# A Review on Base Transceiver Station and Swarm Intelligent Techniques

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***Abstract*: Optimization means to have maximum capacity, better quality and reduced cost. The growth of wireless communication is increasing to provide better services to the customers. This has led the researchers to work on the Radio Coverage. Radio Coverage and performance of Base Station in general gets affected by Antenna arrangements, and Location of Base Transceiver Station. This paper reviewed the problem of finding optimal location of BTS (Base Station Transceiver), so that with least count of BTS, maximum number of users can be covered at less infrastructural cost. The idea of Using Evolutionary algorithm is quite effective and efficient as these algorithms are build up by following the behavior of various swarm of insects and creatures e.g. bees, birds, and ants. These algorithms can be utilized to determine the best Location of BTS.**
**Keywords: Base Station, Genetic Algorithm, PSO, ABC, Propagation Model.**

## I. INTRODUCTION

The increasing development in using wireless communication with additional operators that are entering the market place has activated the necessity for wireless network Optimization. There are numerous issues that are occupied in plan of arrangement that are traffic, coverage, topography, system capability, and propagation features. The place of unit (cell) can be resolute on the behalf of the count of units, the traffic allotment, coverage, and the propagation atmosphere. The network factors at the mobile unit and the base station cannot be précised unless the allotment of cell is finished. Cell planning is not a one time task as it is very important that design should be continuously rationalized based on the cellular arrangement circumstances and as a result such prerequisite must be added in the development tool.

A lot of researches have been completed in the area of RF planning in expressions of the guide assignment, coverage examination, and transmission and routing however only some researches [1], [2] have been carried out in the field of the cell preparation for the price efficient organization plan. In conservative cell preparation the traffic was less and the planning was done according to the frequency reuse pattern. For example in [3], the author has main concentration on the strategies of channel allocation and also discussed about as how segmentation (sectoring) can be utilized so as to attain superior performance of system. Cell planning tool basically necessitate being adaptive and the planning software should have prerequisite for steady judgment of situation and improvement of the plan. By means of position covering difficulty technique it turn into too burdensome and it results to insufficient completion.

While cell planning was projected, usual frequency recycle model is utilized for choosing BTS places. By means of the expansion in cellular skill, it is fitting significant for mobile operators to contain a system which is not simply superior in term of QoS but also gainful than other operators. The price concerned in situating up an arrangement and the QoS presented is straightway proportion to the count of BTS established, large number of BTS, extra is the expenditure but superior coverage at more infrastructure expenditure [1].

Some research has already been proceeded to find the number of required Base Stations to be installed in any area to provide 100% coverage [5]. In this research the unit (cell) positions are determined optimally such that, count of BTSs is least whereas coverage provided by these cells is highest due to which finest probable service is achievable with least infrastructural expenditures.

The situation of BTS is an important work for whole system arrangement plan, the cause being the frequency channel happen to progressively more overcrowded and transmission environment happen to further complex. Suboptimal situation of BTS will not simply increase the cost however also lessening in spectrum competence. In order to deal with the necessity of quick wireless system exploitation, investigation efforts have been placed into build up over the past few years [4].

In this paper the difficulty of locating the finest appropriate position for the BTS is reviewed. Also the use of various Optimizations techniques in this problem is explored in the study. The various parameters to be considered for network planning are also discussed while optimizing the location using these techniques to achieve the QoS at less infrastructural cost.

## II. CELLULAR NETWORK PLANNING

A unit (cell) is the region that is enclosed by base transceiver station (BTS) which is the essential environmental part of the cellular arrangement. Unit (Cell) development address the difficulty of placing the BTS and identifying the factors for every BTS so that the best arrangement performance is accomplished and the arrangement expenditure is reduced. The performance and the costs are characterized by:

**Power Plan Computations:** To assure a high-quality in each uplink and downlink direction the power of Mobile Station (MS) and Base Transceiver Station should be in equilibrium at the border of the unit (cell). The power plan computations supplies following helpful consequences:

**Base Transceiver Station (BTS) Spread Power** is accustomed to supply a fair communication connection i.e. Downlink and Uplink performance is the similar for specified MS and BTS recipient performance, antenna, MS spreader performance, and feeder wire distinctiveness.

**Isotropic Path Loss is** the highest pathway loss among MS and Base Station as per the specified communication network performance necessities.

**Coverage Threshold** describes downlink signal power at covered region boundary for specified position possibility.

*Cell range for coverage* is a irregular sign about unit (cell) choice in diverse region types.

**Path Loss Computation:** The universal pathway loss equation is described by Okumara-Hata metropolitan (urban) broadcast representation and can be described as

$$PL = Q1 + Q2 \log (f) - 13.82 \log (Hbts) – a (hm) + \{44.9 – 6.55 \log (hbts)\} \log (d) + Q0$$

Variables of equation are as follow

PL = Path los in db

f = frequency in MHZ

d = distance between BTS and mobile (1-20Kms)

Hbts = base station height in meters (30-100m)

a (hm) = correction required if mobile height is more than 1.5 meter and is given by

$a (hm) = \{1.1 \log (f) – 0.7\}hm – \{1.56 \log (f) – 0.$ for urban areas

$a (hm) = 3.2\{\log (11.75hm)2 – 4.97\}$ for dense urban areas

hm = mobile antenna height (1-10m)

Q1 = 69.55 for frequencies from 150 to 1000MHZ
46.3 for frequencies from 1500 to 2000MHZ

Q2 = 26.16 for 150 to 1000MHZ
33.9 for 1500 to 2000MHZ

Q0 = 0 db for urban
3 db for dense urban

**Propagation Models:** Spread (propagation) examinations are performed at dissimilar frequencies, locations, and antenna altitudes over diverse times and spaces. The obtained signal information is examined by means of mathematical software and fixed to a suitable curve. Method to contest the resulted curves are then produced and utilized as models. A number of the main propagation models are:

- Long Distance Propagation Model
- Okumara
- Hata
- Cost 231-Hata
- Wolfish-lkegami Cost 231
- Du Path Loss Model

- Diffracting Screens Model

**Coverage Forecast:** The RF signal forecast must be assured and blanks in the forecast region should be kept away from.

**Capability:** In every unit (cell), an adequate count of channels (guides) must be existing to convene its traffic requirement for fresh communications and handoffs.

**Broadcast Superiority:** The ratio of carrier signal power to interference power (C/I) of RF channels (guides) must convince the needs of broadcast superiority.

The cells (units) are strained for ease as hexagons. The boundaries of the area (hexagons) symbolize the hypothetical identical power (energy) borders among units (cells) considering that each BTS (Base Transceiver Station) spreads out the identical power, circulation is homogenous in each unit and the entire BTSs are likewise located in moreover the centre or at the curve of each unit [6]. Though the actuality of the exposure prototype will be fairly dissimilar and can completely decide using broadcast preparation tools attached with a thorough research of the examination region and fields parameters.

## III. SWARM INTELLIGENCE TECHNIQUES

The complexities associated with utilizing numerical optimization on significant manufacturing/engineering problems have donated to the expansion of substitute resolutions. Investigators have projected evolutionary techniques/algorithms (EAs) for penetrating near-best resolutions to difficulties. Swarm intelligence algorithms are probabilistic explore techniques that reproduce the usual organic development or the performance of organic entities. The performance of organic entities is lead by educating, adjustment, and development. A short explanation of the three techniques is offered in the subsequent sections.

### *3.1 Genetic Algorithm*

*A) Summary:* GA (genetic algorithm) [7] is a hunt method utilized in engineering problems to search estimated resolutions to optimization and hunt difficulties. Genetic algorithm is a specific group of evolutionary techniques that utilize methods stimulated by evolutionary biology such as heritage, alteration (also named mutation), assortment (selection), and intersection (also named crossover). The key constraints utilized in the Genetic Algorithm process are resident's volume, generations count, intersection rate and alteration rate.

*B) Algorithm Details:*

(a) Initialization

Firstly a lot of entity resolutions are arbitrarily produced to appear an opening residents casing the complete variety of probable resolutions (the hunt space).

(b) Assortment

Throughout every consecutive epoch, a quantity of the present inhabitants is chosen to generate a fresh population. Individual resolutions are chosen by means of a fitness (cost) based procedure, where best resolutions are naturally highly probable to be chosen.

(c) Reproduction

The subsequent process is to produce a next production of resolutions from individuals chosen using hereditary operators: recombination (also named crossover), and alteration. For every novel resolution to be formed, a couple of "parent" resolutions is chosen for producing from the group chosen individual before. Novel group of parents are chosen every instance and the procedure carries on until a novel inhabitants of resolutions of suitable dimension is produced.

(d) Termination

This production procedure is repetitive until an extinction situation is accomplished. Here the predetermined count of productions (generations) accomplished is used as the criterion for the extinction of the plan.

*C. Pseudo-code:*

- Select preliminary resolutions Repeat
- Assess the individual resolution strength of all the inhabitants
- Choose couples of high strength resolutions to reproduce
- Generate novel population using recombination and assortment
- Carry on until expiry state

### *2.2. PSO (Particle Swarm Optimization) Algorithm*

*A. Summary:* Particle Swarm Optimization was projected by researchers Kennedy and Eberhart. The algorithm is encouraged through the community activities of a group of travelling birds demanding to arrive at an unidentified place [8]. In this algorithm, every resolution is a particle i.e. 'bird' in the group. A bird or particle is similar to a chromosome (inhabitant's member) in Genetic Algorithm. As opposite to Genetic Algorithm, the evolutionary procedure in the Particle Swarm Optimization does not generate novel individuals from parents. Quite, the particles in the inhabitants only develop their community activities and so their association towards a place.

*B. Algorithm Details*

(a) Initialization

The procedure is started with an assembly of arbitrary solutions (particles), N. The ith solution is symbolized by its location as a tip in a D-dimensional room. During the procedure, every constituent part (particle) i checks three parameters: present location (Xi); the finest location it arrived in preceding iteraions (pbesti); its flying speed (Vi).

(b) Swarming

In every instant interval (iteration), the location of the finest individual (gbest) is planned as the greatest strength among all individuals. So, every individual renews its speed Vi to grasp up the finest individual gbest, as given below:

$$V_i^{k+1} = w.V_i^k + C_1.rand_1.(pbest_i^k - x_i^k)+C_2.rand_2.(gbest_i^k - x_i^k)$$

Where w is calculated as given below is called weight factor for current iteration;

$$w = w_{max} - \frac{w_{max} - w_{min}}{iteration_{max}} . iteration$$

Also, C1 and C2 are two constructive constants known as learning factors; rand1 and rand2 both are arbitrary numbers having values in between [0, 1]. As such, utilizing the novel speed Vi, the individual's latest location will be:

$$X_i^{k+1} = X_i^k + V_i^{k+1}$$

As such, the key constraints utilized in this algorithm are: the swarm size (particles count), generations count and w 'the weight factor'. Swarming (brimming) is through until the extinction state is reached.

*C. Pseudo-code*

- Create arbitrary inhabitants of N resolutions or birds Repeat
- For every bird, compute strength
- Initiate w (the weight factor) value for current iteration
- For every bird, decide pbest as the finest location of that bird.
- Decide gbest as the greatest strength of the entire birds.
- For every bird, compute bird speed (V)
- Renew bird location (X)
- Carry on until stopping criterion

*2.3. ABC (Artificial Bee Colony) Algorithm*

*A. Summary*: The ABC technique is also a meta-heuristic algorithm for mathematical optimization. This technique was projected on the basis of the smart exploration behavior of honey bees**.** The Artificial Bee Colony technique was projected by Karaboga in 2005 for unrestrained problems [9, 10].

An extremely exciting crowd in environment is honey bees group that assigns the jobs energetically and adjusts themselves in reaction to modifications in the surroundings in a combined intellectual way. The groups have pictorial recollections, space-age sensory and steering schemes, probably even imminent abilities, assembly verdict building procedure throughout assortment of their novel shell (nest) sites, and groups execute jobs such as ruler (queen) and family treatment, stock up, getting back and dispensing pollen and honey, announcement and exploration. This individuality is encouragement for investigators to represent the smart performance of bees.

*B. Algorithm Details*

(a) Initialization

An arbitrarily dispersed preliminary populace resolutions (xi=1,2…D) is being spread over the search space of dimension D.

(b) Reproduction

An artificial (fake) onlooker bee selects a food resource which depends on the possibility significance connected to the food resource, Pi, computed by the equation:

$$P_i = \frac{fit_i}{\sum_{n=1}^{N} fit_n}$$

Where $fit_i$ is the strength of the resolution i which is relative to the nectar quantity of the food resource in the location i and N is the food sources count which is identical to the employed bees count.

To construct an applicant food location from the older one in remembrance, the algorithm utilizes the equation:

$$V_{ij} = X_{ij} + \Phi_{ij}(X_{ij} - X_{kj})$$

Where k = {1, 2,..., N} (k_i) and j = {1, 2,...,D} are arbitrarily selected index. ψ_i,j is a arbitrary numeral between [-1, 1].

(c) Replacement of bee and Selection

In this algorithm, a location cannot be enhanced more than a pre decided count of iterations, and then the food resource is understood to be discarded. The count of pre decided cycles is a significant organized constraint of this technique, which is known as "*limit*" for discarding. Suppose that the discarded resource is $x_i$ and j = {1, 2,...,D} , then the scout bee determines a novel food resource to be restored with $x_i$. The described process can be given as

$$x_i^j = x_{min}^j + rand(0,1)(x_{max}^j - x_{min}^j)$$

Following every applicant resource location *vi,j* is formed and after that assessed by the bee, its presentation is contrast with its older one. If the novel food resource has an identical or improved nectar than the older resource, it is restored the older in the remembrance. Otherwise, the older is kept in the remembrance.

### *C. Pseudo-code*

- Create the inhabitants of resolutions $x_i$; i = 1. . ..N
- Assess the inhabitants.
- Start Iterations and Repeat
- Create novel resolutions $v_i$ for the employed bees utilizing equation specified above and assess them.
- Choose best resolution through greedy selection procedure for the employed bees.
- Compute the possibility values Pi for the resolutions $x_i$ by equation described above.
- Create the novel resolutions $v_i$ for the onlooker bees from the resolutions $x_i$ chosen depending on Pi and assess them.
- Choose best resolution through the greedy selection procedure for the onlooker bees.
- Find out the discarded resolution for the scout, if present, and restore it with a novel arbitrarily formed resolution xi by equation described above.
- Remember the finest resolution achieved so far.
- Iteration = Iteration + 1
- Carry on until termination criterion is achieved.

## VI. BTS LOCALIZATION USING OPTIMIZATION TECHNIQUES

To discover the best location of Base Station using any of the optimization algorithms, an appropriate objective function is built for the problem. An optimization algorithm will find the optimal locations of BTS by finding the best fit solution for the given objective function. Already many researchers have done the task considering the factors like Received power by MS, Path loss, and Signal Attenuation, coverage, capacity [11, 12, 13]. An objective function considered by some researchers is

$$F = \frac{Power\ Recieved}{Path\ Loss\ X\ Attenuation}$$

Many algorithm like Genetic Algorithm, Particle Swarm optimization, and Artificial Bee Colony algorithms have been applied to find the optimum locations so that the received power to any Ms can be maximized, Path loss of the signal and attenuation will be minimized.

Experiments are performed by considering various parameters like Transmit power 500mW, frequency 850 MHz, BTS antenna Height hBTS is 20 to 200m and MS antenna height hMS is 1 to 10m. And results are analyzed for various numbers of BTS to cover various sizes of population and the results were concluded as per the results of every algorithm. ABC algorithm gives best locations in comparison to locations find out by GA in terms of the above mentioned parameters [12].

## V. CONCLUSION

The endeavor of the document is to review the cellular network planning, parameters to be considered while deciding the location of a BTS, Evolutionary Algorithms and their use in BTS Localization. Power Budget Calculations, Path Loss calculation, Coverage, Capacity, and Transmission quality are considered while planning for location of any BTS. The BTS localization can be done using swarm intelligence techniques like GA, ABC, PSO, etc. to maximize the received power by any mobile station, and minimize the attenuation and path loss.

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