A Review on Cluster Based Energy Efficient Task Scheduling

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Abstract- This paper reviews the present technique for reduction of energy consumption in high end computing i.e. DVFS. Under DVFS processors can be operated at different frequencies when we have different supply voltages. By that means the scaling of the processor supply voltages helps to reduce the consumption of energy. Survey of various papers have been done here which are using this technology.

Keywords:- Energy Efficiency, Clusters, DVFS.

I.INTRODUCTION

High performance computing systems give excellent performance for the applications in scientific and engineering domain. However these applications consume a large amount of energy. It has been observed that computational resources need around 0.5% of the total power that the world uses . This power consumption is assumed to become four times if the same demand continues. More the power consumption , more is the electricity bill. High is the power consumed higher is the cooling costs. Also, to allow computing facilities to operate on high power for a long time will lead to a high temperature of computing systems, which further harms a system's reliability and availability. By reducing the demand for energy, the amount of CO2 produced each year by electricity generators can also be mitigated. Therefore, minimizing consumption of power for high end computing is a critical research topic.

II.CLUSTER SYSTEM

A cluster system is made out of various Processing Elements (PEs) and a resource controller. Jobs submitted to each PE executes as an independent processing unit so that it manages its own job queue and scheduler. When jobs are submitted to the cluster system by the user, then it is the role of the resource controller to admit the job or not based upon the information available from PEs. PEs are most likely homogeneous in this way these can deliver the same processing performance in terms of MIPS (Million Instruction Per Second).

III.DYNAMIC VOLTAGE FREQUENCY SCALING

Dynamic voltage-frequency scaling (DVFS) is a very good method which is added into recent processors. Direct relation of the power consumption with the frequency and square of voltage supply is the main fact on which this method is based. Using this fact, if we switch between frequencies and voltages of processor the execution time and consumption of power can be controlled. In early stages this technique was made for task scheduling with single processor.

Task scheduling in DVFS technique is of two ways: Schedule generation, and Slack reclamation. In this method of schedule generation, tasks graph are scheduled on DVFS-enabled processors inside a global cost function which include energy saving and make span to meet both energy and time constraints at the same time. The method of slack reclamation works as post processing procedure on the output of scheduling algorithms. In this DVFS method is being used for minimizing the consumption of energy of tasks in a schedule which is generated by a separate scheduler.

IV. RELATED WORK

Task scheduling algorithms are basically divided into two categories: static scheduling algorithms and dynamic scheduling algorithms. In the static task scheduling algorithms, before applications are being executed, the assignment of the tasks to resources is determined. Information regarding execution cost of task and time taken for communication should to be known beforehand at compile time. Static task scheduling algorithms generally are non-preemptive, it means a task which is assigned to the resource will keep running unless it volunteers to stop[13]. Dynamic task scheduling algorithms generally do the scheduling of the tasks to the particular resource on runtime in order to achieve load balancing among PEs, are based on the redistribution[14,15].

Wang et al.[1] studies the slack time of the jobs which are not that critical, extend execution time of these jobs and also try to reduce the consumption of energy in such a way that the execution time of the whole task is not increased. In this paper two new static scheduling algorithms have been purposed. PALS (Power aware list based scheduling) and PATC (Power aware task scheduling). The scheduling algorithms which are list based they assign priorities to tasks and then sorting of the tasks is being done into a list which is in the decreasing priority order. After that based on the priorities assigned the tasks are scheduled. The task graph clustering method is efficient static scheduling method which is used for scheduling parallel tasks. In this we are given a task graph and, we are to map the nodes of task graph onto clusters which are labelled.

Laszewski et al. [2] concentrates on scheduling virtual machines in a compute cluster to diminish power utilization by means of the procedure of Dynamic Voltage Frequency Scaling (DVFS). It likewise exhibit the outline and execution of a efficient scheduling algorithm to distribute virtual machines in a DVFS-empowered cluster by progressively scaling the supplied voltages. The algorithm can be studied with help of simulation and implementation inside a multi-core cluster.

Tang et al. [3] proposes a DVFS-empowered Energy-effective Workflow Task Scheduling algorithm: DEWTS. It merges the processors which are inefficient by reclaiming the slack time, useful slack time can be leveraged by DEWTS in an recurrent manner after severs are merged. DEWTS uses the Heterogeneous-Earliest-Finish-Time (HEFT) algorithm in a manner that at first it calculates the scheduling order of all tasks in initial stage, and then it obtains the whole make span and deadline.

Rizwandi et al. [4] have stated the fact that majority of energy aware scheduling algorithms that are being used in DVFS involve two methods: schedule generation and slack reclamation. The schedule generation method includes redistributing the tasks processors that are DVFS enabled which is followed from a given cost function that includes make span and energy consumption; and, while the slack reclamation pass is being calculated when we execute tasks which are individual with slacks at a processor frequency which is lower.

Dhiman et al. [5] purposes an effective dynamic voltage and frequency scaling method focused on towards cutting edge multi-tasking frameworks. The system uses processors runtime insights and a web learning calculation to appraise the most appropriate voltage and recurrence setting at any given point in time.

Le Sueur et al. [6] studies the basic technique of DVFS. The energy savings that result from DVFS are limited by previous developments. This paper analyses this by experimenting the potential of DVFS on different three platforms.

Pietri et al. [7] proposes an algorithm that uses frequency scaling to minimize consumption of energy of various tasks which are scientific, and to schedule these tasks on machines and focusing on deadline to be completed. It is observed that even if we use lowest frequency that is possible it still may not be energy efficient, the presented algorithm works iteratively to scale the frequency further and it distributes the slack time, just when general energy utilization can be diminished.

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Taheri et al. [8] presents a new slack reclamation algorithm which utilizes a straight mix of the greatest and least processor frequencies to decrease consumption of energy. This algorithm has been assessed in view of results acquired from examinations with three distinct arrangements of graphs.

Ruan et al. [9] presents an energy-efficient scheduling algorithm TDVAS which uses dynamic voltage scaling technique for providing significant energy savings on clusters. The TDVAS algorithm goes for sensibly utilizing processor unmoving times to lower processor voltages (i.e., the dynamic voltage scaling strategy or DVS), in this way diminishing energy utilization experienced by parallel applications running on clusters. Lessening processor voltages, in any case, can definitely prompt expanded execution times of parallel task assignment.

Author	**Approach**	**Advantage**	**Limitation**	**Technology Used**
Wang[1]	Reduction of energy consumption by scaling processor supply voltages	Energy efficiency is increased up to 44.3%	Not efficient with less number of PEs	MATLAB
Laszewski [2]	Allocation of virtual Machines in a DVFS enabled cluster by dynamically scaling supplied voltages.	Efficient in the reduction of power consumption of a DVFS enabled cluster.	SLA is not considered.	DVFS SIM
Tang [3]	Merges the inefficient processors by slack reclamation	Can be applied to various parallel applications on heterogeneous environment	No parameter to indicate	Cloud SIM
Rizwandi [4]	Execute each task with a linear combination of more than one frequency.	Finding the suitable time portions of maximum and minimum operating frequencies.	Has not been implemented on real time applications.	Cloud SIM

Taheri[8]	Uses a linear combination of max and min processor frequencies to achieve optimal energy consumption	Can be effectively applied in grids.	Increase in number of processors increases slack time of system.	MATLAB

Wang et al. [10] presents formal models for precedence-constrained parallel tasks, DVFS enabled clusters, and energy consumption. This paper proposes a scheduling algorithm in DFVS enabled clusters for executing parallel tasks. The proposed algorithm finds slack time for non-critical jobs without increasing scheduling length. This paper also develops green SLA based mechanism to reduce energy consumption by return users tolerant increased scheduling makespan.

Gruian et al. [11] concentrates on the scheduling techniques which are for the architectures that contain voltage processors that include supply that is variable, running tasks that are dependent. LEneS is definitely based on a list-scheduling heuristic with dynamic recalculation of priorities, and considers a given allocation and assignment of tasks to processors.

Luo et al.[12] proposes a scheduling algorithm for applications that are real time and catches both information stream and control stream data. It performs effective directing of communication events through multihops, and productive slack assignment among heterogeneous processors and correspondence connections to expand energy saving while meeting all constraints that are real time.

V. CONCLUSION

Dynamic voltage frequency scaling has been proved as an effective technique to reduce energy by consuming low power. Above work also includes various scheduling algorithms that have been implemented on the DVFS technique to achieve energy minimization and low power consumption. The experiments that have been performed in the above techniques show a substantial reduction of energy consumption in the clusters, data centers. The future scope of this technology is to implement it in some real time applications.

REFERENCES

[1] Lizhe Wang, Samee U. Khan, Dan Chen, Joanna Kołodziej, Rajiv Ranjan, Cheng-zhong Xu,Albert Zomaya, Future Generation Computer Systems,Volume 29, Issue 7, September 2013, Pages 1661–1670.

[2] Gregor von Laszewski, Lizhe Wang, Andrew J. Younge, Xi He, Power-aware scheduling of virtual machines in dvfs-enabled clusters in: CLUSTER, 2009, pp. 1–10.

[3] Zhuo Tang,Ling Qi, Zhenzhen Cheng, Kenli Li · Samee U. Khan · Keqin Li, An Energy-Efficient Task Scheduling Algorithm in DVFS-enabled Cloud Environment, Springer Science+Business Media Dordrecht 2015.

[4] Nikzad Babaii Rizvandi, Javid Taheri, and Albert Y. Zomaya, some observations on optimal frequency selection in DVFS based energy consumption minimization, Journal of Parallel and Distributed Computing Volume 71 Issue 8, August, 2011.

[5] Gaurav Dhiman, Tajana simunic rosing, Dynamic voltage frequency scaling for multi-tasking systems using online learning, Low Power Electronics and Design (ISLPED), 2007 ACM/IEEE International Symposium on 27-29 Aug. 2007

[6] Etienne Le Sueur and Gernot Heiser, Dynamic Voltage and Frequency Scaling: The Laws of Diminishing Returns, Proceeding HotPower'10 Proceedings of the 2010 international conference on Power aware computing and systems,Article No. 1-8.

[7] Ilia Pietri, Rizos Sakellariou, Energy-awareWorkflow Scheduling Using Frequency Scaling, 2013.

[8] Nikzad babaii rizwandi, Javid taheri, Albert Y. Zomaya, Young Choon Lee, Linear combinations of DVFS enabled processor frequencies to modify the energy aware scheduling algorithms, Cluster, Cloud and Grid Computing (CCGrid), 2010 10th IEEE/ACM International Conference on, 17-20 May 2010.

[9] Xiaojun Ruan, Xiao Qin, Ziliang Zong, Kiranmai Bellam, Mais Nijim, An Energy-Efficient Scheduling Algorithm Using Dynamic Voltage Scaling for Parallel Applications on Clusters, Computer Communications and Networks, 2007. ICCCN 2007. Proceedings of 16th International Conference on 13-16 Aug. 2007.

[10] Lizhe Wang, Gregor von Laszewski, Jai Dayal and Fugang Wang, Towards Energy Aware Scheduling for Precedence Constrained Parallel Tasks in a Cluster with DVFS, Cluster, Cloud and Grid Computing (CCGrid), 2010 10th IEEE/ACM International Conference on 17-20 May 2010.
[11] Flavius Gruian, Krzysztof Kuchcinski, LEneS: Task Scheduling for Low-Energy Systems Using Variable Supply Voltage Processors, Design Automation Conference, 2001. Proceedings of the ASP-DAC 2001. Asia and South Pacific,2001.
[12] Jiong Luo, Niraj K. Jha, Simultaneous Dynamic Voltage Scaling of Processors and Communication Links in Real-Time Distributed Embedded Systems, IEEE TRANSACTIONS ON VERY LARGE SCALE INTEGRATION (VLSI) SYSTEMS, VOL. 15, NO. 4, APRIL 2007.
[13] Virginia Mary Lo, Heuristic algorithms for task assignment in distributed systems, IEEE Trans. Comput. 37 (11) (1988) 1384–1397.
[14] John Zahorjan, Derek L. Eager, Edward D. Lazowska, Adaptive load sharing in homogeneous distributed systems, IEEE Trans. Softw. Eng. 12 (5) (1986) 662–675.
[15] Y. Wang, R.J.T. Morris, Load sharing in distributed systems, IEEE Trans. Comput. 34 (3) (1985) 204–217.