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A Green-Cloud Network Scenario: Towards Energy Efficient Cloud Computing

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Abstract— There has been a rapid growth in demand for computational power which has led to the creation of large data centers. These consume enormous amounts of electrical power resulting in high cost of operation and carbon dioxide emissions. The computing model of cloud usage is also increasing the power consumption by the ICT equipments involved in between a service provider and the user across the network. The paper proposes a few new strategies and solutions to reduce the energy usage in the network involving data center, network and client system.

Keywords— cloudcomputing;virtualization; consolidation; clock gating.

I. INTRODUCTION

The cloud computing is the talk of town in it industry in present years. the reports daily emerge displaying the benefits of usage of this new computing model based on grid computing. it handles multi level virtualization and abstraction through effective integration of several computing resources, data, storage, applications and other related infrastructure so that the user just makes a wayout with minimum pay-as-per-usage basis. at the same time with the usage of more it based strategy there is alongside a load on the environment as the carbon footprint is enhanced. thus ultimately the balance for usage and the load on environment has to be maintained, hence an energy efficient mechanism for cloud computing platform has to be developed.

II. RELATED WORK

A. *Cloud Computing*

The term cloud is a metaphor for the Internet. This usage was originally derived from its common depiction in network diagrams as an outline of a cloud. This concept dates back as early as 1961, when Professor John McCarthy suggested that computer time-sharing technology might lead to a future where computing power and even specific applications might be sold through a utility-type business model. This idea became very popular in the late 1960s, but by the mid-1970s the idea faded away when it became clear that the IT-related technologies of the day were unable to sustain such a futuristic computing model. However, since the turn of the millennium, the concept has been revitalized. It was during this time of revitalization that the term cloud computing began to emerge in technology circles[2]. Now cloud computing has become more established in the technical terms. The organizations are taking advantage of the cloud, build infrastructure and deliver new applications, services and business models, many of which are also tied to their mobile applications[1].

B. *Green Star Network*

In [3], a GreenStar Network GSN has been proposed which comprises of the GSN core established in Canada includes six nodes powered by sun, wind and hydroelectricity. Solar power is used at Cybera (Calgary, AB) and CRC (Ottawa, ON). Wind power is generated at BastionHost (Truro, NS). Three nodes at Rackforce (Kelowna, BC) and ETS-UQAM (Montreal, QC) are powered by hydro energy. Since BC and QC provinces have a large capacity of hydroelectricity, there is no risk of service interruption in the network due to power outages. However, using renewable energy like wind and solar ones is considered a higher priority because hydroelectricity is unlikely considered renewable sources of energy. Therefore, applications are forced to run in solar and wind powered nodes whenever it is possible. The GSN node at Montreal plays a role of manager (so called the hub node) that opportunistically sets up required connectivity for Layer 1 and Layer 2 using dynamic services, then pushes virtual machines (VMs) or software virtual routers from the hub to sun and wind nodes (spoke nodes) when power is available. VMs will be pulled back to the hub node when power dwindles. In such a case, the spoke node may switch over grid power for running other services if it is required. However, GSN services are powered entirely by green energy. The VMs are used to run user applications, particularly heavy- computing services. Based on this testbed network, research experiments are performed targeting cloud management algorithms and optimization of intermittently-available renewable energy sources. The GSN is also incorporating green nodes in Ireland (HeaNET), Belgium (IBBT), Spain (i2Cat), China (WiCo), Egypt (Smart-Village) and USA (ESNet).

C. *Efficient LAN Switches*

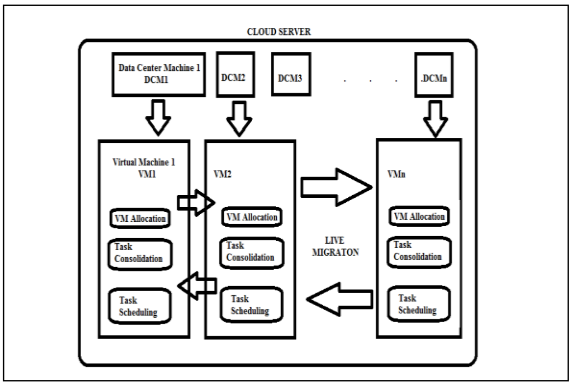
In [4], the feasibility of Dynamic Voltage Scaling technique has been checked for being deployed over the LAN switches. The authors focused on the LAN switches in particular especially because they form the bulk of the network devices in the LAN and they consume the largest percentage of energy. The thorough approach for routers was being excluded from the study. Saving energy in LAN switches means powering off or putting to sleep LAN switch components, interfaces or entire switches. In the paper there are the set of basic questions that arise from the approach of putting the switch components to sleep. There is the analysis of traffic data from the LAN showing several periods of its inactivity that can be used for sleeping. Then later is an algorithm proposed for the sleeping module for the switches.

III. RESEARCH WORK

We divide the whole scenario of Cloud Access Network by any user into the three main levels namely as Cloud Server Level, Network Level and Client User Level. The Cloud Server will comprise of data center machines over which Virtual Machines (VMs) will be made to run. The Virtualization levels be dealt as dealing with allocation of VMs, task consolidation of VMs and in the end the task scheduling of VMs. The Network will be first operated upon by the special attention to the power used by the network equipments and later the efficiency through the LAN switches. The Client Level will be dealt in the end finalizing the efficiency of the entire network. The most basic criterion to be observed is the usage of best energy efficient hardware available throughout the entire network of cloud proposed.

A. *Energy Efficiency Improvement at the Cloud Data Center*

To begin with we will be establishing energy aware solutions at the server level. It includes the development of energy aware hardware. The first progressive step in this regard is the usage of labels like US Energy Star or the European TCO certification which rate the IT products as per their effect on the environment. The computer power can be minimized by the usage of several well known techniques. It can be done by lowering the power usage of the processors which can be accomplished by the usage of available power down mechanisms like SpeedStep, PowerNow, Cool'nQuiet or demand based switching. These applications function on the phenomenon of clock gating or power gating. Clock gating is slowing down of the CPU Clock Speeds. Power Gating is powering off the parts of chips when not in use or idle to any process load. By sensing the lack of user machine interaction different redundant hardware parts can be turned off or put in hibernating mode(display, discs, etc.)[5].



FigureI. Cloud Server

The Advanced Configuration and Power Interface defines four energy states that an ACPI compliant computer system can be in. These states range from G0-working to G3-mechanical off state. The states G1 and G2 are further subdivided into sub-states defining which components are to be off in what particular state. For devices and CPU separate power states (D0-D3 for devices and C0-C3 for CPU) are defined which are similar to Global power states. Some of these mentioned techniques are defined for mobile devices but can be used for desktop PCs and the Servers. So these services are to be deployed upon the cloud servers. Also the live migration of processes over the memory of VMs must be taken into account during virtualization.

A Zero-Carbon Network(ZCN) proposed in [3] is based on the Green Star Network(GSN) project initiated by the Canadian Consortium focused on the relationship between the network and and green data centers proposes a good platform for the development of a green-energy network. The GSN project focused upon allocating the physical data centers close to cheap energy sources. The Zero-Carbon network focuses on the active and virtual migration of the data centers around green nodes while maintaining the user services. We propose the Green-Energy Network comprising of the hybrid of the GSN and ZCN based on the geographic distribution of the data centers. In contrast to the GSN the Green Energy Network comprises of the small and medium sized data centers which allow the network to be cost-effective in terms of construction costs. But where the Green Energy Network has to be functioning outside the probability of the Green Star Network the cost of producing and maintaining the network elements such as routers and servers(for tiny and large scale data centers) has to incorporated. But these hardware equipments are to well handled and managed by the use of power gating and clock gating mechanisms employed at machines.

With the usage of Virtual machines and doing Server Consolidation at a data center, a cloud provider can reduce total power consumption for the clients with a little compromise of performance degradation[6]. By choosing a more energy efficient allocation policy, energy consumption on cloud platforms can potentially be reduced by approximately 7% to 14%, lowering overall energy costs by anywhere from 11% to 26%. Such an improvement comes at the cost, however, of increased CPU load[7]. For allocation of Virtual Machines we need to allocate the series of Virtual Machines(VM) to the several processes the criterion to be observed is that there must be minimum number of migrations and the migration is to be done on the VMs which have the no or least load of the assigned processes or in other words the VMs with the lowest usage of CPU. Keeping in view this criterion of VMs selection for process allocations we select the Modified Best Fit Decreasing algorithm proposed in [8] for dynamic reallocation of the VMs to minimize energy consumption.

After the allocation of the VMs the next step is Task Consolidation at cloud, which is a way of maximizing cloud computing resource, which brings many benefits such as usage of resources, rationalization of maintenance, IT service customization, QoS and other reliable services, etc however it didn't mean maximizing energy efficient usage. But considering the architecture proposed in [9] the Energy-aware Task Consolidation (ETC) mechanism there has been a significant reduction in the power consumption of up-to 17% improvement in managing task consolidation for cloud systems and hence it can be implemented here.

A data locality driven task scheduling algorithm called Balance Reduce (BAR) has been proposed in [10] and it schedules the tasks by taking a global vies and adjust task data locality dynamically according to the network state and cluster workload. BAR tries to enhance data locality and when cluster is overloaded it decreases the data locality to make tasks start early. Thus this task scheduling algorithm can be implemented for task scheduling at the Virtual Machines.

B. Energy Efficiency Improvement in the Network

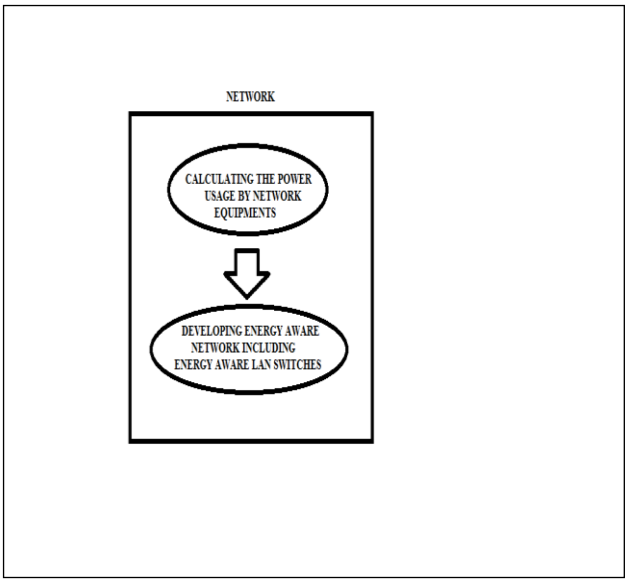


Figure 2. Network Level

The More Energy Efficient Network is the second stage of development of our Green-Cloud. It includes the mechanism for calculation of the power consumed in between any two nodes across the packet path. Depending upon the data collected for the power usage we will be able to transfer the power load across the network in a more suitable manner so that we have an energy-aware network distribution.

In order to lay down minimum pressure over the network in the cloud computing resource utilization we need to measure the power consumed by all the network devices. Several power measurement tools have to be utilized within the network at first to measure the power usage and the extent of Carbon Dioxide release parallel to it in order to manage the energy efficient network. The data then collected has to be used to calculate the network load of power distribution along the network.

Similar to the way in which a bank evaluates the pressure load over the network ATMs so as to re-credit the bank ATMs depending upon the load on the machines. For example the ATMs at the more populous cities would be required to be re-credited on a much prior basis than the machines in the less populous cities, or there can be the scenario of several other ATMs available in its locality. The busy machines will be required to be re-credited, more frequently than the machines which have lesser load.

Parallel to this phenomenon, the data has to be collected in order to evaluate a more highly trafficated network to be distinguished from the less trafficated networks. The unit of transaction in the network is the Data Packet. So multiple probes can be deployed on the network junctures to measure the traffic distribution at different hours of the day and based on this data collected power consumed by the network is calculated and then later assigned to individual users or the network users in that direction. The routing path of the data packets can be identified by sending route identifying packets among all edge nodes periodically. Based on the data collected for the high traffic network there must be the power management schemes in the network devices in the LAN or any other type of network encountered over the network.

The energy efficient mechanism for LAN switches as proposed in the [4] can be implemented for the establishment of energy efficient network for our Green-Cloud infrastructure and the final network level scenario as shown in the Figure 2 is developed.

C. Energy Efficiency Improvement at the Client Level

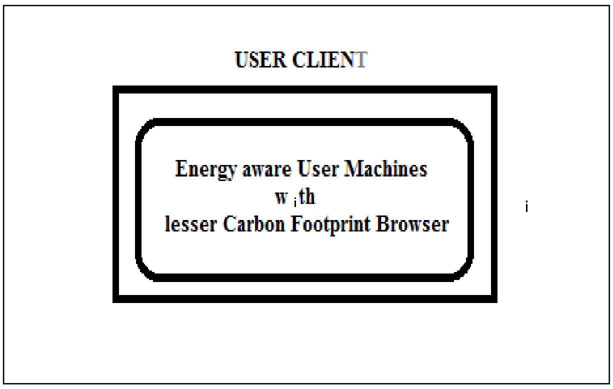


Figure 3. Client User Level

To begin with energy-aware network compliance at the client level we propose the usage of web browser having less carbon footprint, in addition to the usage of clock gating and power gating based user machines as is shown in the Figure 3.

IV. CONCLUSION AND FUTURE SCOPE

The energy efficient mechanisms have to be managed through all the intermediates involved right through the communication network beginning from the server level to the client level. We have proposed the techniques which enable energy efficient mechanism to be employed over the cloud network and wheresoever there is the possibility of reducing the carbon footprint with the employed infrastructure or the available alternate is present it is being proposed which ensures the reduction of Carbon Dioxide emission from the used ICT equipments. We conclude the establishment of a more energy-aware network which we call as the Green-Cloud Network as shown in the Figure 4.

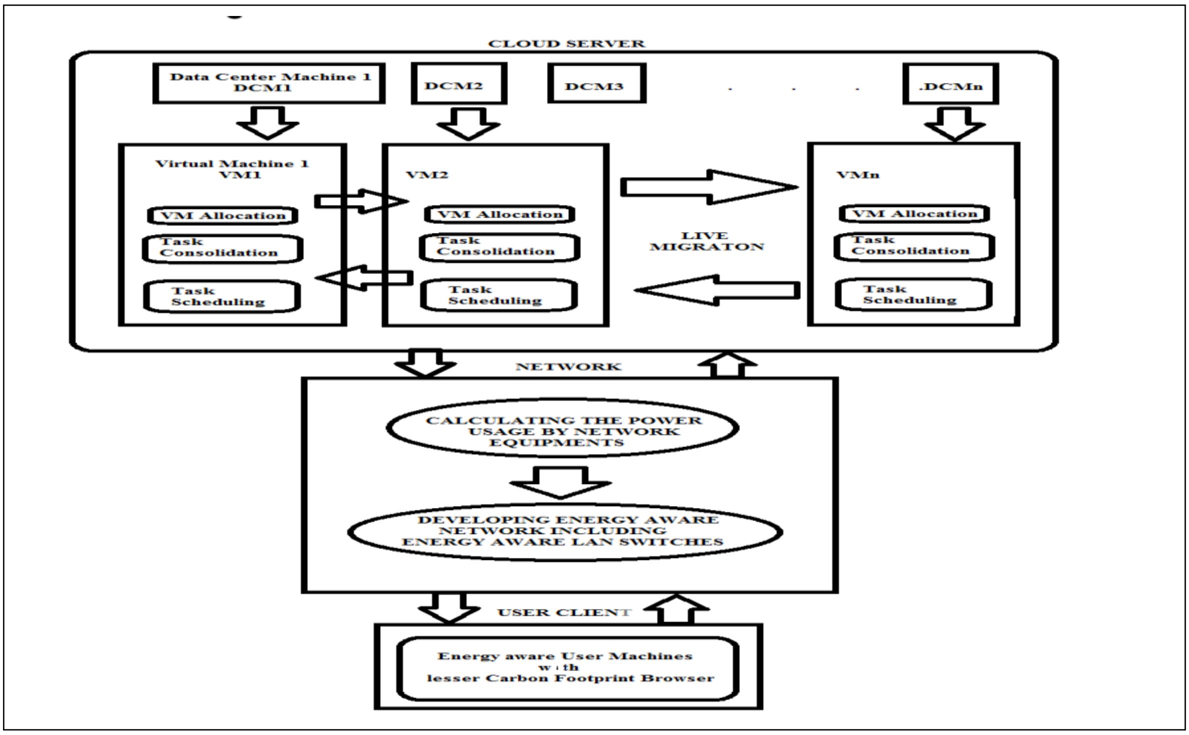


Figure 4.Green-Cloud Network

The future work can include the incorporation of new energy efficient mechanisms to be laid over the network inclusive machines and also the usage of the client machines with web browsers having less fatal effect on environment.

REFERENCES

[1] Cloud Computing, The 2011 IBM Tech Trends Report, 2011, pp.8

[2] John W. Rittinghouse and James F. Ransome, Cloud Computing, CRC Press: 2010, pp. xxvi.

[3] Mathieu Lemay, Kim-Khoa Nguyen, Bill St. Arnaud, Mohamed Cheriet "Convergence of Cloud Computing and Network Virtualization: Towards a Zero-Carbon Network, " unpublished but accepted for publication in IEEE Internet Computing.

[4] Maruti Gupta, Satyajit Grover, Suresh Singh,"A feasibility study for power management in LAN switches," Proceedings of the 12th IEEE international conference on network protocols, ICNP 2004, 5–8 Oct 2004, pp 361–371 .

[5] Andreas Berl, Erol Gelenbe , Marco di Girolamo , Giovanni Giuliani , Hermann de Meer , Minh Quan Dang and Kostas Pentikousis "Energy- Efficient Cloud Computing." *The Computer Journal*, August,2009.

[6] Hadi Goudarzi and Massoud Pedram, "Energy-Efficient Virtual Machine Replication and Placement in a Cloud Computing System," IEEE Fifth International Conference on Cloud Computing, 2012.

[7] Ryan Jansen Paul R. Brenner," Energy Efficient Virtual Machine Allocation in the Cloud," DOI *978-1-4577-1221-0/11*, IEEE, 2011.

[8] Anton Beloglazov and Rajkumar Buyya , "Energy Efficient Allocation of Virtual Machines in Cloud Data Centers, " 10th IEEE/ACM International Conference on Cluster, Cloud and Grid Computing , 2010.

[9] Ching-Hsien Hsu, Shih-Chang Chen, Chih-Chun Lee, Hsi-Ya Chang, Kuan-Chou Lai, Kuan-Ching Li and Chunming Rong," Energy-Aware Task Consolidation Technique for Cloud Computing, " Third IEEE International Conference on Coud Computing Technology and Science , 2011.

[10] Jiahui Jin, Junzhou Luo, Aibo Song, Fang Dong and Runqun Xiong, "BAR: An Efficient Data Locality Driven Task Scheduling Algorithm for Cloud Computing," 11th IEEE/ACM International Symposium on Cluster, Cloud and Grid Computing , 2011.

