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Energy Aware SLA with Classification of Jobs for Cloud Environment

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Abstract

The accelerated growth of the cloud eco-system is leading to the progress of new services, innovative ideas for the service replenishing and the newest interaction models both among the cloud providers and the customers which take advantage of the cloud resources. SLAs are one of the factors which allow for different interactions by keeping the objectives over privacy,QoS attributes and security constraints driving towards QoP attributes, the description of actions is needed in order to deliver the services according to the QoS attributes as expected by the customers. Energy aware SLAs extends the existing SLA agreements in order to include energy and carbon aware parameters. In this paper we propose an approach in order to relax certain jobs in a standardized way to obtain high energy consumption without disturbing the efficiency and availability of the system especially during the peak load times. The results for the above proposal are being discussed in this paper and were able to find that it is energy efficient.

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Keywords: Cloud computing; Service Level Agreement; Energy Aware SLA; Cloud federation;

1. Introduction

Cloud computing is a distributed computing prototype which provides the customers with a wide variety of services. Cloud providers provides their customers with services and charges as per their usage. The cloud environment provides the customer with a different virtualized platform that helps the customers to achieve their jobs with minimum finish time and lesser costs.

Today, many of the organizations benefit from cloud computing to host their applications. It eliminates the need to invest in new IT infrastructure that includes network, computers, software and database administrators. It expels the need to create new data centres and manage them, thereby saving a huge amount of cost. It also improves accessibility since any user can access the services from anywhere. The customers of cloud computing need not have to own the infrastructure and hence need not care about their maintenance.

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Cloud computing uses a pay-as-you-use scheme. The various services provided by the cloud vendors can be broadly classified as Infrastructure as a Service, Platform as a Service and Software as a Service. Also the cloud computing model delivers softwares, computing power,storage services, and platforms on demand to a wide variety of customers over the internet and thus making it possible for users to use services provided by cloud providers from anywhere around the globe at any time. The chances of improving the way services are provisioned and managed increases since the cloud service model booms and becomes ubiquitous,this allows the service providers to satisfy the various needs of their consumers. In this stage of necessity, SLAs(Service Level Agreement) crop up as the main facet, since these serves as a basic for the most wanted quality level of the services between the service consumer and the provider.

In a service agreement lifecycle the SLAs plays a vital role by catching the various service expectations and accountabilities.An SLA always will not guarantee that you will get the service it tells, but makes sure that the services are delivered according the maximum QoS level. An SLA can lighten the risk of choosing a poor quality service. One [1] of the main concerns in IT industry these days is the large acceptance of cloud-based services, high amount of energy consumption and carbon emissions of the cloud infrastructures.According to current trend, the investigation went about the ways cloud providers can meet the SLA with sustainable requirements. The carbon emissions produced from the cloud resources should not go beyond a particular amount in these types of SLAs.As a number of organizations and people are shifting their works to the cloud resources, the drive towards analysis and exposure will lead to the request for differentiated sustainable cloud services. Hence the need for a new class of services, apart from the current set of services are to be adopted by the cloud provider. This will provide clients with specific service-level agreements which can be termed as Energy aware SLAs in which the available energy is to be used efficiently especially during the peak load times, which is our main focus.These energy aware SLAs extends the existing SLA agreements in order to include energy and carbon aware parameters.

This paper presents with an Energy aware SLA to efficiently utilize the available resources wisely by relaxing certain jobs in a organized way in order to obtain high energy consumption with minimized effect on the efficiency and availability of the underlying system. An algorithm is being proposed to do the above. The achieved results show that the proposed method can reduce the energy consumption rather than the traditional one which executes the all types of jobs.The organization of the paper is as follows: Section II gives a brief description on SLAs and Energy Aware SLAs. Section III gives some of the related works, section IV throws light on a Case study. Section V defines the problem; section VI about the proposed method. The following two sections gives details on the algorithm used and the results obtained and we conclude the paper along with some improvements to be done in future in Section IX.

2. Energy Aware SLA-Overview

Service Level agreements play an important part in any of the customer based services.In the case of cloud computing also SLAs paves a path towards customer satisfaction as well to satisfy the Quality of the services provided.The Energy Aware SLAs comes into the picture of cloud computing inorder to make the cloud ecosystem more eco-friendly.

2.1. Service Level Agreements

A *Service Level Agreement*(SLA) is a formal, negotiated document that gives the detailed description on the services provided to a Customer[13]. The various terms specified in a SLA are to be monitored regularly.A *Contract* is an agreement between two or more customers/providers whereas service-level agreement is a portion of a service contract in which a service is defined in a formal way. The main service aspects are quality,quantity,scope, responsibilities and those of which are agreed between the service provider and the service customer.

The main highlight of cloud computing is the employement of shared resources, which in turn is made possible through the shared cloud infrastructure. The SLAs spreads over all the cloud environment. Usually the SLAs are given as a customer based agreement.But here it is offered by the service providers as a service based agreements .The underlying side of cloud computing, compared to SLAs, it is very difficul to find out the main cause for service disturbances in cloud environment as it is very complex by nature. Here the applications are being brought from a

hardware to the cloud resources.Due to this reason there is a need to attain the same level of service or sometimes high levels of service.

The cloud service SLAs mainly focuses on the various properties of the data center as well as the properties of the net to support the other SLAs. The SLA management approach takes care of two phases: the first one where the contract is being negotiated and next one is monitoring whether the given terms are satisfied in real-time. SLA Management comprises of the SLA contract definition: basic schema with the QoS parameters; SLA negotiation; SLA monitoring; SLA violation detection; and SLA enforcement according to defined policies. In our proposed method mainly SLA violation detection is dealed out.

2.2. Energy Aware Service Level Agreements

Energy aware SLA contracts are agreements between Cloud providers and service customers, which reflects the agreed scope for the cloud provider/Data centre to operate in energy aware way and at the same time, guarantee a certain level of QoS (Quality of Services) for the IT customer. A number of organizations and even people moves their work to the cloud resources these days, this movement towards the evaluation and revelation will drive in the demand for assessable green cloud services.

The cloud providers may have to additionally offer a new set of eco-friendly services, with the services that they provide currently. This new set would add customers with specific SLAa which can be termed as Energy aware SLAs in which the energy used to execute their tasks at hand is specified or in other way we can say that the available energy is to be used efficiently especially during the peak load times, which is our main focus.

Fig. 1. Energy Aware SLA

Energy Aware SLA extends the existing SLA agreements in order to include energy and carbon aware parameters. By using Energy Aware SLA relaxing of certain jobs are done in a standardized way in order to achieve high amount of energy consumption with minimized effect on the efficiency and availability of the system. The energy requirements on the data centres have increased massively in the last few years. One of the optimization challenges for reducing its energy requirements is to keep servers well utilized .The amounts of money spend by the customers and data centres for the purpose of energy requirements are also increasing day by day.

During the peak hours a large amount of energy is required to process and execute the jobs by the cloud provider, here comes the significance of Energy Aware SLA which is an energy efficient SLA which specifies certain requirements to the provider asking to hold back the low priority jobs for some period of me that is during the peak time which will in turn reduce the power consumption. Also the $C0_2$ emission bound is also specified in the agreement so that the available energy is utilized in an efficient way also by reducing the amount of money at the customer side and the provider side.

3. Related Work

As we have already mentioned in Section II a SLA is an agreement between the service provider and the service customer whereas a Energy Aware SLA is an extension to the normal SLA with some energy aware parameters. The

data centers, which runs under the Cloud computing scheme executes a variety of applications that run for a few seconds as well as for long time span on hardware resources which is shared these days. The challenge of an on demand resource allocation and furnishing in response to various time spanning tasks are to manage the various applications running/created on a data center. The main objectives of green Cloud computing aims at efficient processing and utilization of computing infrastructure.In addition to this was to minimize the energy consumption. This ensures that in future the cloud computing should turn out to be more environment friendly. Otherwise,this will cause an extensive increase in energy usage.

In [1] the need of green SLAs over SLAs in Cloud Environment and how cloud providers can meet SLAs with sustainable requirements are being discussed. The leased resources should not surpass a fixed amount of carbon emissions;this was the condition given by the cloud providers .A resource management framework is being proposed which allows the cloud providers to arrange the resources in VDCs(Virtual Data Centers) across a geo-distributed infrastructure.They aimed at reducing operational costs and green SLA violation penalties. A generic architecture to enable Demand Response between Energy Provider and Data Centres realized in All4Green [2]. In [3] they proposed an approach for cloud providers with high performance computing to offer a green SLA service. All of the client job specifies a green SLA, in that the minimum amount of green energy that must be used to run the job will be specified. If the green SLA is meet the provider will earn a premium, whereas the provider will have to pay the penalty if it accepts the job but violates the green SLA.

An application oriented green SLAs [4] which allow the contract between computing service providers and consumers to include constraints on the acceptable environmental impact.These papers focused on data centres that exploit green energy [5][11]. Among these, [6], [7], [8] studied the scheduling of deferrable batch jobs inorder to increase the use of reusable energy. Krioukov et al. proposed to adjust service quality in non-deferrable interactive workloads [10]. For data centres that run a both interactive and batch workloads, [5] and [11] proposed to alter the amount of batch processing dynamically. In general, the above works focused mainly to maximize the use of green energy while maintaining performance bounds. Even though the above works focused on many aspects of energy consumption the method proposed in our paper is a novel approach to efficiently manage the resources inorder to satisfy the requirements given by consumers via SLAs, but also to reduce energy consumption which is made possible with the Energy aware SLA.

4. Problem Description

One of the main problem that is faced by the IT industries these days is the acceptance of cloud services, the large amount of energy consumption and carbon emissions from the cloud infrastructures. The governments and other organizations have asked the IT enterprises to adopt green IT and monitor the carbon emissions and give report to the concerned authorities.Also they have asked to put on actions and in order to control the various impact on the environment of the cloud resources and the running applications. According to current trend, the investigation went about the ways cloud providers can meet SLAs with sustainable requirements. The carbon emissions produced from the cloud resources should not go beyond a particular amount in these types of SLAs.

As a number of organizations and people are shifting their works to the cloud resources, the drive towards analysis and exposure will lead to the request for differentiated sustainable cloud services. Hence the need for a new class of services, apart from the current services are to be adopted by the cloud provider. This will provide clients with specific service-level agreements which can be termed as Energy aware SLAs in which the available energy is to be used efficiently especially during the peak load times, which is our main focus.

5. Methodology

The energy requirements for data centres have grown massively in the last few years. One of the optimization challenges for reducing its energy requirements is to keep servers well utilized .The amounts of money spend by the customers and data centres for the purpose of energy requirements are also increasing day by day. During the peak hours a large amount of energy is required to process and execute the jobs by the cloud provider, here comes the significance of Energy Aware SLA which is an energy efficient SLA which specifies certain requirements to the provider asking to hold back the low priority jobs for some period of me that is during the peak time which will in turn

reduce the power consumption. Also the $C0_2$ emission bound is also specified in the agreement so that the available energy is utilized in an efficient way also by reducing the amount of money at the customer side and the provider side.Energy aware SLA is given by the client as a XML file to the cloud provider in which in order to efficiently use energy especially at the peak load times by temporarily holding back certain jobs, say for example the low priority are kept in hold for some time. For that the following steps are done: Firstly the jobs are to be prioritized based on the metrics i.e. The Length of the job, the later deadline job etc. Once the prioritization is done, the low priority jobs are kept in hold at the time of peak load which will be specified by the cloud provider. During the peak time only the jobs with priority 1 is submitted to the broker. As a result the high priority jobs can use the enough energy from the available energy.

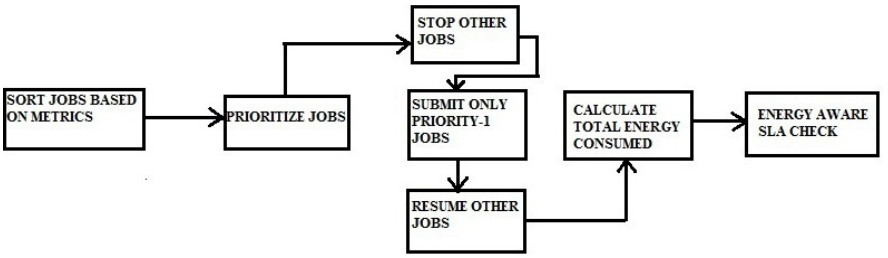

Fig. 2. Process Flow

Once the peak time is over, other jobs are allowed to resume. Finally the energy consumption is calculated and checked with threshold value which is specified in the Energy aware SLA also the $C0_2$ emissions bound is specified in the SLA is checked. If the particular threshold is violated the Energy aware is violated.

6. Assumptions and Algorithms

The main assumptions which are used in the method are discussed in this section. Among them the most important is that the jobs are independent from each other. The jobs after prioritizing are assumed to be scheduled during the peak time. The jobs once in progress should not be moved to a different virtual resource. The Cloudlet with the highest length is considered to be the job which consumes the maximum energy to execute that particular job; the same assumption is applied in case of the other jobs.

6.1. Green Algorithm

Green algorithm describes the steps to minimize the energy consumption and efficiently use the available resources. The algorithm initially gets the cloudlet list and sort the cloudlet list based on the cloudlet length in descending order also sort the cloudlet list in ascending order based on deadline. Based on the prioritization list, we get two categories of jobs i.e. the jobs in descending order based on cloudlet length and based on the deadline in ascending order.

The mean of the two above priorities will make the final priority for scheduling the jobs during the peak time .The jobs with priority 1 is submitted to the broker and are executed. Rest of the jobs are paused till the priority 1 jobs are finished with their execution, once these are done executing the other jobs are allowed to resume back. The power is calculated in terms of the total work done in the particular amount of time and the energy is being calculated from the power value which we have obtained already.The power consumed is calculated and from that the energy consumption is calculated. The carbon emissions are to be calculated but since we deal with simulation the carbon emissions will be zero by default. Once the calculations are done the value is cross verified with the Energy aware SLA threshold values. If the threshold value is exceeded the Energy aware SLA is violated and if not Energy aware SLA is satisfied.This algorithm provides the output whether the SLA is being violated according the various conditions provided.

Algorithm 1 Green Algorithm

Input: Energy Aware SLA=(Energy consumption threshold, carbon emissions bound])
Output: Priority decision P =(priority 1,2,3) Job Execution J=(Priority 1 jobs),Energy Aware SLA Violation

```
Sort the jobs in decreasing order based on cloudlet length
Sort the jobs in increasing order based on deadline
Calculate the priority for both category of jobs
Calculate the mean priority
while ( PEAKTIME = TRUE ) do
    for each jobs do
        if (priority=1) then
            Submit the jobs to VMs and pause the rest of the jobs
        end if
        Calculate energy consumption;
        Calculate carbon emissions;
    end for
    if (calculated energy ≥ threshold) then
        Energy Aware SLA Violation
    end if
    if (calculated carbon emissions ≥ threshold) then
        Energy Aware Violation
    end if
end while
```

7. Experiment and Results

The implementation was done using the CloudSim toolkit that was developed in the CLOUDS Laboratory at Melbourne by Rajkumar Buyya et al [12][13][14]. The traffic congestion in a crowded city where in certain cities like mumbai the police have stopped the flow of heavy vehicles during the peak hours can be related to the peak load in the cloud provider-customer environment, According to the proposal only the high priority jobs will be allowed to execute during the peak load and the low priority jobs are kept in hold for certain period of time. The prioritizing of jobs is based on the metrics mentioned in the proposal section.

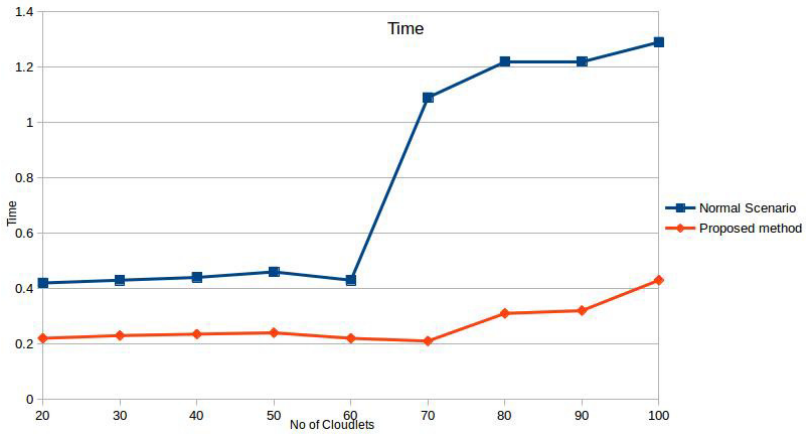

Fig. 3. Comparison on Time

Graphs plotted on the basis of observations made while performing different test cases in the CloudSim. The graph-1 provides the information about the comparison of time taken to complete the simulation of various numbers of cloudlets. In an Energy Aware SLA the main aim is to minimize the energy consumption and utilize the resource efficiently. Time (in secs)is one of the factors that will affect the utilization of the resources and thus the energy consumption. To prove the above we have taken simulation time for the entire job submission and the time taken for the submission of priority-1 jobs. The priority-1 jobs are those which consume high level of energy and may take lot of time. From the graph we can see that the time taken in the second case is comparatively lesser than the first case respectively. We have compared the normal scenario with the proposed method.In the proposed method first the priority-1 jobs and submitted once it is executed the other jobs are resumed.So here the energy consumption in the proposed method is the energy (in Watts) consumed for running after the prioritization.Thus the Energy Aware SLA could increase the resource utilization to some extend by efficiently utilizing the available resources. The graph-2 provides the information about the comparison of energy consumption to complete the simulation of various numbers of cloudlets in the two cases.

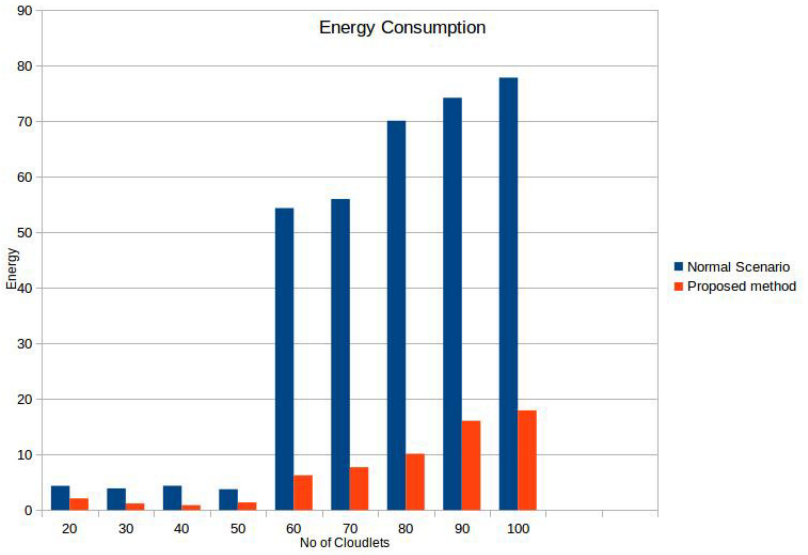

Fig. 4. Comparison on Energy Consumption

From the graph we can see that the energy consumption is more in the case of entire jobs whereas the energy consumption is lesser in the other case. Thus we can see that the Energy Aware SLA conditions are able to be met in the proposed method.But one of the drawback that may arise is that when the no of jobs are very large i.e. if we take the case of a real-time scenario the energy consumption graph in the two above cases may not show much difference but to some extend we will be able to consume the energy.

8. Conclusion

To conclude,these days SLAs are increasingly becoming the key for the customers to select the services in the cloud computing environment.The customers these days demands agreements with fair obtainable terms, services which has a certain amount of quality levels. Hence the cloud providers should examine SLAs as an urging force for getting into the market of cloud.

According to the Energy Aware SLA given by the customer to the Cloud Provider, Data Centre during the peak hours some of the jobs i.e. the low priority jobs are kept in hold, the other running jobs will be able to use the available energy efficiently. Once the specified time is lapsed the jobs which was kept in pause, can be resumed and may continue or start the execution. So the Energy Aware SLA plays an important role in green cloud computing thus

by making the SLA green. The promising results obtained shows that we can used this method in th real scenarios as well.In future as an addition to the current work a novel cloud federation scheme among a set of CPs is to be formed which will control the CP workload in an energy-aware fashion, in order to reduce CP energy costs. Also each CP individually decides whether to leave the current coalition to join a different one according to his preference, meanwhile improving the perceived net profit.

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