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Managing Energy Consumption in Distributed Data Centers using Genetic algorithm

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Abstract*: This work shows a multi-target approach for planning vitality utilization in server farms thinking about customary and environmentally friendly power vitality information sources. Cloud computing is a developing innovation. Cloud computing offers administrations such as IaaS, SaaS, PaaS and it gives computing resources through virtualization over data network. Data center consumes huge amount of electrical energy in which it releases very high amount of carbon-di-oxide. The foremost critical challenge in cloud computing is to implement green cloud computing with the help of optimizing energy utilization. The carbon footprint is lowered while minimizing the operating cost. We know that renewable energies that are produced on-site are highly variable and unpredictable but usage of green energy is very important for the mankind using huge amount of single sourced brown energy is not suggested, so our algorithm which evolves genetically and gives practical solution in order to use renewable energy.

Keywords* : cloud provisioning, Genetic algorithms, operating cost minimization, self-determining errands, Total cost of ownership.

I. INTRODUCTION

There are important cloud providers like IBM, Oracle, Google, Microsoft, and Amazon that are developing the world's biggest and advanced data centers across the globe.
The cloud computing platforms offers fully featured services, in order to provide these services cloud providers have huge number of datacenters with huge storage capacities. They provide resources to clients such that the clients could use services from cloud platforms. Renewable and brown energy are used in reducing the operational cost. Due to very high usage of Internet services, there is a huge growth in the number of data centers around the world. Subsequently it is compulsory for all datacenter operators work on providing green energy to the datacenters. Utilization of green energy from onsite sources the best solution for providing renewable energy to the data centers. We know that all the other data centers in the globe are now working with the help of renewable energy either fully or partially. We know that green energy integration should be the cheapest in combination with lower carbon footprint while providing all requirements for data centers. The requirements of data centers include continues availability of energy. As we know there are many constraints for building a data center some those important constraints are servers, power source, cooling equipment and server maintenance. Our work deals with power management which should maintained daily as with increase and decrease in internet traffic power usage changes occur, therefore data needs to be collected and should be subjected in the evolutionary algorithm and the algorithm gives the optimal output. Green cloud computing is a Virtualized computing platform adopts a policy to provide operations of IT by ensuring minimal carbon footprint. Green computing is achieved by minimizing energy consumption, using green energy and best site selection for data centers. Additional efforts for implementing Green architecture are using recyclable materials and efficient load optimizing software. Application area of green computing are optimal management of power, virtualization of servers, data centers architecture, recycling methods, Eco-label for IT products and long-term sustainable design.[1][2]

The scheduling of demand is done considering the availability, generation and utilization of green energy and its cost variation to lower the TCO. In order to reduce the total cost of ownership (TCO)for geo-distributed data centers which are connected in grid with on-site power generation capability. We reduce the cost considering generation and utilization, while targeting effective usage of green energy. Our concept helps in selecting optimal datacenters that could considered in the grid for consuming green energy reduces the TCO. This model uses evolutionary algorithm for efficient power consuming datacenters which is most important scenario in today's research. Genetic algorithm is an improvement for other methods for looking through vast number of spaces. Wellness is controlled by analyzing countless individual wellness cases. This procedure can be exceptionally productive if the wellness cases likewise develop by their own GAs.[1][9]
The proposed model deals with managing energy consumption between data centers which are geo distributed and connected with each other in a grid. Data centers are self-powered with its own power generation, supply, backup and management resources.

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The objective is to reduce total cost of ownership which includes even reducing carbon footprint. The evolutionary algorithm after analyzing the power generation and utilization in grid gives output that which data centres in the grid could considered for green energy utilization and states which data centre needs to be managed with additional brown energy.

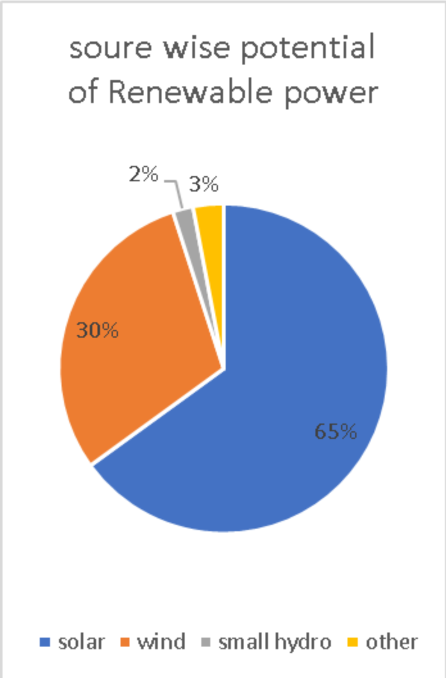

Fig.1.Total renewable energy from source

II. OPTIMIZATION FRAMEWORK

Table 1: Notations

S	Set of data centres with m_s number of servers
∂_s^{fh}	Average utilization
σ	Total cost of the server
ω	Brown energy cost
r	Renewable energy cost
ϵ	Empirical constant
P_{peak}	Power that is consumed while the server is running at peak utilization
P_{idle}	Average power consumed when it is in idle
E_s	Power usage effectiveness (PUE)
α	Cost of server
τ_{su}^{afh}	Denote the number of requests mapped from client region 'u' to data center 's', at hour 'h' for application 'a'
B	The processing rate of the server and with the job size 'J_a'
R_{si}^{fh}	Denotes the amount of renewable energy from source I while hour 'h'
θ_s^h	cost of brown energy at a data center 's' while hour 'h'
δ_{si}^h	cost renewable energy at a data center 's' while hour 'h'
PB_s^{fh}	Brown energy fetched
P_s^{fh}	Total power consumed

Let us assume S be the set of data centers housing m_s number of servers. [1]

The average utilization is calculated as

$$\partial_s^{fh} = \frac{\sum_{u,a}\tau_{su}^{afh} J_a}{m_s B} \qquad (1)$$

Let p be the fraction of servers failing at any given site. The processing rate of a failed data center reduces to $(1-p)m_s B$. [1]

The data center utilization after the failure can be expressed as

$$\partial_s^{fh} = \begin{cases} (1) \\ \frac{\sum_{u,a}\tau_{su}^{afh} J_a}{(1-p)m_s B} \\ 0 \end{cases} \qquad (2)$$

The total power consumed by s ∈ S, at hour h ∈ H is modeled as

$$P_s^{fh} = m_s (P_{idle} + (E_s - 1)P_{peak}) + m_s (P_{peak} - P_{idle})\, \partial_s^{fh} + \epsilon$$

(3)

Brown energy usage: Let us assume θ_s^h is the price of brown energy at a data center s during hour h and δ_{si}^h be the price of green energy of type i, i corresponds to solar, wind, small hydro and other. PB_s^{fh} denote total brown energy drawn at hour 'h' and R_{si}^{fh} denotes the amount of green energy used from source i. As the brown energy is utilized only after proper utilization of green energy, the brown energy that is used from the grid is given by

$$PB_s^{fh} = P_s^{fh} - \sum_i R_{si}^{fh} \qquad (4)$$

Cost calculation:

Server cost: Let α be the cost of purchasing a server. Total cost of servers in all the data centers is

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$$\sigma = \alpha \sum_s m_s \tag{5}$$

Brown energy cost: The cost of brown energy that is utilized from all the data centers is given by

$$\omega = \sum_{s,h,f} \theta_s^h PB_s^{fh} \tag{6}$$

Renewable energy cost: The cost of green energy that is utilized from all the data centers is given by

$$r = \sum_{s,h,f} \delta_{si}^h R_s^{fh} \tag{7}$$

Final objective is to minimize TCO(F):

$$F = \omega + \sigma + r\,; \tag{8}$$

The final objective if is to minimize the sum of all the before mentioned costs.

III. METHODOLOGY

Genetic algorithm is a search technique which developed inspired by Charles Darwin's theory Genetic algorithms are part of evolutionary algorithms which are heuristic search algorithms genetic algorithms follow the process of natural selection. The Genetic algorithms are applied in the fields of engineering and considered as the best solution for optimization problems.[10]

The algorithm is based on the population and natural genetics where the individual's population is modified, based on evolution and is hence termed as an evolutionary algorithm. The algorithm produces a random initial set of individuals of a population selected at random in each step of the process, and they are input for the next repeated steps for the algorithm. Selection, crossover and mutation are the three operations which leads to the creation of new population and those three steps are repeated until best chromosome is produced. [4][10]

psuedo code:

```
START
Generation of preliminary population
Computation of fitness
REPEAT
    Selection
    Crossover
    Mutation
    Compute fitness
UNTIL Ideal population is generated
STOP
```

GAs have different kind of advantages which have made them immensely popular. These include Does not require any derivative information.This method is effective and low time consuming when compared to other techniques. It has good parallel capabilities. It can optimize continuous, discrete functions and multi objective problems. Gives list of solutions. It deals with any kind of problem and provides solution for it and it gets better overtime. If the search space is very huge then Genetic Algorithms have ability to provide accurate solution with in very less duration of time. Genetic algorithm is attractive to use in which it can provide solution to optimization problems.[4][10]

IV. RESULTS AND DISCUSSION

The proposed model is solved centrally using Genetic Algorithm on a device with Intel i5 processor and 8 GB of RAM. The evaluation is done on generation and utilization of green energy by datacenters on the optimization of the energy usage. Using the green energy depends upon the generation and utilization, it improves evolutionally on implementing genetic algorithm constantly, the population is generated with better optimization. We obtained the necessary data for Grid A with 30 data centers(nodes) with 49 edges in it and Grid B with 40 data centers(nodes) with 49 edges in it, all these data centers are mapped to each other in a certain pattern in which data centers that are located at different geographical locations. The collected data consist of amount of generation and utilization in terms of units. Considering 24 hours of working and of no failures the values are calculated the best chromosome that is produced states which datacenters are eligible of green energy utilization and remaining data centers are supplied with brown energy, with this we can ensure that minimal TCO is achieved. After subjecting data collected to genetic algorithm for Grid A the minimal TCO achieved at 51% of green energy utilization in data centers and remaining 49% data centers can be switched to brown energy and for Grid B the minimal TCO achieved at 58% of green energy utilization in data centers and remaining 42% data centers can be switched to brown energy. The result that is generated with genetic algorithm is the best chromosome.

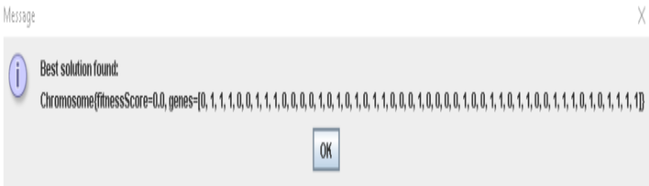

Fig.2.best chromosome generated

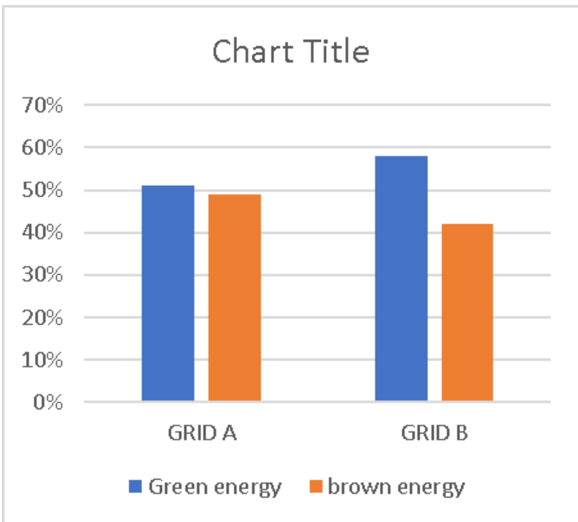

Fig.3.Percentage Of Green Energy And Brown Energy Used In Grids

V. CONCLUSION

The datacenters all around consuming huge amounts of energy in order to meet today's needs.

The biggest challenge is to reduce carbon footprint by utilizing renewable energies. Utilization of renewable energies is a complex process as it is variable and random. The result shows 51% of renewable energy usage for grid A and 58% of renewable energy usage for grid B. The results demonstrate that using highly variable renewable energies can be possible by determining optimal data centers and integrating with brown energy. In this dissertation we charted out a new but complementary direction, exploring another aspect of efficiency. Our work concludes that efficient usage of green energy in the grid of datacenters and in integration with brown energy lowers the total cost of ownership and carbon footprint.

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