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Balancing of Load in Smart Grid Environment Using Cloud Computing

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Abstract: Based on the time-of-use patterns of individual customer electricity consumption, this article proposes a method for regulating the load on a single feeder and a node or distribution transformer. The reality that different customers use different amounts of electricity at different times is accounted for by this method. The findings of a research project that made use of three different service agent strategies in addition to an algorithm for live VM migration are described in this article. The authors of this paper were responsible for carrying out the investigation. The GWO algorithm was put into place as a means of finding a middle ground between the variety of different network resources that were available at one time. Using VM Migration as an experimental setup, we present the findings of the GWO algorithm in this article. VMware is responsible for developing VM Migration. Cloud service providers have the possibility to implement the GWO energy efficiency enhancement system, which can save them both money and effort. This is a win-win situation for everyone involved.

Keywords: *GWO, Cloud computing, Load balancing, smart grid*

1. Introduction

It is essential to have access to extensive quantities of data storage space in addition to stringent safety precautions for there to be a proliferation of smart devices. The idea of doing computing in the cloud was developed with the intention of finding solutions to the issues that were discussed previously. In recent years, there has been a meteoric rise in the demand for cloud computing services. This demand has been matched with an equally meteoric increase in supply [1]. If users have access to the Internet and are utilizing the cloud, they can make use of a wide range of services regardless of where they are physically situated. Cloud computing has the potential to offer a wide variety of benefits, including low costs for the storing of data, high speeds and performance levels, and adaptability. The data centers that are part of the cloud host a significant number of physical processors. (PMs).

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Virtualization is a technology that enables cloud service providers to offer their customers the flexibility of allowing their customers to share resources and virtual computers (VMs) [2]. This enables cloud service providers to offer their customers the benefits of cloud computing. There is a possibility that research into methods of intelligently loading VMs into PMs will result in a reduction in both the amount of energy used and the amount spent on operating expenditures. Cloud computing can be implemented using any combination of public, blended, or private resources. This is something that is technically possible. The utilization of cloud computing has a great number of benefits, but there are major concerns regarding the level of latency and the level of security.

The application of fog computing is a powerful tool that can be used to facilitate the distribution of services with low latency at the periphery of a network. The use of computing done in the cloud not only makes it easier for users to keep in continuous communication with one another, but it also helps reduce the strain that is placed on the cloud. A predetermined communication pathway, in this case WiFi, enables information to be passed back and forth between the user and the fog.

The process of consolidation begins with the moving of simulated computers, which is followed by the relocation of those computers. The complexity of cloud data centers makes it impossible for users to rely on the initial placement of their virtual machines (VMs), even though placement is intended to intelligently position VMs based on the processing capability of each node. This is because users cannot rely on the initial placement of their VMs [3]. VM relocation refers to the process of reorganizing VMs based on the amount of bandwidth that they consume, and it is the method that is the most efficient technique for distributing network traffic evenly [4].

When intelligent task assignment is implemented, there is a sizeable increase in the amount of money that is needed to keep operations running [5]. An algorithm for live virtual machine migration is presented in this research as a means of obtaining optimal utilization of a variety of network resources. Because of the introduction of VM-to-PM packaging, the total number of operational PMs has been reduced by a sizeable margin. A VM migration is the process of moving a virtual computer to a new location while simultaneously redistributing network traffic. The resources that are available through your network will be utilized in a more efficient fashion.

Based on the patterns of electricity consumption at the time of use by individual consumers, we describe in this article a method for balancing the load on a single feeder, a node, or a distribution transformer. Different consumers use different amounts of electricity at different times and this technique can also be utilized to equalize the burden that is being carried by a distribution transformer.

2. Related works

An intelligent decision support system (IDSS) [6] was used were integrated together to provide the utility with the capability of communicating in both directions with its end users simultaneously. The knapsack algorithm for wind-driven optimization (WDO) to cut down on the amount of money spent on electricity while simultaneously raising the level of consumer satisfaction. There is a description that includes both the minimal and maximum requirements that must be met. When we were determining how to categorize the various smart home appliances, we took into consideration not only the preferences of our customers but also the reputations of the various brands [7].

An ACOA-based model, which is based on the ant colony optimization algorithm, was recommended as the best method to achieve optimal power flow by [8]. This is because the algorithm is based on the ant colony optimization model. (OPF). The primary objective of the OPF was to ascertain the load that would be necessary to continuously provide support to the end user. In the research that has been made public, a variety of statistical approaches are utilized to present potential solutions to these issues.

The writers centered their attention on load scheduling as a means of achieving a more equitable distribution of the load. This gave rise to the concept of a multi-agent system for load balancing, in which each consumer would operate as a separate agent and the electric burden of all consumers would be divided into discrete time slots. This led to the development of the notion of a multi-agent system for load balancing [9].

A load-balancing system that involves multiple agents was developed. The electricity was turned on and off for each agent at regular intervals that had been established in advance. Within the scope of this research endeavor, investigations were carried out into the residential, commercial, and industrial sectors of demand-side businesses. There is coverage of both the fundamental concepts behind DEA as well as an improved variant of DEA that contains five trial vectors. This improved variant of DEA is described in greater detail. To bringing the population up to speed, both a modified vector and test vectors were developed [10].

The challenging issue of simultaneously optimizing for several different characteristics is addressed in [11]. A DEA experiment that made use of Pareto sets (PS) was carried out so that the character of the optimization problem could be evaluated. The model that was proposed is an example of a type of evolutionary algorithm known as a multi-objective evolutionary algorithm. It was successful in mapping complex PS structures.

In [12], the authors suggest a forecasting model that is based on a hybrid evolutionary strategy as a means of taking into consideration the extensive variety of energy rates. This model is proposed as a means of taking into consideration the extensive variety of energy rates. Using data that looks into the future, the algorithm makes predictions about how prices will change during the following day and the following week. PSO and a neuro-fuzzy logic network worked together to produce the composite evolving strategy. This strategy was the result of their efforts. The unpredictability of the selling rates in the energy market prompted the implementation of this hybrid strategy as a solution to the problem.

3. Proposed Method

Based on the patterns of electricity consumption at the time of use by individual consumers, we describe in this article a method for balancing the load on a single feeder, a node, or a distribution transformer. This method is since different consumers use different amounts of electricity at different times. This technique can also be utilized to equalize the burden that is being carried by a distribution transformer. As a direct result of this, the method is suitable for use in smart grids that already possess measurement infrastructure. This makes the method suitable for use in smart grids.

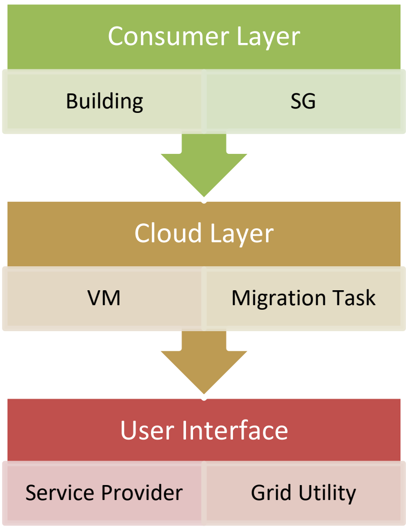

Fig 1: Proposed Cloud Framework

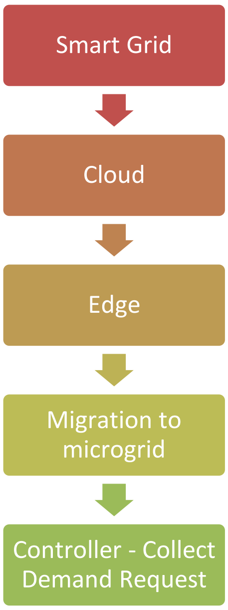

Fig 2: Data Processing Flow

GWO

This heuristic approach to tracking prey and taking control was conceptualized after being influenced by the natural behaviors of wolf packs. There are four separate levels of authority, each of which is denoted by a α, β, δ, and γ. α is the most perceptive member of the group, and as such, it directs the other members β and δ of the group in the strategies that they apply when they are searching for food.

The α appear after the in the sequence of event chronology, and γ is the weakest of the three in terms of its power. It is exceedingly clear that they do not possess the necessary qualities of a leader, and as a result, they should be disqualified from the competition. To keep prices down and prevent spikes in demand, the α gives the most weight to the timetable of the member who has the best overall health when choosing how to distribute electricity to smart homes. This is done to prevent spikes in both costs and demand. First, populations are generated at random, and then they are examined.

$$P(k,n)=rand(pop,Atn),$$

where

pop - gray wolves population and

Atn - overall appliances.

With the help of coefficients D and E, one can conduct a comparison of the many objective functions that are offered by the different search agents.

Encircling Prey

Encircling Prey is a method of hunting that is practiced by gray wolves. This method involves the wolves surrounding the prey animal in a close circle before making their attack. Equations (2), and (3) are used to construct a quantitative model of the encircling behavior displayed by gray wolves. This model is used to better understand the dynamics of this behavior. The preceding formulations have been adapted from.

$$P(t+1)=Pp(t)D\times Atn,$$

$$Atn=||E\times Pp(t)P(t)||,$$

where

Pp - prey position,

P - wolf position.

D and E - co-efficient vectors:

$$D=2b\times r_1 b$$

$$E=2\times r_2$$

where

r1 and r2 - random vectors.

Following a predetermined number of repetitions, the value of D is brought all the way down to zero, and a value for E ranging from 0 to 2 is chosen at random from the range. This number is a measurement that is used for determining the attractiveness of food, which is also referred to as E.

Hunting

During the hunt, the α serves as the principal guide while also performing any additional duties that may be required. Secondary participants β, and δ remain near the target because they have the most accurate information regarding the location of the target. The remaining players, including γ, will rearrange their positions so that they are equivalent to those of the winner once the top three responses have been determined. Utilizing the equation, one can determine the precise position of the canines at any given moment in time.

$$P_{t+1} = v1 + v2 + v33$$

where

$$v1 = v\alpha D1 \times (d\alpha)$$

$$v2 = v\beta D2 \times (d\beta)$$

$$v3 = v\delta D3 \times (d\delta)$$

where vα, vβ and vδ - best solutions:

$$P\alpha = E1 \times v\alpha v$$

$$P\beta = E2 \times v\beta v$$

$$P\delta = E3 \times v\delta v,$$

where g - variable gradation:.

$$g = 2t2Mx.itr$$

The objective function is:

$$FitnessF = par \times XSa(t)$$

Mx.itr - maximum iterations,

Pop - total population,

Atn - total appliances and

F - fitness function.

α - best participants

β and δ - secondary solutions.

This method is as a search for the optimal value that can be achieved within the constraints of what is achievable. This is accomplished by branching the feasible region into smaller regions, removing the parts of the region that are not feasible, and then continuing the process over the remaining parts of the feasible region. This allows for a more precise analysis of the feasible region. Once the search tree reaches a point where it can no longer be branched further and all the nodes have been linked, the method is considered to have reached its conclusion.

The issue has been resolved, and the algorithm has reached the place where it should end its processing at the appropriate time. If GWO is terminated in the correct fashion, which means not stopping the process too early, the response will unquestionably be the most optimal one possible from a global perspective. If GWO were to end normally without discovering a solution to the original challenge, then the feasibility of the project would be questioned.

4. Results and Discussions

Cloud Analyst is a computing simulation tool that is housed in the cloud, and to accomplish the goals of this investigation, we made use of it. Dividing network traffic, the use of certain techniques for live virtual machine migration has been proposed. In the paper, the results of the experiments that were conducted using the live VM migration algorithm and three different service agent strategies are described. When moving a virtual machine (VM) in real time, the goal is to find the technique that is the most effective at doing so while simultaneously minimizing costs and maximizing throughput.

When the live VM migration technique is utilized in conjunction with the three service agent strategies, there is still ongoing debate regarding the cost of GWO, the present configuration of the fee should not be preferred. The amount of time that passes between a virtual machine submitting a request during the initialization procedure, the execution of that request, and the receipt of a response is referred to as the reaction time. The quantity of time that is spent attending to an individual request in its entirety is referred to as the processing time. The processing periods for each of the three service agent methods are broken down in Figure 3, which provides an overview of the data. As a result of the combination of the real-time VM migration algorithm and ORT, we can select the fog that provides the quickest response time. This enables us to select the fog that best meets our needs and because of this, the processing time is optimized to its full potential.

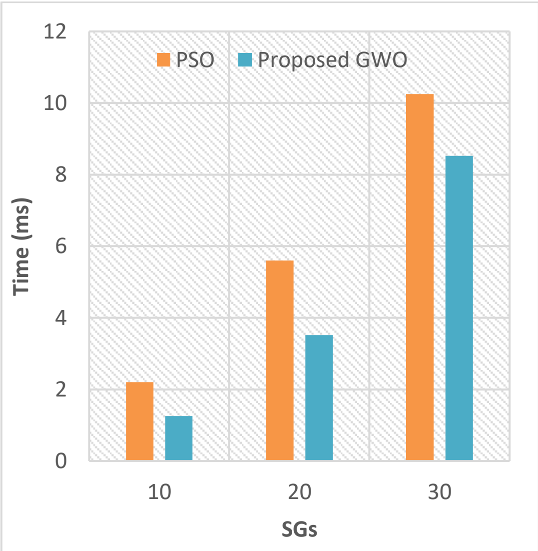

Fig 3: Processing time

The term processing time refers to the total quantity of time that must elapse before a request can be satisfied. The processing periods for each of the three service agent methods are broken down in Figure 4, which provides an overview of the data. As a result of the combination of the real-time VM migration algorithm and ORT, we can select the fog that provides the quickest response time. This enables us to select the fog that best meets our needs.

A centralized web server that is connected to fog nodes located all over the place stores the data regarding the grid electricity production. These fog nodes can be found anywhere. Each computer that is part of the cloud is connected to a specific region of the world, and it is able to make decisions in an instant based on the data that is connected to that region to figure out the approach that will be most successful in meeting the needs of the users in terms of the amount of electricity that they consume.

Cloud hosts carry on a conversation with a remote server to determine which energy supplier is best suited to fulfill the requirements of helpless SGs. This information is gleaned through the course of the conversation. It is hoped that by putting into action the system that has been proposed for increasing energy efficiency, the costs associated with downtime and maintenance of cloud servers can be reduced. It is kept to a minimum how much time it takes for the server and the SGs to respond to one another, which serves to keep delays to a minimum.

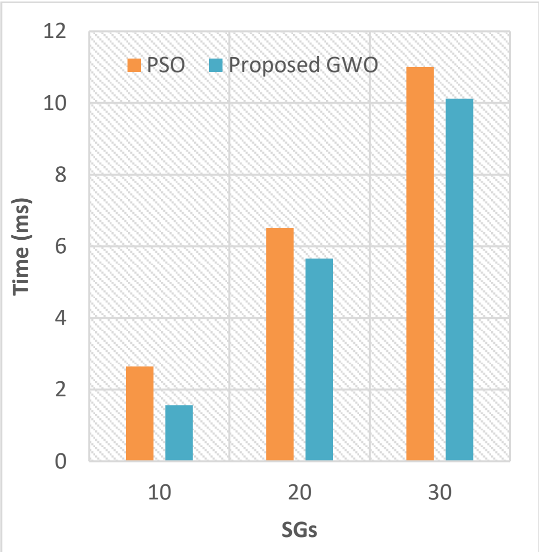

Fig 4: Average Response time

The term reaction time refers to the amount of time that elapses between the point in the initialization procedure at which a request is made to the virtual machine and the point at which a response is obtained from the virtual machine. Figure 4 depicts the average response time for each of the three service agent techniques that were incorporated into the live VM migration algorithm. These techniques were used to migrate live virtual machines.

Figure 5 provides an illustration of the average response times for the three service agent techniques that were incorporated into the live VM migration algorithm. These response times are presented in milliseconds. The response times are sped up to their full potential because of an algorithm that, when combined with ORT, chooses the cloud that demonstrates the shortest reaction time. This causes the response times to be accelerated to their maximum potential.

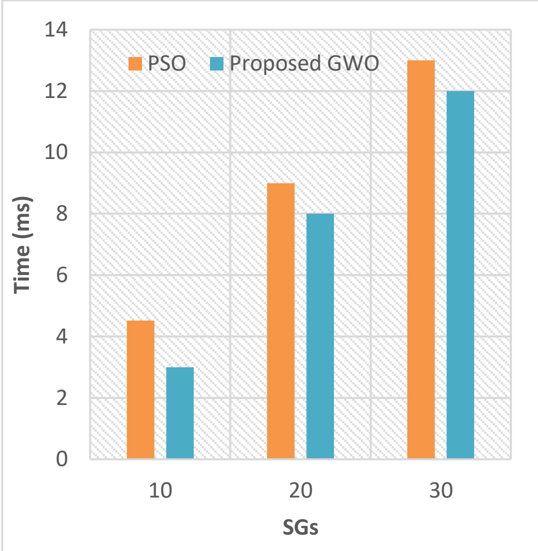

Fig 5: Overall Response time

5. Conclusions

The patterns of electricity consumption at the time of use by individual consumers, we describe in this article a method for balancing the load on a single feeder, a node, or a distribution transformer. This technique can also be utilized to equalize the burden that is being carried by a distribution transformer. This article demonstrates that the VM migration algorithm with ORT is preferable because it chooses the fog with the quickest reaction time for the experiment. The reason for this is demonstrated in the previous sentence. This is an example of one of the arguments that are presented in the article. Cloud hosts carry on a conversation with a remote server to determine which energy supplier is best suited to fulfil the requirements of helpless SGs. This information is gleaned through the course of the conversation. It is hoped that by putting into action the system that has been proposed for increasing energy efficiency, the costs associated with downtime and maintenance of cloud servers can be reduced.

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