BS antennas =200
- Number of tiers of hexagonal =5
- Coherence interval length =400 m
- Forbidden Region = 0.2
- Normalized Inter site distance = 2
- Normalized cell radius = 1
- Normalized shortest distance from base station = 2
- Pilot reuse =3
- No. of base station =91

The pattern of reuse is identified with the genetic algorithm technique. Genetic algorithm is an evolutionary algorithm to identify the optimum pattern of the input to reduce the objective function. The ultimate goal of the use of GA here is to increase the SE. Hence the objective function of GA is to reduce the inverse of average spectral efficiency.

II. SIMULATION AND RESULT:

The convergence curve for GA optimization for reuse pattern is shown in the figure 2. The objective function of the GA is average spectral efficiency of all the base station.

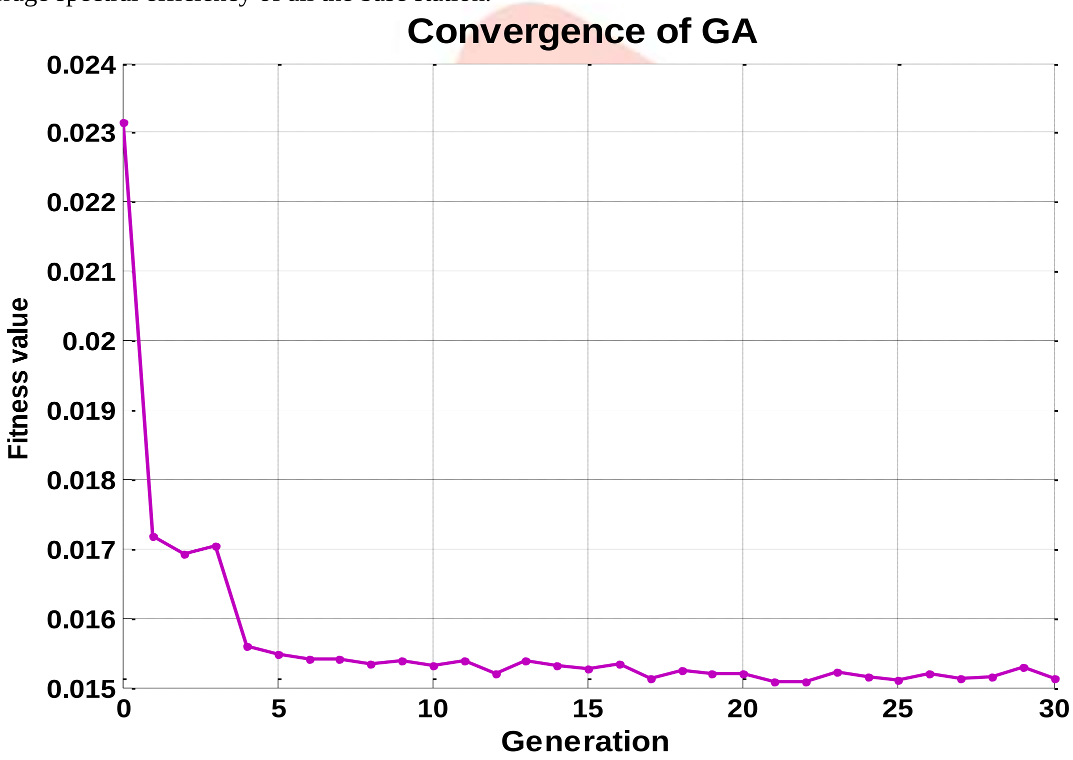

Figure 2: Convergence curve of the GA

After 16 generation of GA the inverse of average spectral efficiency is almost become constant. The optimized reuse pattern is shown in figure 3.

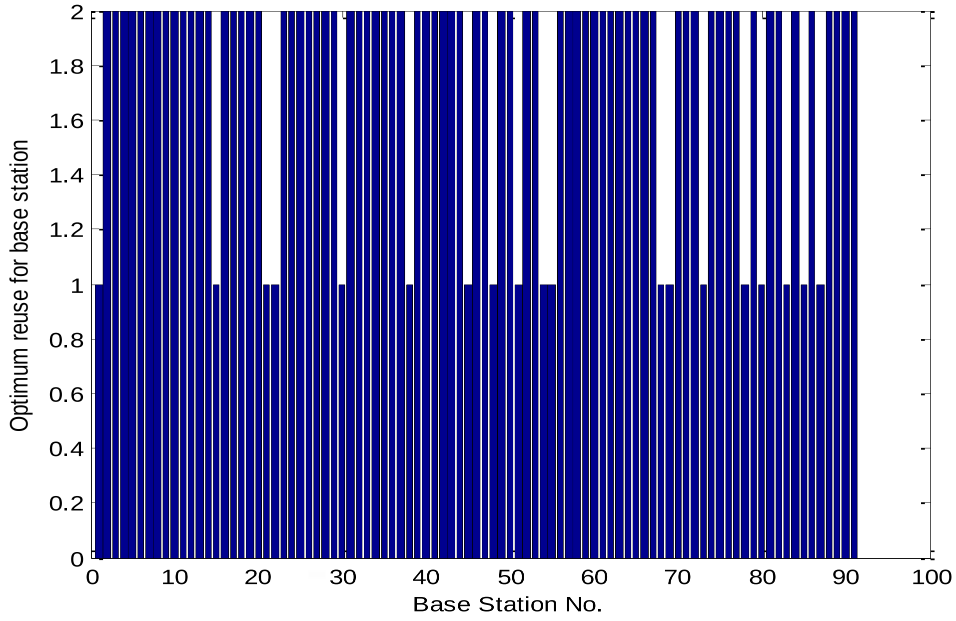

Figure 3: Optimized pilot reuse pattern of the GA

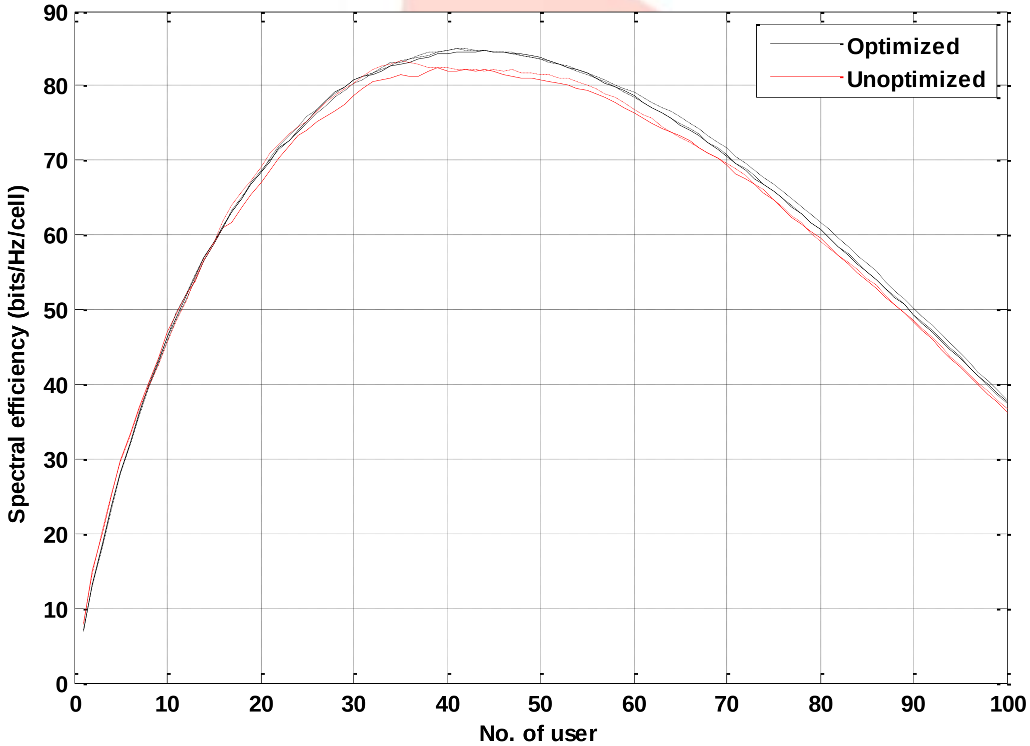

Figure 4: Typical graph of spectral efficiency with no. of user for optimized and un-optimized case.

The optimized average spectral efficiency becomes 65 bits/Hz/cell in compare to 63.4 bits/Hz/cell (unoptimized).

III. CONCLUSION

The use of the GA for identification of pilot reuse pattern is enhancing the spectral efficiency. With the figure 4, it is clearly shows that only with higher no. of users, improvements in SE are observed. Maximum 5 % improvement is shown in the spectral efficiency. With these initial results, in future other methods of the optimization and different configuration of the wireless networks may be explored.

IV. REFERENCES

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