ISSN2394-3777 (Print)
ISSN2394-3785 (Online)
Available online atwww.ijartet.com

International Journal of Advanced Research Trends in Engineering and Technology (IJARTET)
Vol. 5, Special Issue 12, April 2018

An Adaptive Metaheuristic Algorithm for Efficient Optimization in LTE

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***Abstract*— Over the past decade and a half, world has witnessed exponential growth in telecom system. To keep pace with this growth, mobile operators have to constantly expand their network. So, reliability and capacity are the most important aspects that have to be considered to satisfy user demand. In this situation homogeneous cellular network will face limitations and so heterogeneous network act as a key solution. Intelligent user allocation is necessary, because of large imbalance in transmit power in HetNets. At the cell edge, user equipments will experience strong inter - cell interference due to the use of same frequency sub-band in LTE systems. Thus to minimize ICI resource allocation required. In this paper we propose, a BAT algorithm to optimize user association and resource allocation in LTE networks. The simulation result shows that this proposed scheme can obtain high spectral efficiency and efficient throughput compared to the existing optimization algorithm.**

Key words: Inter cell interference, user association, resource allocation, and optimization.

I. Introduction

LTE is given as the abbreviation for the extension Long Term Evolution. In telecommunication, LTE is a 4G wireless communications standard developed by the 3rd Generation Partnership Project (3GPP) that's designed to provide high speed accesingfor mobile devices such as smartphones, tablets etc and wireless hotspots. It can also provide data and multimedia streaming at speeds at high rates ie, from several Mbps range to Gbps range.

LTE - Heterogeneous Network or HetNets mainly consists of three kinds ofcells- macrocells, microcells and femtocells. These HetNet has emerge out of the need for cellular communication operators to be able to operate networks consisting of a variety of radio access technologies forformattingthe cells and for many other applications, and combining them to operate in any absolute conditions.Conventional cellular systems had many standard approaches, in which the base stations were characterised by the mast and antennas.

The heterogeneous networkmainly consist several layers of networks of different cell sizes. There is a manifold variations of lowpower base stations that include, microcells,picocells, femtocells and relays. These low power base station nodes can be deployed indifferent settings such as hotspots,office environments, homes etc.However, such mixed deployments might trigger high interference conditions.Wheninfact, severe Inter -Cell Interference (ICI) challenges this evolution. Technically, this is attributed to two reasons; thefirst being theunityfrequency reuse factor in LTE networks.This means that all neighbourbase station nodes(eNB) use the same frequency channels, which willlead tomore interference. The second is the mixedheterogeneous networkdeployment in LTE.Therandomplacement ofthese miniature access points can cause severe interference problems particularly for cell edge users.In OFDMA systems, ICI is caused by the collision betweenthe resource blocks. With the conflicting conditions, theoverall system performance is determined by the collision probabilities and the impact of a given collision on the Signal to Interference and Noise Ratio (SINR) associated with the colliding resource blocks.The ICI problem was handledby coordinating base-station transmissions tominimize interference.

In the existing system for LTE, that optimize UA (user association) and RA (Resource allocation). The game theory which provide solution for this adversary, it is done by computing the Cell Individual Offset (CIO) and a pattern of power transmission over time and frequency domain for each ofcell in the provided cellular network. The analysis results implied that, this can improve the cell edge throughput and improved energy efficiency.The Long Term Evolution (LTE) cellular networks use the same frequency sub-bands and so

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User Equipment's (UEs) may experience strong Inter Cell Interference (ICI), especially at cell edge.Due to the large imbalance in transmit power between MCs and SCs in HetNets, intelligent User Association (UA) is required to perform load balancing and to favour some SCs attraction against Mcs.The energy inefficiency is also a concern here.

So this paper proposes a modified Bat algorithm for optimization which is ametaheuristic algorithm for global optimisation. Reliability and capacity are the important aspects considered to satisfy user demandThus femtocell networks emerged as a major concept to improve the cellular system. Because of its cost effective, low power, and small size cellular advantages .Main objective of proposed algorithm is to select the best combination of resource blocks for usersto minimize the inter cell interference in the networkAlso provide high quality wireless data connection.

The structure of this paper is as follows. Section II outlines

therelated work, while Sections IIIdiscus about the BAT algorithm and Section IV summarizes the comparison of the proposed algorithm with existing GA. Finally, Section 7 concludes briefly.

II. RELATED WORK

In this section abbreviate a schemeto optimize LTE networks in user association and dynamic radio resource sharing, and to coordinate the inter-cell interference for enhancing overall network utility. Our work is based on a two-tier model that permits the separation of some control decisions among the eNodeBs (eNBs) and the centralized entity, called the eNB coordinator. The latter receives periodically, via S1 interface, updated measurements from the eNBs. Then, it performs a global optimization to select the best CIOs for user association, to coordinate the allocation of subset of frequency resources to the eNBs, and to adjust the transmission power on each frequency sub-band.

This optimization, based on an iterative algorithm and considering the state of the whole network, results in the best CIO, frequency and power settings for each cell. These values are then sent to the eNBs and to be used by their LTE local schedulers for transmissions. Coordinating the transmission power and frequency reuse across cells allows to limit the interference experienced by the mobile users and to improve the quality-of-service (QoS) over the network and also cell edge. It could also yield higher energy efficiency.

Because of the exponential increase in the number of connected devices the communication network is facing certain problems.The rapid growth of data traffic and the demand for higher data rates, LTE networks have been facing great difficulty to handle the data amount, especially in the most crowded environments and at cell edges.These large Inter Cell Interference at the cell edges is caused by as Long Term Evolution (LTE) cellular networks use the same frequency sub-bands.Lack of coordination of the Resource Allocation (RA) among the cells and to minimize the ICI is the problem here.

The limitations of the use of genetic algorithm (GA), Compared to other optimization algorithms are,

- Repeated fitness function evaluation
- Do not scale well with complexities
- Tendency to converge towards local optima rather than global optima of the problem
- Less efficient in terms of speed of convergence

III. PROPOSED APPROACH

In this paper weconsider an LTE cellular network model to both homogeneous and heterogeneous networks which composed of K cells:M macro cells and N small cells, where N to 0. Each basestation k is composed of S sub-frames in the time domain and R resource blocks which is considered in the frequency domain. All the sub-frame duration issame and the bandwidth of all RBs isalso a constant.Example: according to 3GPP LTE standard, they are 1ms and 180 kHz, respectively. Fig 1 shows the framework overview of the proposed scheme.

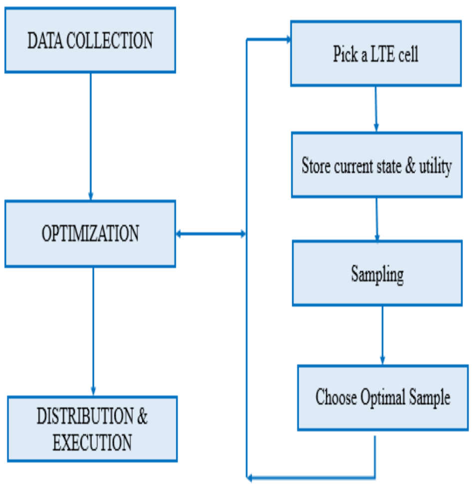

Fig 1:Framework overview

A. *Data Collection*

Each user equipment reports to itsserving eNB long term statistics, such as Channel Quality Indication(CQI) and Reference Signal Received Power (RSRP).These measurements are processed by the eNB to group theusers in pools having

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similar channel quality, then they are sentvia S1 protocol to the coordinator. The groupingallows to limit the data exchange between the eNBs and thecentral entity that is in charge of the optimization. Thus, the eNB keeps a precise and real time knowledge ofits attached users. Meanwhile, the coordinator keeps a globalview over the cells in the network with access only to long-termstatistics that are averaged both in spatial dimension and in time dimension.

B. *Optimization*

At the end of collection step, the coordinator has a database containing the needed information concerning the state of the network. Working on this database, it performs an optimization to deliver the optimal parameters. BAT algorithm is used for optimize user association and recourse allocation in LTE network.

Bat algorithm (BA) is a biological algorithm, advanced by Yang and additionally BA has been determined to be greater efficient. The bat algorithm is based on the echolocationbehaviour of bats. This is considered as very powerful and promising algorithm according to the primary studies. This paper formulate the BA by idealizing the echolocation behaviour of bats. The echolocation behaviour of microbatsis formulated byassociating the objective function to be optimized. Thus formulates a new optimization algorithm.An obvious simplification is that no ray tracing is used in estimating the timedelay and three dimensional topography. Though this might be a good feature for theapplication in computational geometry, however, we will not use this feature, as it ismore computationally extensive in multidimensional cases.

In addition to this simplified assumption, here alsousing the followingapproximations, for simplicity. In general the frequency f in a range [fmin, fmax]corresponds to a range of wavelengths [λmin, λmax]. For example, a frequency range of[20, 500 kHz] representing a range of wavelengths varying from 0.7 to 17 mm.Considering theidentified problem, it is found that it is possible to use any wavelength for the ease of implementation.In the actual implementation, we can adjust the range by adjusting the wavelengths(or frequencies), and the detectable range (or the largest wavelength) should be takensuch that it is comparable to the size of the domain that is chosen, and then toning down tosmaller ranges.

And, here we do not necessarily have to use the wavelengthsthemselves; instead, we can also vary the frequency while fixing the wavelength. The f are related due to the factthat λ,f is constant. The later approachis used in our implementation steps.For simplicity, here assume f is within [0, f_{max}].We know that higher frequencieshave short wavelengths and travel a shorter distance. For bats, the typical ranges are afew meters. The rate of pulse can simply be in the range of [0, 1] where 0 means nopulses at all, and 1 means the maximum rate of pulse emission.Based on these approximations and idealization, the basic steps of the BA can besummarized as the pseudo code2.

Thesimulationuse virtual bats naturally. This paper define th rules how theirpositions xi and velocities vi in a d-dimensional search space are updated.The newsolutions$x^t_i$and velocities v^t_i at time step t are given by:

$$f_i = f_{min} (f_{max} - f_{min}) \beta$$
$$v^t_i = v^{t-1}_i + (x^t_i - x^*) f_i$$
$$x^t_i = x^{t-1}_i + v^t_i$$

whereβ [[0, 1] is a random vector drawn from a uniform distribution. Here x* is thecurrent globalbest location which is located after comparing all the solutionsamong all the n bats. As the product $\lambda_i f_i$ is the velocity increment, in this paper we use eitherf_i (orλ_i) to adjust the velocity change while fixing the other factor λ_i (or f_i), dependingon the type of the problem of interest.

In our implementation, we will use f_{min}= 0 andf_{max} = 100, depending the domain size of the problem of interest.Comparing with the existing genetic algorithms, there is no explicitcrossover; even if the mutation varies by means of the variations ofloudness and pulse emission. However, variationsof loudness and the pulse emission rates can also provide anautozooming ability in the sense thatutilization becomesexplosive as the forage is approaching the global optimality.Thus it is transparently clear that, this approach essentially switches an explorative phase to an exploitativephase automatically.

IV. PERFORMANCE EVALUATION

In this section we are comparing over proposed scheme with existing system.

A. *Packet loss ratio*

Packet loss occur when one or more packet of data travelling across a network fail to reach their destination. It is measured as a percentage of packet lost with respect to packet sent. Fig 2 shows a graph which shows the comparison of packet loss ratio in the proposed scheme with the existing scheme. The graph implies that, as the number of users increases packet loss ratio is less in the proposed system which uses the bat algorithm compared to the existing system.

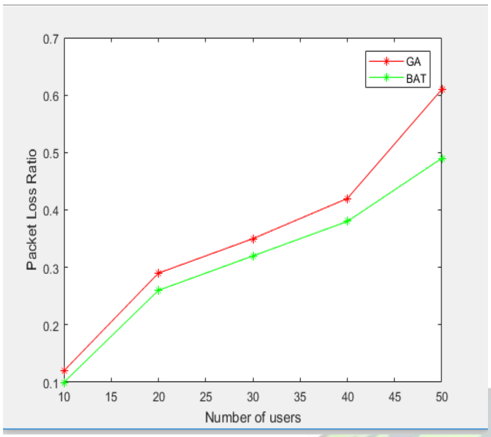

Fig 2: Packet loss ratio verses number of users

B. Spectral efficiency

Spectral efficiency or bandwidth efficiency refers to the information rate that can be transmitted over a given band width in a specific communication system. Fig 3 shows a graph of spectral efficiency comparison of bat algorithm and genetic algorithm. Figure shows that spectral efficiency is high in the proposed system compared to that of previous system.

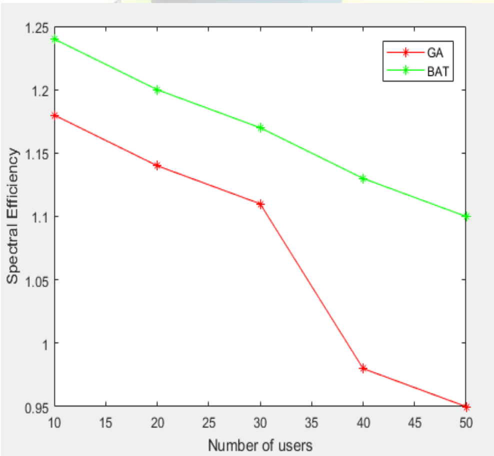

Fig 3: Spectral efficiency verses number of users

C. System throughput

In data transmission, network throughput is the amount of data moved successfully from one place to another in a given time period. Fig 4 shows a graph of system throughput comparison from. From the graph we can see that highest system throughput of proposed algorithm than that of existing system.

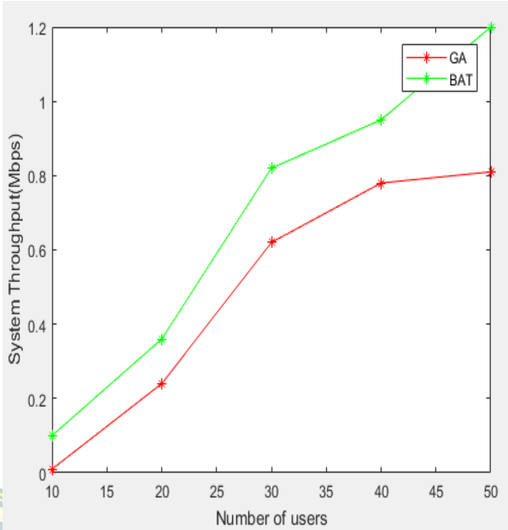

Fig 4: System throughput verses number of users

D. Packet delay

Fig 5 shows the comparison of packet delay in seconds in the proposed algorithm and previous algorithm. From the graph we can see that packet delay is less in the system uses bat algorithm than the existing system which uses genetic algorithm.

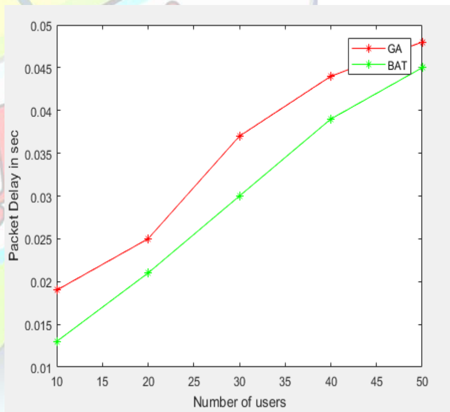

Fig 5: Packet delay verses number of users

V. Conclusion

This paper proposes a modified BAT algorithm for optimal resource allocation and user association in LTE networks. Due to the increasing rate of mobile devices, the inter cell interference will occur especially at the cell edge. By using proper optimization, we can minimize the ISI and also it will increase the system throughput. In this paper, BAT algorithm is used for optimization technique. The simulation results shows that the proposed algorithm improves several factors compared to that of previous algorithm.

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