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A WELL ORGANIZED ENERGY EFFICIENT CLOUD DATA CENTER USING SIMULATED ANNEALING OPTIMIZATION TECHNIQUE

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Abstract: Cloud computing, a technology for manipulating, setting and accessing a number of distributed applications through internet worldwide. As more and more organizations involve in these fields the energy consumption by data center that hold all cloud applications increase significantly. So, there need a well developed energy saving mechanism without alter its performance. An efficient energy saving mechanism helps in reduce not only carbon footprint in the environment but also save money with few compromise on Service Level Agreement (SLA) violation thereby ultimate benefitting service provider of cloud. In this paper, Simulated Annealing has been used to decrease the consumption of power by continuously monitoring resources allocation over the guests and develop a cost efficient cloud infrastructure for the cloud service provider.

Keywords: Data Center; Power Consumption; Simulated Annealing; Green Computing

I. INTRODUCTION

Cloud computing uses virtualization technique over internet where end user can access cloud server and store their data or information without knowing internal storage structure in cloud. In computing world, cloud is the most recent technology to turn the visual sensation of "computing utilities" into a real world. In a cloud environment, it is a challenging event to manage the resource in energy efficient manner because of dynamic behaviour of cloud where end-users can login and logout from the cloud at any time. Therefore, a service provider should be able to making an accurate decision for scaling up or downwards [1]. Works in cloud requires lots of energy, lot of maintenance costs and carbon emission to the environment. In cloud there need a powerful data center uses gigantic power to perform all complicated tasks and emits huge CO_2 and makes the temperature high in the environment.

II. RELATED WORK

It is challenging event to allocate resources in the data center for minimize power consumption in cloud. There have lot of parameters concatenated faces a huge challenge for proper allocation of resources in a suitable manner. Today, the researcher has taken several strategies to overcome various challenges such as maintenance cost, service cost, reliability, system utilization, network bandwidth, response time etc [2]. Strategies such as: In [3], Genetic Algorithm (GA) based algorithm exhibits a much more dependable quality of solution than other algorithms. GA is the class of evolutionary algorithm (EA), which bring forth more optimized using the techniques by natural evolution, like inheritance, mutation, fittest, and crossover. Genetic algorithms are optimization techniques inspired from natural evolution processes but not very promising method in tackling the virtual machine placement. In [4], an algorithm has been proposed for efficient managing the network resources by allocating proper workload to the data center. Cloud computing work as demand computing takes requests from the user, compute the result of user's query and transfer the result to the end- user over the web. It performs simple to complex computing with minimal latency. In [5], internet-oriented utility analytic model, takes a number of resource request from various user to provide service such as e-commerce or e-book database web application and reduce energy consumption by the maximize utilization of resources with equal quality of service as use in the dedicated servers. In [6], powernap technique where rapidly moves the server between running state to idle state (nap state). In [7], Min-Min uses static balancing technique and works well with task taken small execution time than the task having larger execution time but can lead to starvation.

III. OPTIMIZATION BASED ON THE SIMULATED ANNEALING METHOD

Simulating (SA) an optimization technique generally proposes a solution of complex optimization problem by assuming temperature. In SA, there a temperature variable initially defines high and then cool steadily as this procedure operates further. When boiled down the temperature, probability of getting the worst solution is also coming down and probability of accepting is high. Annealing can work with a solid where temperature is increased slowly until the solid is melt. After hitting a melting point temperature decrease gradually until the particles are rearranged in the ground state of solid called steady or frozen state [8]. It starts from a random state and after an interval generates a new neighbourhood state, calculates respective cost function. The new neighbourhood cost function is accepted as an initial cost, if the neighbourhood cost is lower than initial cost otherwise accept the neighbourhood cost function with a probability value.

```
LOOP
Step 1: Select a state randomly. Suppose S.
Step 2: Generate a neighbourhood State
randomly.
        Say, S`
Step 3: Set Δ =  C(S') – C(S)
Step 4:IF Δ <= 0 THEN
                S= S'
        ELSE
        IF e^(-Δ/T) > random(0,1) THEN
        Accept S=S'
        ELSE
        Reject
Step 5: Modify temperature using cooling ruler ᾰ
Step 6: Exit
END LOOP
```

Fig.1 Simulated Annealing Procedure

This helps the System go ahead to a state corresponding to possible global minima. However, most optimization function stuck in local minima. To escape from local minima cost function is accepted with a certain probability value [8].

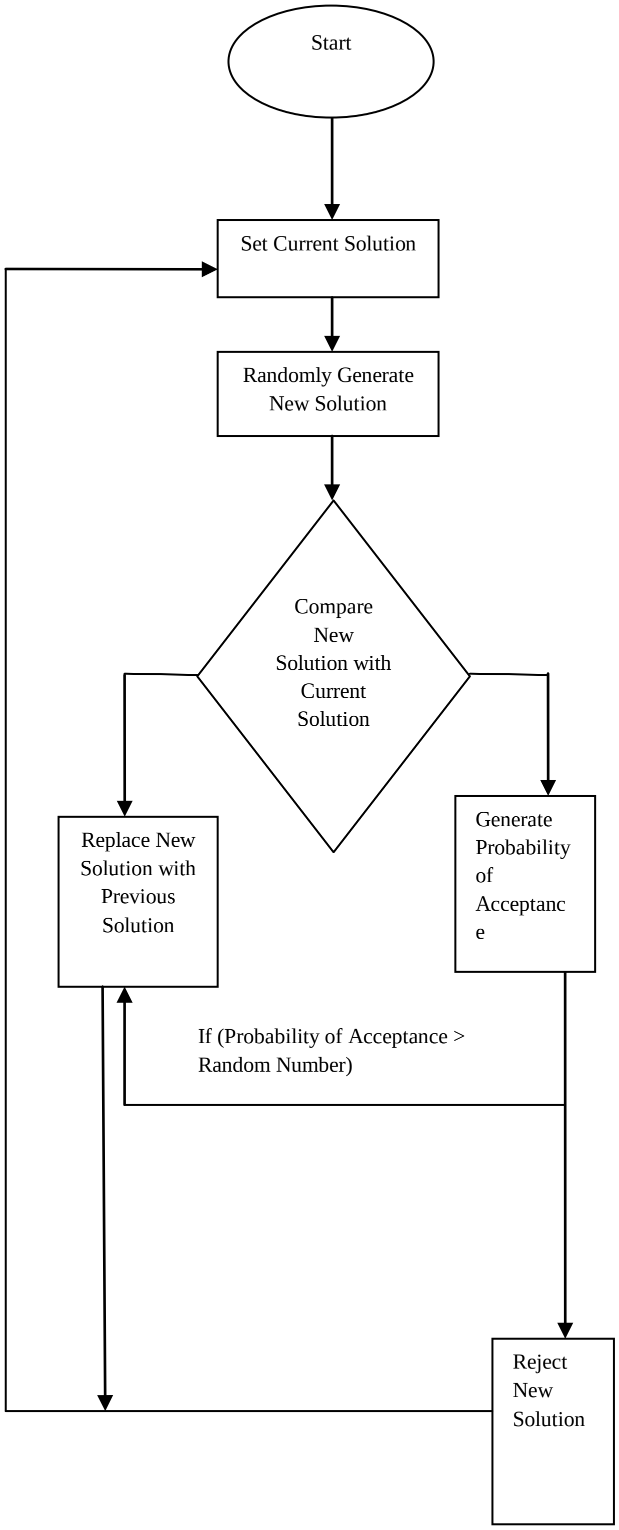

Fig.2 Flowchart for accepting a solution using Simulated Annealing method

In figure 2 if initial consumption value by data center is high than new consumption (after adding resources to host1) value then there no problem to allocate new resources with host 1. Otherwise, acceptance of new resources for host1 getting down. This to be noted higher the temperature, high the possibility of getting worst solution. Thus in every iteration of the algorithm, reduce the temperature T by the cooling ruler ǎ which helps to produce a more optimal solution.

Table.1 Temperature vs. Probability of getting worst solution

Temperature	Probability of Getting Worst Solution		
	1- Worse	2- Worse	3- Worse
10	0.90	0.82	0.74
8	0.88	0.78	0.69
6	0.84	0.72	0.61
4	0.77	0.61	0.47
2	0.61	0.37	0.22
1	0.37	0.14	0.05
0.5	0.13	0.02	0.002
0.25	0.018	0.003	0.000006

Table 1 shows acceptance of worse solution at various temperatures with certain probability. Here k-worse means that difference between initial value and new value. For example, it is 1-worse (i.e., InitialValue-NewValue=1),for 2-worse InitialValue - NewValue=2 and so on.

Suppose when the temperature is 10 (i.e., T=10), the probability $e^{-0.1}$ approx 0.9, for temperature 8 probability 0.88, for temperature 6 probability 0.84 and so on for 1-worse. Again a change in 2-worse, the probability $e^{-0.2}$ approx. 0.82 at temperature 10, for temperature 8 probability 0.78 and so on. Same way in 3-worse, the probability value 0.74 at temperature 10, 0.69 for temperature 8, 0.61 for temperature 6 and so on. Therefore, the temperature increased probability of detecting the worst solution increased that minimize the probability of acceptance of new solutions.

Consider probability P_s at the beginning of the optimization that a worse solution could be accepted. In the same way P_f is set at the end of the optimization.

$$T_s = -\frac{1}{log(P_s)}\ T_f = -\frac{1}{log(P_f)}$$

Consider the total cycle N that has to run. Each cycle corresponds to a temperature. Minimize the temperature according to the equation (1) .

$$T_{n+1}=F.T_n \quad \text{.................................(1)}$$

$$F = \left(\frac{T_f}{T_s}\right)^{\frac{1}{N-1}}$$

where T_{n+1} is temperature for the next cycle and T_n is present temperature. Continue reduce the temperature until a frozen or steady state is reached.

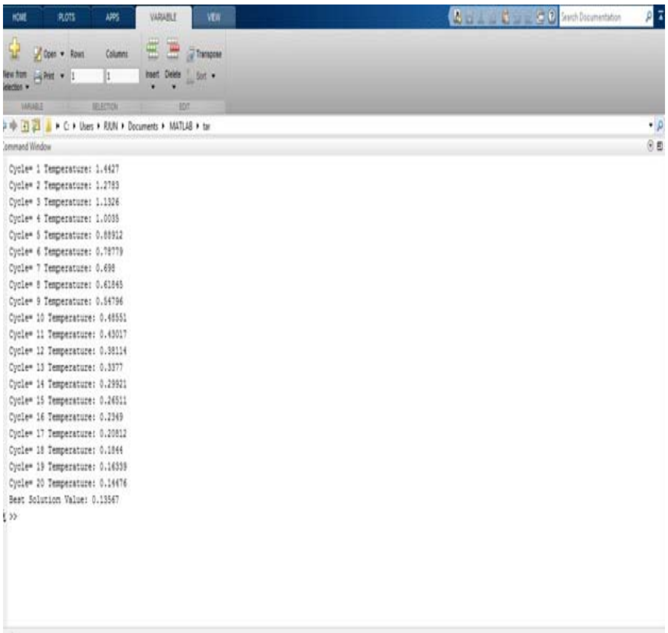

Fig.3 Best solution value after completed 20- cycles matlab output

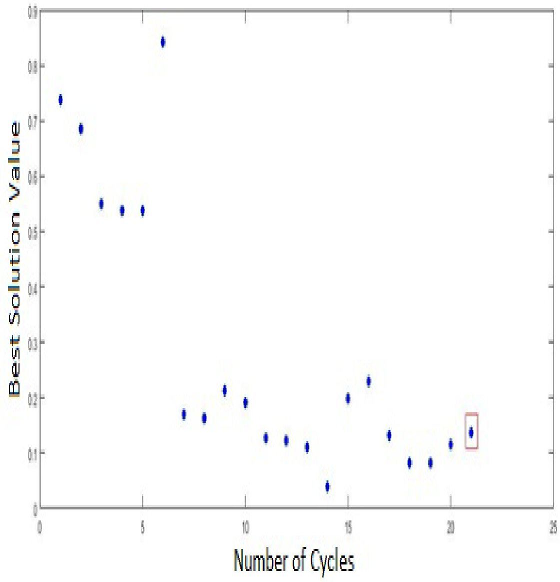

Fig.4 Best possible solution value

Finally after completion a number of cycles ,figure 4 shows a best possible solution value (bounded by rectangle).

IV. FUTURE WORK

A statistical tool that monitor the cloud data center continuously, take appropriate actions to reduce power consumption by looking existing power of the cloud data center before migrated new resource request and necessary cooling equipments that achieve a great efficiency. Thus, need more advance tools that calculate power usage by all the network components in cloud network starting from user personal computer to cloud data center. Service provider minimizes the consumption of electricity by concentrate more on renewal energy source and also proposes new optimization policy using artificial intelligence that forward to more flexible, dynamic and less carbon emission cloud infrastructure [9].

V. CONCLUSION

Simulated annealing defines an interesting similarity between combinatorial optimization and the statistical behaviour of system that slowly moves ahead to a steady state with minimal energy. Simulating annealing encourages both cloud provider and cloud user for allocating proper resources alignment in cloud with maximum profit, minimum power consumption, achieving higher efficiency respectively direct to a green cloud deployment.

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