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***Research paper***

# A Comprehensive Parametric Analysis of Vertical Handoff using Ant Colony Optimization

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**Abstract**

With the development of 4G mobile telecommunication systems, providing users with the convenience of a seamless continuous connection is not enough anymore. With best Quality of Service (QoS) users want to be connected to the best available network. Hence, it is necessary to have good decision making algorithm that will decide whether to perform handoff to another network, the best network to vertically perform handoff to, and the right time to initiate the handover. The key aspects leading to deployment of extensive array of wireless and mobile networks are advances in miniaturization, circuit design with low power and development in radio access technologies and demand for high speed internet access increase in user. The choice of parameters plays significant role in the decision of vertical handoff. Parameters like power consumption, bandwidth, velocity, signal strength, cost, throughput, user preferences and load falling on network are considered during vertical handoff. Optimization helps in using these available resources in best possible manner as in many cases vertical handoff takes place in situations where the resources are very limited. In this paper only the parameter Power is taken into consideration and Ant colony optimization technique is applied and the comparison for power before and after optimization is plotted.

***Keywords:*** *Optimization, handoff, power*

## 1. Introduction:

In early 1970s Mobile wireless industry began its technology evolution, revolution and creation. In the last few decades, mobile wireless technologies have encountered four generations specific from 1G will 4G and 5G will be yet on make deployed. The cellular concept is introduced in the 1G technology which settled on those huge scale mobile wireless communication conceivable. The Analogy technology is supplanted for Digital communication in 2G which fundamentally improved the remote correspondence caliber. Data communication, furthermore of the voice communication, need been those fundamental center in the 3G innovations Furthermore a system for both data and voice will be rising. Here we focus on one of such challenge that is vertical handoff management in 4G networks.

Generally vertical handoff takes place in situations where the resources are very limited. So, it is necessary to use the available resources in the best optimistic way. To ensure the system performance, an assortment about parameters might be utilized in the handover decision, for example, such that the channel propagation characteristics, signal-to-noise ratio (SNR) [1], pathloss and bit error rate (BER). Moreover, for certain client's battery power might be a significant component. The user might connect to a network with easier control requirements whenever the battery level is minimum, for example, such that a specially appointed Bluetooth network.

Wireless devices that are running on battery need to limit the power consumption. Whenever there is decrease in battery level, swapping for one network to another with low power consumption can provide extensive usage time. The requirement of power becomes serious issue if the battery is low. In such conditions, it is preferably shifted to an attachment point(AP), and this will increase the battery life. At a given instant, the attachment to the nearby base station (BS) is known to consume the minimum power for individual mobile devices. Thus if the battery level is less the mobile need to handoff to the nearby base station, on condition that RSS is above the threshold. The congestion is increased as number of users increases and in turn the nearest base station consumes more power. This can be improved by going for Optimization and which will not increase congestion.

Section 2 of this paper describes what is vertical handoff and the various vertical handoff decision algorithm are discussed. Section 3 of the paper describes the vertical handoff parameters and the algorithm implemented in [6] and the important parameters which will decide the network performance is highlighted. Section 4 of the paper highlights why on "power" is considered and the advantage of going for optimization is also discussed. Section 5 describes the simulation procedure and the simulation results.

## 2. Vertical Handoff in 4G

Vertical handoff/handover (VHO) is a handover between two eNodeB (base station) operating with dissimilar wireless technologies. The VHO methodology may be carried on mobile nodes and battery power which is significant parameters for mobile nodes.

Vertical handoff around a reach about wired and wireless access technologies remote get advances including WiMAX can be Media independent handover which is institutionalized as IEEE 802. 21. Main feature of vertical handoff is dynamic new call blocking probability which was made handoff decision for wireless network. Fig.1 shows the basic difference between vertical handoff and horizontal handoff.

Various Vertical handoff decision algorithms [2] are developed and they are clustered as: (i) Traditional (ii) function-based (iii) user-centric (iv) Multiple attributes decision making (v) Fuzzy logic and neural networks and (vi) context-aware.

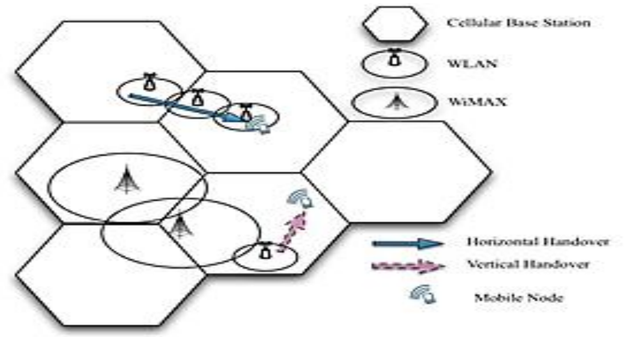


**Fig 1**. Difference between Vertical Handoff Vs Horizontal Handoff

In the Traditional handoff decision algorithm, the received signal strength (RSS) along with other parameters are considered. The first policy-enabled handover scheme is considered in order to select the best accessible network.

Multiple Attribute Decision Making (MADM) deals with the struggle of selecting a substitute from a set of choices which are categorized with respect to their characteristics. The best approaches are SAW (Simple Additive Weighting), GRA (Grey Relational Analysis), AHP (Analytic Hierarchy Process) and TOPSIS (Technique for Order Preference by Similarity to Ideal Solution) algorithms.

Fuzzy Logic (FL) and Neural Networks (NN) ideas need aid connected with decide at and in which network should handover "around distinctive approachable access networks. These need aid consolidated with the various criteria alternately quality particular idea with the purposeful with enhance propelled decision algorithms to both ongoing real-time and non-real-time requisitions.

The Dynamic Decision Model for VHO implements a 3-level method consist of Priority, Normal and Decision phases. The Priority Phase allocates the precedence to all existing networks. The information of the system and preferences of the user are recorded in the Normal Phase. Then for each candidate network a cost function is computed [3]. Last of all in the Decision phase, for each candidate network a Score function is computed. Then it picks a network having the maximum value as "Best" network to handover and handover every last one of current transmissions on specific system if unique in relation to those present organize.

## 3 VOHC Decision Making Parameters

In HetNets, Vertical handover could be started to comfort more willingly over connectivity issues [4]. When various parameters are considered the decision algorithm offers upgraded performance, moreover. Yet the tradeoff is that the difficulty of the algorithm will be with the growth in decision time. The decision could be influenced by several constraints like,

- Network- Related Parameters- Latency, RSS, Security, Bandwidth, Cost, SIR etc.
- Terminal Related Parameters - Location Information, Battery power etc.,
- User-Related Parameters - User Priorities and Profiles
- Service Related Parameters – QoS, Service Capacities etc.

The VHOD algorithm implemented in [6] works in two phases i.e., Quick Evaluation Method for the Pre-Handoff Decision and Vertical Handoff Decision Function.
In the first phase of the algorithm the decision for handoff depends on the Minimum Guarantee Function (MGF) and it is represented as.,

MGF for network one i.e., i=1

$MGF_1 = f(\omega_1 - \omega_{th})\cdot f(R_{S1} - R_{Sth})\cdot f(\upsilon_1 - \upsilon_{th})\cdot f(t_1 - t_{th})\cdot f(P_1 - P_{th})\cdot f(c_1 - c_{th})$

MGF for network two i.e., i=2

$MGF_2 = f(\omega_2 - \omega_{th})\cdot f(R_{S2} - R_{Sth})\cdot f(\upsilon_2 - \upsilon_{th})\cdot f(t_2 - t_{th})\cdot f(P_2 - P_{th})\cdot f(c_2 - c_{th})$

MGF for network i i.e., i=N

$MGF_i = f(\omega_N - \omega_{th})\cdot f(R_{SN} - R_{Sth})\cdot f(\upsilon_N - \upsilon_{th})\cdot f(t_N - t_{th})\cdot f(P_N - P_{th})\cdot f(c_N - c_{th})$

$\omega_i$ , $R_{Si}$ , $\upsilon_i$ , $t_i$ , $P_i$ and $c_i$ represent the values of available bandwidth, received signal strength (RSS), velocity, estimated time MN will stay in a particular network i (where i=1,2,3...N), battery power and monetary cost of mobile node (MN) from a particular network i and the respective threshold for these parameters are represented by $\omega_{th}$, $R_{Sth}$, $\upsilon_{th}$ , $t_{th}$ , $P_{th}$ and $c_{th}$.

In the second step of algorithm an Extended Vertical handoff decision function (EVHDF) is presented, which is an extended version of VHDF. EVHDF is used to measure the improvement gained by handing off to a particular network j included in the candidate network set S. Here we assume the size of the candidate network set S is m. The network with the highest calculated value for EVHDF is the most optimal for MN based on specified preferences. The EVHDF for a particular network j, $E_{vfj}$, is defined by:

$$\text{Evfj} = \frac{\omega_c\left(1/C_j\right)}{\max\left(\left(1/C_1\right),\ldots,\left(1/C_m\right)\right)} + \frac{\omega_S S_j}{\max\left(S_1,\ldots,S_m\right)} + \frac{\omega_P P_j}{\max\left(P_1,\ldots,P_m\right)} + \frac{\omega_{NC} NC_j}{\max\left(NC_1,\ldots,NC_m\right)} + \frac{\omega_S NP_j}{\max\left(NP_1,\ldots,NP_m\right)}$$

Where, $\omega_C, \omega_S, \omega_P, \omega_{NC}, \omega_{NP}$ are weights for each of the network parameters. *C, S, P, NC, NP* present the cost of service, security, power consumption, network conditions, network performance, respectively., The network with the highest $E_{vfj}$ is the preferred network. If the preferred network is not the current network, vertical handoff takes places; otherwise, MN remains connected to the current network.

## 4 Ant Colony Optimization

So from the algorithm discussed above, in both the phases Power, Bandwidth, Received Signal Strength (RSS), Cost etc., are the main parameters that will decide whether handoff is required or not.

While doing handoff we may face fading. After fading before entering into receiver we need to do all kind of optimization. That is done in the equalizer side after channel. Means, we are doing it between after handoff transmission and before it entering into receiver.

By using optimization techniques network performance can be maximized, thereby enabling it to offer higher data rate, better quality of service and quality of end user experience. High data rate demand, high network capacity and coverage are the basic challenges of every wireless cellular networks as user's demand for data usage soars, various technologies, methods and optimization techniques have been designed for network improvement and spectral efficiency.

While processing High Datarate high power consumption is required. By optimizing the power, we can send more data in the limited power environment. So, in this paper, Power is considered as the parameter and the simulation is carried with respect to power which will be discussed in section. 5 of this paper.

Ant behavior fascinates in various ways. These are distributed systems that, in spite of the simplicity of their individuals, present a organized social organization. Ant colonies can achieve difficult tasks that in some circumstances far exceed the individual skills of a single ant. Ants deposit pheromone trail (indirect communication way among ants) on the ground in searching for food source. Other ants smell this pheromone and create probabilistic movement based on the strength of pheromone to find the shortest paths between the food source and the nest; i.e., they lean towards to the strongest pheromone concentrations. The term "stigmergy" used by the French entomologist Grass´e to describe this particular type of indirect communication in which the "workers are stimulated by the performance they have achieved."

## 5. Simulation Results

The simulation for Power Optimization is implemented by considering IEEE 802.11 WLAN system by generating random input bit stream with 64 bits per frame using QPSK modulation with frequency spectrum length as 64 block. Here QPSK scheme is used to generate the baseband signal. The following are the steps which are considered during implementation

Step1: Generate the Input bit pattern.

Step 2: Applying the modulation.

Step 3: IFFT algorithm is applied for Time Domain conversion.

Step 4: The signal is fed as input to the transmitter and thereby it is fed with the channel and later to the receiver.

Step 5: The power spectrum for the signal that is fed to the channel is calculated.

Step 6: The threshold for each and every frame data and clipping the signals as much as possible can be calculated from the power spectrum.

Step 7: From the clipped signals, decode the output bit pattern can be decoded and the performance comparison can be done that gives the normalized Power.

Now in order to optimize the power, generate the optimization coefficient and generate spacing data between limits. Using these coefficient, input signal find out the similarity, distance between them and indexing positions. Using this optimized data, regenerate the new signal.

The simulation is carried out in MATLAB 2016b and the results are as shown in the following figures.

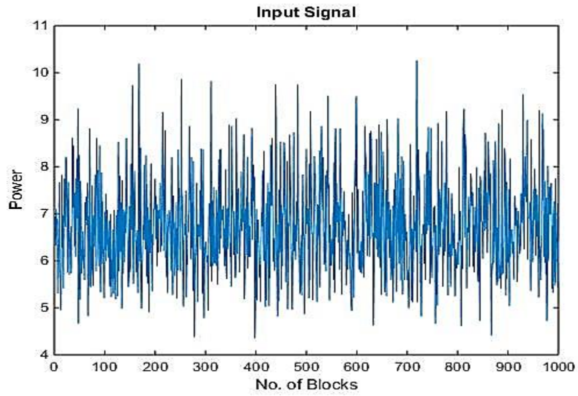


**Fig. 2** Represent the Input Signal which is generated using Random Input Bit pattern

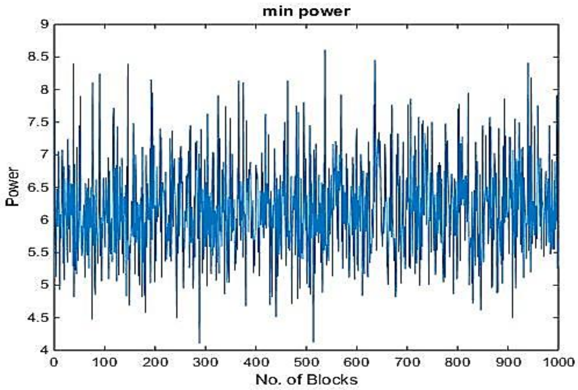


**Fig. 3** This is plotted by considering the blocks which have generated minimum power

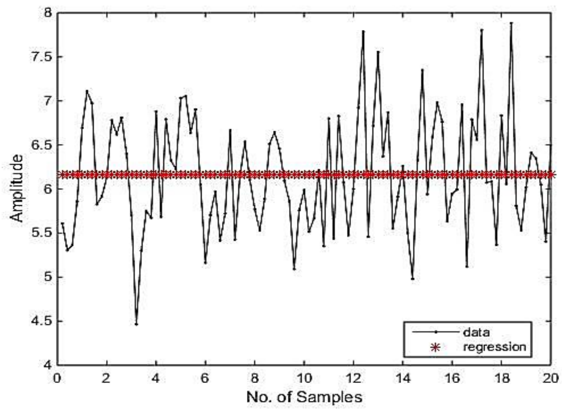


Fig. 4(a)

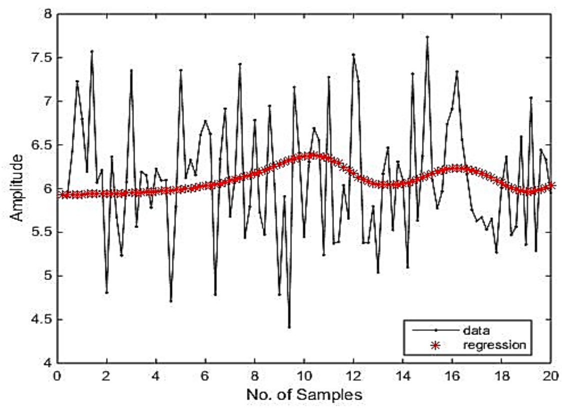


Fig. 4(b)

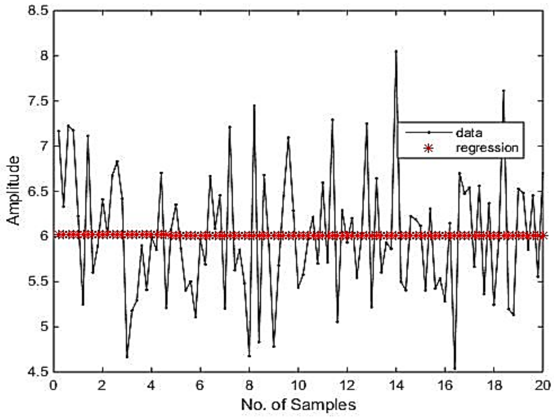


Fig. 4(c)

**Fig. 4** (a), (b) & (c) Represent the variations in amplitudes of the data before and after optimization.

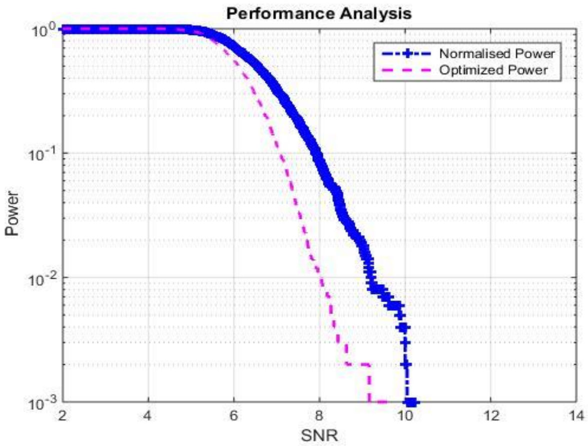


**Fig. 5** Normalized Power vs Optimized power.

Fig. 2 represents the input signal which is generated for 1000 blocks. It is clearly observed that the power levels at each block is non-uniform therefore the block which is generating minimum power is considered and is as shown in Fig. 3. Now optimization is applied and the variation in amplitude levels of the signal before and after optimization is shown in Fig. 4 (a), (b) & (c). The signal represented in black is in case of Normal conditions, whereas the signal represented in Red i.e. Regenerated data is generated after applying optimization. The comparison of Normalized Power vs Optimized power is shown in Fig. 5. The Fig. 5 clearly shows that normal data's reached .001 error rate at 10.6 SNR which means the data takes more power to reduce errors also needs more power to reach saturated. But here we optimized the data as well as power so it takes less power to reach that saturation. Also it achieves 2 dB less to reach the same bit error region.

## 6. Conclusion

The parameters which effect the performance of the system is studied. As discussed that Vertical handoff takes place in conditions where resources are very limited, it is necessary to use the best of the available resources by using Optimization. Here optimization is applied to Power and the results generated between Normalized power and optimized power is plotted and it is clearly observed from the plot that at SNR 10.5 the Power is 0.001 in Normal case, whereas using optimization the same value is obtained at SNR of 8.6. Here we optimized the data as well as power so it takes less power to reach that saturation. Also it achieves 2 dB less to reach the same bit error region. Hence, we conclude that using Ant Colony optimization technique power can be optimized and it can be used in best possible manner.

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