Survey of various Power Management Techniques for Datacenter in Cloud Computing

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Abstract— **Cloud Computing is considered to be the next step towards the evolution of on-demand services and products. The concept of cloud computing involves a datacenter somewhere in the world, or even multiple datacenters scattered around the world. These datacenters are hosting the applications on their servers and the clients use them to operate their business. As the demand of these services is increasing day by day, the cloud service provider's (CSP's) are also trying to give best services as they can, but still there is a problem that they are facing, is the high power consumption by their equipment's, which increases their expenditure also. In this paper, we will provide the survey of various power management techniques and detail working of the technique which is currently in use.**

***Index Terms*—Cloud Computing, Datacenter, Power Management, DVFS.**

I. INTRODUCTION

The role of Cloud Computing involves a provision of on-demand services and products. It is considered as a kind of computing technique, where IT services are provided by massive low-cost computing units, connected by IP networks. The concept of cloud computing involves a datacenter somewhere in the world, or even multiple datacenters scattered around the world. This is the paradigm shift from the historical client-server architecture, where the network users owned, maintained, and operated their own network infrastructure, server rooms, data, and applications on servers. Typical cloud computing providers deliver common business applications online that are accessed from web browsers, while the software and data are stored on the servers or devices. These datacenters are hosting the applications on their servers and the clients use them to operate their business. As the demand of these services is increasing day by day, the cloud service provider's (CSP's) are also trying to give best services (QoS) as they can, but still the problem that they are facing, is the high power consumption by their equipment's, which increases their expenditure also. Today, the most important requirement is to reduce power consumption and the simplest way to do this, is to change the mode of idle switches or servers from active to sleep or hibernate. To do this various power management techniques has been developed which may uses the methods such as consolidation, migration, and merging of traffics. Virtualization is also considered to be the method to utilize the partially occupied server's capacity for executing the tasks by creating the number of virtual machines per server. In this paper, we will discuss the schemes which may help to significantly reduce the power consumption. The rest of the paper organized as follows: Section II, covers the related work behind these techniques, Section III, provides the overview of various power management techniques, In Section IV, we will cover the detail working of the technique which is currently available, and in last Section V, provides the conclusion of complete study.

II. RELATED WORK

In recent years, power consumption by network equipment's has been become as the most crucial issue toward its worldwide development and to reduce this many researchers are working on it. Diary R. Suleiman et. al. (2005) [1], has proposed the dynamic voltage frequency scaling (DVFS) loop, to vary or set the supply voltage V_{dd} and operating frequency f_{clk} according to the desired frequency f_{des} which is predicted via the operating system and speed control circuit. Priya Mahadevan et. al. (2009) [2], has describe and analyze three approaches to saving energy in single administrative domain networks, without significantly impacting the networks' ability to provide the expected levels of performance and availability. Candy Yiu and Suresh Singh (2011) [3], has proposed a design for merging traffic from multiple end-hosts and feeding that to small port density switches that can replace the high port density switches. Xiaodong Wang et. al. (2012) [4], has proposed a correlation-aware power optimization algorithm (CARPO) that dynamically consolidates traffic flows onto a small set of links and switches in a DCN and then shuts down unused network devices to save energy. Yichao Jin et. al. (2012) [5], has characterized the energy usage on virtualized servers. An empirical approach is adopted to investigate how server virtualization affects the energy usage in physical servers.

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III. Overview of Power Management Techniques on Datacenter

Different Power Management Schemes has been proposed and implemented in various cloud simulation tools. In this section, we will provide an overview of few techniques for power management.

1. Link State Adaptation

In this scheme, the power controller uses information about traffic on each link and adapts its state accordingly. Typically, each link can operate in four states, namely, disabled, 10 Mbps, 100 Mbps and 1 Gbps. This basic scheme just ensures that the traffic can be accommodated without regard to performance and availability [2].

2. Network Traffic Consolidation

This scheme is based upon a traffic engineering approach to route traffic such that it is consolidated on fewer links (and switches), while some of the non-utilized links (and switches) can be disabled. This approach reduces energy consumption significantly by removing all redundancy in the network. The energy consumed is the minimum required to support the offered network load, but it comes at a great cost to reliability, as there are no redundant paths in the topology. This case can be used to show the trade-offs between power savings and availability [2].

3. Server Load Consolidation

It is an indirect way to consolidate network traffic into fewer links and allow the controller to turn off non-utilized ports (and switches) to migrate the jobs, so a fewer number of servers are being used. In this technique, we need to ensure that server resources such as CPU and memory are adequate to handle the assigned jobs. After performing server load consolidation, we can further reduce energy consumption by resorting to network traffic consolidation as well [2].

4. DVFS

Dynamic voltage frequency scaling (DVFS) is accepted as a technique to reduce power and energy consumption of microprocessors (Servers processor in case of datacenter). The proposed dynamic voltage frequency scaling (DVFS) loop, is used to vary or set the supply voltage V_{dd} and operating frequency f_{clk} according to the desired frequency f_{des} which is predicted via the operating system and speed control circuit. This technique is widely accepted now a days, as it provides high performance due to accuracy in progress, and can significantly improve processor energy efficiency [1,7].

5. DNS

As the name suggests, the Dynamic Network Shutdown (DNS) technique allows to dynamically shutdown the servers or switches, whenever it is possible. By shutting down any component of datacenter at any time helps in reduction of considerable amount of power consumption [7].

6. Merge Network For Traffic

This technique uses a approach for merging traffic from multiple links and feeding the merged stream to a switch with fewer ports. In this network, packets are dynamically switched to follow some path through the merge network. The design of this network ensures very small latency, the energy cost of the merge network is minimal and this design allows us to make the merge network relatively transparent to the PHY and MAC layer protocols [3].

7. Server Virtualization

Virtualization is a technique that allows multiple operating systems (OSs) to run concurrently on one server. This technique allows the utilization of servers up to some predefined threshold which are partially loaded. Hence, we can shut down the servers which become idle due to the creation of VM (virtual machines) and helps in minimizing the energy consumption [5,8].

8. Traffic Correlation

This technique consolidates traffic flows based on correlation analysis among flows in a DCN. Another important feature of it is to integrate correlation-aware traffic consolidation with link rate adaptation for maximized energy savings. It takes the data rates of the traffic flows in the previous consolidation periods as input and analyzes the correlation relationship between different traffic flows by using method in which if the traffic is negatively correlated, then the path is consolidated of the respective traffic flows, otherwise no need to consolidate the path [4].

IV. Evaluation of best Technique: DVFS

These days, DVFS is considered to be widely used technique, as we can find its implement in cloud simulation tools such as CloudSim and GreenCloud [6,7]. Also it is the only technique which incorporates all the above technique in itself and is accepted as a technique to reduce power or energy consumption of processors (Servers processor in case of datacenter) as well as minimization of SLA violation [1]. In the Linux kernel, DVFS can be activated in five different modes: Performance, PowerSave, User- Space, Conservative, and OnDemand. Each mode has a governor to decide whether the frequency must be changed (increased or decreased) or not. Three of these five modes use a fixed frequency [6]:

- **Performance** uses the CPU at its highest frequency.
- **PowerSave** uses the lowest frequency.
- **UserSpace** mode allows the user to choose one of the available frequencies for the CPU.

The last two modes, Conservative and OnDemand, have a dynamic behavior. It means that the CPU frequency can vary over a time according to the CPU demand. The governors of these two modes work with thresholds (one or two) and periodically check whether the CPU load is under (or over) these thresholds before making the decision to change the CPU frequency.

- The **Conservative** governor works with an upper threshold and a lower threshold. When the CPU load is above the upper threshold, the frequency is increased,

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and when the CPU load is below the lower threshold, the CPU frequency is decreased. This mode is progressive, and each CPU frequency change is performed at one step using all available frequencies.

- The **OnDemand** mode uses only one threshold and favors system performance by directly setting the fastest frequency when the CPU load exceeds the threshold. A decreasing CPU frequency, performed at steps as in the Conservative mode, is performed if the CPU load stays below the threshold for a predefined amount of time.

V. CONCLUSION

After studying various power management techniques, it has been found that each technique has a capability to minimize the power consumption to some extent with some of their own limitation. The DVFS technique dynamically switches the datacenter component states by increasing or decreasing the voltage and frequency. In this technique, by specifying a predefined threshold value, the CSP (cloud service provider) able to provide the QoS services to its customer without violating the service level agreement.

REFERENCES

[1] Diary R. Suleiman, Muhammed A. Ibrahim, and Ibrahim I. Hamarash, "dynamic voltage frequency scaling (dvfs) for microprocessors power and energy reduction", In IEEE, April 2005.

[2] Priya Mahadevan, Puneet Sharma, Sujata Banerjee, Parthasarathy Ranganathan, "Energy Aware Network Operations", In IEEE, April 2009.

[3] Candy Yiu and Suresh Singh, "Merging Traffic to Save Energy in the Enterprise", In E-Energy, May 2011.

[4] Xiaodong Wangy, Yanjun Yao, Xiaorui Wangy, Kefa Lu, and Qing Cao, "CARPO: Correlation-Aware Power Optimization in Data Center Networks", In IEEE, March 2012.

[5] Yichao Jin and Yonggang Wen, Qinghua Chen, "Energy Efficiency and Server Virtualization in Data Centers: An Empirical Investigation", In IEEE, July 2012.

[6] Tom Guerout, Thierry Monteil, Georges Da Costa, Rodrigo Neves Calheiros, Rajkumar Buyya, and Mihai Alexandru, "Energy-aware simulation with DVFS", In ELSEVIER, June 2013.

[7] Beant Singh Gill, Satinderjit kaur Gill, Prince Jain, "Analysis of Energy Aware Data Center using Green Cloud Simulator in Cloud Computing", In IJCTT November 2013.

[8] Md. Faizul Bari, Raouf Boutaba, Rafael Esteves, Lisandro Zambenedetti Granville, Maxim Podlesny, Md Golam Rabbani, Qi Zhang, and Mohamed Faten Zhani, "Data Center Network Virtualization: A Survey", In IEEE communications surveys & tutorials, August 2013.

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