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Energy Efficient Cloud Networks Towards A Sustainable Green Environment

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Abstract

In the recent years, there are many arguments in Cloud which says that cloud is energy efficient; but there are some areas in which cloud consumes a lot of energy. The Energy consumption problem in the Cloud network is very crucial. The main performances of the Green Access Network have shifted from energy efficiency to energy sustainability. As the cloud grows, the clients, servers and also the communication in the cloud are also growing drastically. For the sustainable growth of network, energy efficiency of network access system has to be improved. There are three ways for saving energy in the Green Access networks: Time, Frequency and Spatial Domains. This paper focuses on the optimization of networks with Frequency Domain. That's by reducing the bandwidth and carrier aggregation. A hybrid Ant colony Genetic algorithm is used here for optimizing bandwidth and carrier aggregation.

Keywords: *Energy Efficient, Green Networks, Frequency Domain, Bandwidth, Carrier Aggregation.*

1. Introduction

Cloud computing is the usage of computing resources (hardware and software) that are delivered as a service over the network. While using cloud computing applications, it might be aware that, there are many troubles involved in cloud computing like log-in or connection maintenance with online email; the online documents won't load; online transaction payment has not been updated; etc... This is the resultant of slow and poor quality of bandwidth and connections. These real frustrations often cause people not to use cloud computing services and rather to revert to traditional tools which store and manage data locally on the user's computer. Cloud computing doesn't require high speed connections, but needs high quality broadband connections that are always connected. When many websites are unable to open non-broadband connections or slow connections, cloud-based applications are often not usable. Important factors here are Quality of Service (QoS) which indicates the amount of time the connections are dropped, response time (ping), and the extent of the delays in processing the network, data (latency) and loss of data (packet loss)[3].

The main problem in cloud computing is the performance, reliability, and security of connections to the cloud infrastructure. These network connections, due to the increasing complexity and bandwidth demands of software applications, will become more and more crowded with dynamic applications in the network. The trend now towards cloud computing is leading to more traffic and more congestion occurrence in the network. In a cloud infrastructure, in many cases, congestion may not be easily predicted. Cloud computing may easily increase the cost of communication if network optimization is not properly implemented. When the cloud applications are response-dependent, network connections from end-to-end are crucial to prevent applications from timing out, corrupting data, or prevent workers at remote sites. Applications such as videos, virtualized server applications, and software-as-a-service (SaaS) running in the cloud require more bandwidth [4].

The above scenario not only lead to degradation of QOS but also lead to usage of large number of computing resources focusing on giving QOS for the users. As these resources increase, power conception and the co2 emission from the machines used to operate the computing resources is also increased even when the system is not in use. According to one source, "Information Technology energy demand is growing 12 times faster than the overall demand for energy" and "Cloud network emit over 150 metric tons of CO2 per year, and the volume is increasing every year polluting the environment[7][8].

Focusing on the above problems, an optimization of bandwidth and resource management strategy that can be applied on a Cloud network is proposed that leads to an optimized QOS also leading to a green computing environment. Here resources are dynamically reallocated according to current resource requirements and the allocation policy. A hybrid Ant colony Genetic algorithm is used here for optimizing bandwidth and carrier aggregation**.** After optimization, if the resources available are not usable for the cloud network, these can be switched off to save power and energy.

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2. System Architecture

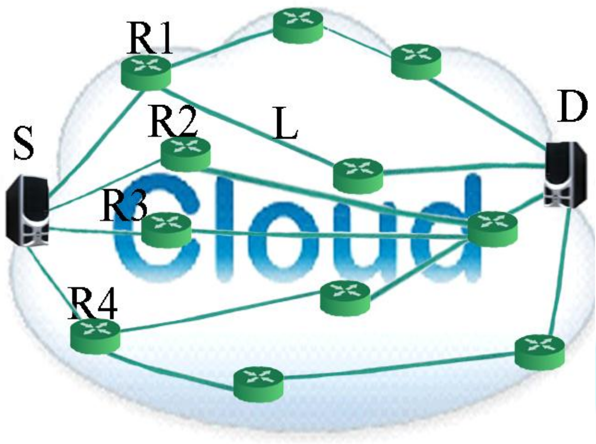

Fig 1

In this Cloud network model (Fig-1), S represents Source node, D represents Destination node, R represent the Router/Switch and L indicate the connecting media, connecting each node. In each paths created between sources to destination, bandwidth allocation to each path is based on the algorithm proposed here. After successful allocation, the network nodes (switches or routers) which are not utilized are switched off so by saving energy utilized by the particular node.

3. Algorithm Simulation Results

3.1 Ant Colony Genetic Algorithm

Ant colony algorithm [5] is a positive feedback search algorithm using that simulates the ants' behavior and ways of communication in searching for food. In nature, the behavioral rules of ants are very simple, and the rules for ants' communication via pheromones are also very simple. But a swarm of ants can solve very complex issues such as finding the shortest path between their nest and the food source. If finding the shortest path is looked upon as a problem of optimization, then each path between the starting point (their nest) and the terminal (the food source) can be viewed as a feasible solution. Correspondingly, the objective function of optimization is the length of the path; and the shortest path will be the solution of this issue. Therefore, as long as a problem can be transformed into the above issue of optimization, one can use the Ant colony algorithm to solve it.

Step-1: Identify the different paths (bandwidth) (Int. Population)

Step-2: Calculate the free space in each bandwidth

Step-3: Calculate the fitness values for the QoS parameters
$\{BW\} > \sum$ BW req for individual data

Minimum bandwidth {BW}

Step-4: Optimized shortest path is identified using fitness function (Ant colony)

Step-5: Erase the unused path (free path)

Step-6: Repeat the steps from 1 through 5 for further transfers.

This algorithm extracted from Genetic Algorithm [6], starts by generating an initial population consisting of individual paths between source and destination in the cloud network. Each path contains a specific bandwidth limit for data transfer.

Selection process is related with bandwidth allocated for each network. This is done by calculating the fitness function ie, the minimal number of network lines with maximum utilization for each line.

The Ant colony algorithm can solve very complex issues such as finding the shortest path in the selected network between the source and the destination.

The unutilized network is identified and the route is powered off. But if the input packet size exceeds the current utilized network bandwidth, the unutilized routes will be switched on in the next generation.

3.2 Simulation Results

The simulation is done with a private cloud designed with 300 systems and 25 switches/ routers connected across.

Table 1: Cloud Network Energy

Resource	Nos.	Energy(in terms of power consumption approximately)
Router/ Switch	25	15.4*25=385wats(in hr)*24(hr)=9240wats*365(days)= 3372600 wats (year)

Table 2: Green Network Energy

Resource	Nos.	No. of resources kept switched off	Energy(in terms of power consumption apex)	
			On Stage	Off Stage (Saving)
Router/ Switch	25	10	10*15.4 154wats	10*15.4 154wats

4. Conclusions

The main challenge now in Green Environment is changing from energy efficiency to energy sustainability. This paper mainly focused on bandwidth optimization and optimizing the number of network resources in the cloud network. The simulation work confirms that the number switches that can be used are minimized to a considerable amount thereby reducing the energy utilized for the resources. This work can be extended to the real cloud environment for reducing the network utilization thereby saving energy and earth.

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