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Energy efficient approach to Cloud Computing

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Abstract

Cloud computing is an emerging area within the field of information technology (IT).It is turning upside down the way we realize computation by enabling the use of storage, processing, or higher level elements such as operating systems or software applications, not by owning them and having them installed on computers that we own - but rather to use these resources simply as a service. The term cloud computing causes confusion due to the multiple aspects of service that it may include. From a generic point of view, it could be said that cloud computing is a kind of computing where scalable, adaptable, and elastic IT capabilities are provided as a service to multiple users. In a pure cloud computing model, this means having all the software and data hosted on a server or a pool of servers, and accessing them through the internet without the need for very much (if any) local hard disk, memory, or processor capacity, allowing the use of very light weight client computers by the end user.

Key Words: Cloud Computing, DVFS, Cloud, VM Consolidation, Power consumption, energy efficiency.

INTRODUCTION:

Cloud computing is a new paradigm which combines concepts, technologies and creates a platform for IT infrastructure and cost-effective business applications. The embracing of Cloud computing is increasing steadily for past few years in the technology market. By adopting cloud computing, IT (information technology) industries got benefited as cloud provides with less maintenance costs and infrastructure costs. Cloud computing thus, may be defined as a multitenant environment that provides you with the resources and services abstracted from the underlying infrastructure. Services and resources are provided “on demand “and “at scale” in cloud environment. It is being forecasted that more and more users will rent computing as a service, moving the processing power and storage to centralized infrastructures rather than located in client hardware. This is already enabling startups and other companies to start Web services without having to invest upfront in dedicated infrastructure. The demand of cloud computing is increasing day by day. Increased demand in computational power has made the IT companies and the industries to shift to the cloud computing models which have been deployed by huge scale virtualized data centers. These data centers consumes ample amount of power. All the cloud providers must have to meet their user service requirement yet have to take care of the power being consumed. The aim of this paper is to design such an algorithm which can reduce the amount of power consumed by servers in cloud computing. The algorithm is based on dynamic voltage and frequency scaling. Cloudsim simulator has been used to carry out the simulations.

ADVANTAGES OF CLOUD COMPUTING

- Lower computer costs
- Improved performance
- Reduced software costs
- Instant software updates
- Improved document format compatibility
- Unlimited storage capacity
- Increased data reliability
- Universal document access
- Latest version availability
- Easier group collaboration
- Device independence

LITERATURE SURVEY

Jayant Baliga et al in [1] have highlighted that the administration of power utilization in data centers has prompted various significant enhancements in energy efficiency .Cloud processing foundation is housed in data centers and has profited altogether from these advances. Point of reference investigations of energy utilization in cloud computing, have concentrated just on the energy consumed in the data center. Nonetheless, to acquire a reasonable picture of the aggregate energy consumption of a cloud computing environment, and comprehend the

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potential part of cloud computing to give vitality resources, a more far reaching analysis is needed. The analysis considered both public and private clouds and included energy consumption in switching and transmission as well as data processing and data storage. They have evaluated the energy consumption associated with three cloud computing services, namely storage as a service, software as a service, and processing as a service. They have introduced an outline of energy utilization in cloud computing and contrast this with energy consumption in conventional computing.

Hadi Goudarzi et al in [2] have considered a resource allocation quandary whose main objective is to minimize the total energy cost of cloud computing system and ascertain that they meet the designated client level SLAs in a problematic sense. Here SLA implicatively insinuates Service Level Agreement which designates constraints on performance and/or quality of the service that it receives from the system. Eventually these constraints result in rudimentary tradeoff between the total energy cost and client gratification in the system. They have presented an efficient heuristic algorithm predicated on convex optimization and dynamic programming to solve the aforesaid resource allocation quandary. They additionally have verbalized that virtualization technology can help in ameliorating the power efficiency of datacenters (server) consolidation, which enables the assignment of multiple virtual machines (VMs) to a single physical server.

Dzmitry Kliazovich et al in [3] have designed and proposed simulation environment for energy-aware cloud computing data centers. This simulator is designed in such a way that it will capture energy consumed by the data center components and packet-level communication patterns in realistic setups as well, along with the workload distribution. The result of the simulation received for two tier and three tier high speed data centers shows the usefulness of the simulator in utilizing the power management scheme such as voltage scaling, frequency scaling and dynamic shutdown which are applied to the computing and networking components.

Abbas Horri et al in [4] have proposed a novel QoS-aware VMs consolidation approach for cloud environments using CloudSim simulator. They have shown improved results in QoS metric and energy consumption and have also demonstrated tradeoff between energy consumption and QoS in the cloud environment. The simulation results justifies that the proposed algorithm significantly reduce number of VM migration, SLAV and total transmitted data as compare to current algorithm.

Yuan Tian et al in [5] have optimize the performance and power consumption tradeoff for multiple heterogeneous servers considering two problems:(a) optimal job scheduling with fixed service rates.(b) Joint optimal service speed scaling and job scheduling.

They have proposed a mechanism called dynamic voltage and frequency scaling (DVFS) which can dynamically scale the server speed by reducing the processor voltage and frequency when the load is light. Without DVFS the service rate is a constant so they prove that with DVFS, the feasible service rates are discrete and bounded and can save 50% power cost compared to the servers without DVFS.

Verma et al in [6] have proposed and formulated the problem related to power aware dynamic placement of application in which they have used bin packing problem with the bin size and cost. Although they have worked upon live migration to move VMs to their new frame but did not work upon SLA. They divided the VM consolidation into three categories:

Static VM consolidation,Semi static VM consolidation and Dynamic VM consolidation. They have focused only on the first two categories. However Dynamic consolidation has not been taken in account.

Gregor von Laszewski et al in [7] has concluded in their research work that DVFS is an effectual technique to reduce power dissipation of a processor. DVFS technique lowers the processor clock speed and supply voltage while intensive application phase and idle times. We can achieve large reduction in power consumption with modest performance loss. They also concluded from their observations that 1) their algorithm can reduce power consumption in a DVFS enabled cluster. 2) In case the number of PE is fixed, the power consumption increases as the no. of incoming virtual machines increases. 3) If the no. of virtual machines which are coming is fixed, the power consumption reduces as the no. of PEs increases.

Robert Basmadjian et al in [8] in this paper, they have examine those situation of private cloud computing environments from the context of energy saving. However, those recommended methodology can be applied to either of the computing styles may it be private or public traditional and supercomputing. On this end, we give acceptable a nonexclusive theoretical depiction to ICT resources of data center furthermore recognize their comparing energy-associated attributes. After that, they have provided power consumption foreseen models for servers, storage devices and network apparatus. We demonstrate that by applying energy optimization arrangements guided through exact power utilization prediction models, it is conceivable to save around 20% for energy consumption the point when average single-site private cloud centres are recognized.

Diary R. Suleiman et al in [9] have proposed dynamic voltage and frequency scaling (DVFS). Loop, which they have introduced in this work, is to change or set the supply voltage Vdd and operating frequency fclk as well, as per the desired frequency fdes which may be predicted via OS and speed control circuit. They mentioned that DVFS proposed loop has a better performance factor because of correctness and accuracy in progress and could essentially enhance or improve the Processor energy proficiency particularly for general purpose Microprocessors, multimedia interface systems, and UPS or battery powered electronic gadgets. They have presented a technique that can decrease the processors average energy utilization or we can say energy consumption at runtime depending upon the applications and the cutoff or we can say limit of the supply voltage Vdd. Therefore, this suggested DVFS technique might be considered as a critical constraint for the current and future performance of the processor.

METHODOLOGY

The scenario is the pictorial representation of VM consolidation algorithm in which we have a host list as a collection of different hosts. We apply the Local Regression method to check if the node is overloaded. If the node is overloaded we will migrate the VM based on MMT method i.e. maximum migration time and will add them to migration list, else we will check the host list again to confirm that we have not missed any other host to check. Once we have added the VMs of overloaded host to the migration list we will find the new placements for the VMs. Then we can clear the migration list. Same procedure has to be followed to check for the under loaded list based on VDT method i.e. VM based dynamic threshold. Once the under loaded hosts are determined and their VMs have migrated, idle host then will be kept on sleep mode. We again will get the host from the host list and check if it is under loaded. Then we will apply DVFS on those under loaded host to reduce the power consumption. This technique will reduce the static and dynamic power being consumed by the host.

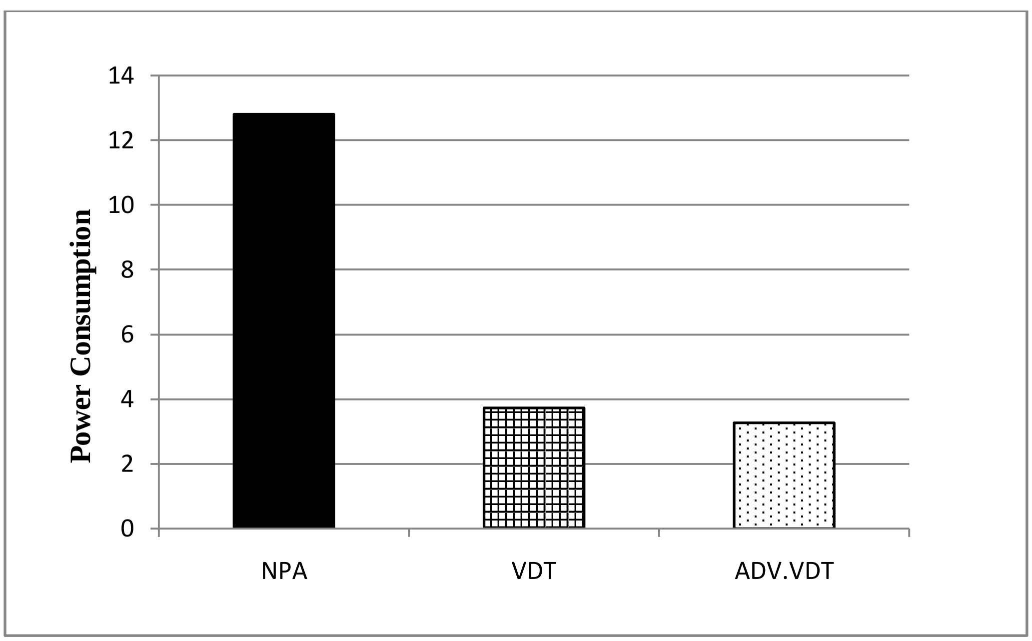
PROPOSED ALGORITHM

1) Determine which hosts are overloaded.
2) Select some VMs from those overloaded hosts.
3) Determine which hosts are under loaded.
4) If VM are less than the HOST threshold value
5) Then select all VMs from them for migration while keep it on sleep mode.
6) Else if VM are greater than equal to HOST threshold value than apply DVFS on the machine.
7) Now find the new placements for VMs.
8) Get a host from host list and again check if it is under loaded.
9) Apply DVFS (dynamic voltage and frequency scaling) on the under loaded host.

RESULTS AND DISCUSSIONS:

By hybridization of VM based threshold and DVFS (Dynamic voltage and frequency scaling) energy consumption by the data centres have decreased. Cloudsim simulator is used to show the results.

A. COMPARISON OF POWER CONSUMPTION AT VARYING NO. OF VMS Number of Virtual Machines = 50

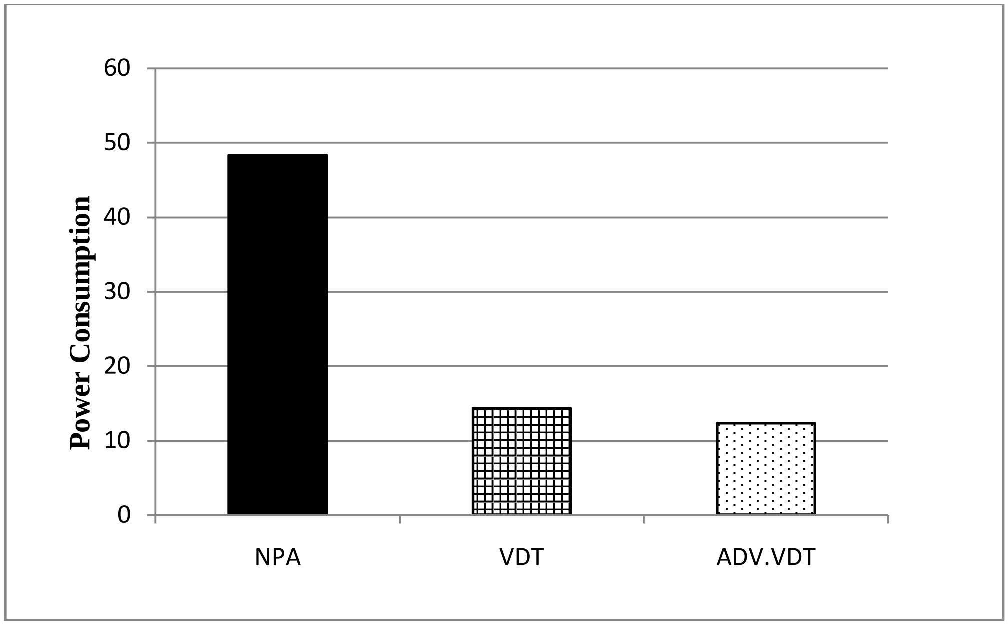


Graph 1: Comparing average power consumed by 50 VMs.

Power consumed by NPA (Non-power aware), VDT (VM based dynamic threshold) and Advance VDT is compared by taking 50 virtual machines for 2 hours. The power consumed by NPA is highest and power consumed by Advance VDT is lowest.

Number of Virtual Machines = 200

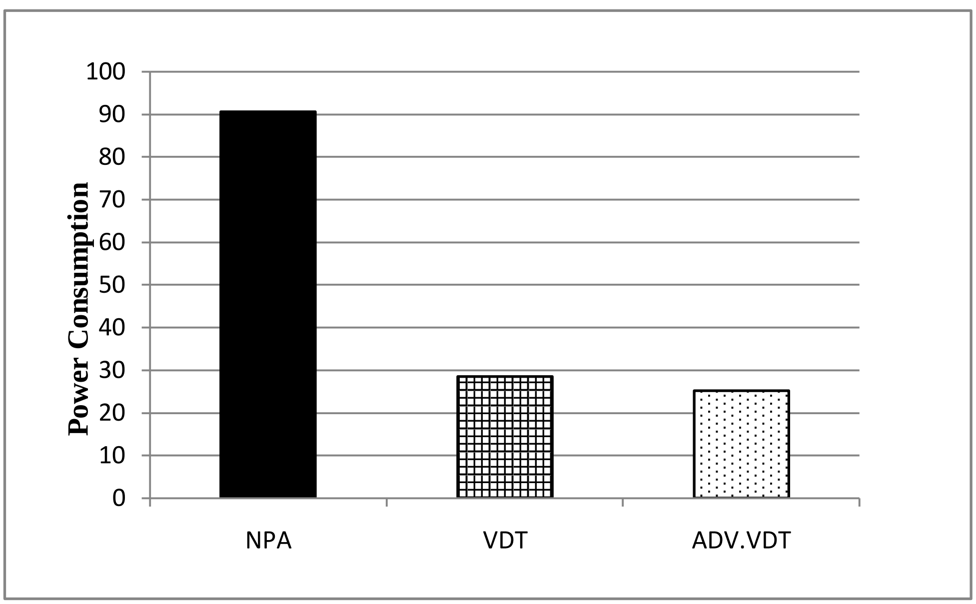
Power consumed by NPA (Non-power aware), VDT (VM based dynamic threshold) and Advance VDT is compared by taking 200 virtual machines for 2 hours.



Graph 2: Comparing average power consumed by 200 VMs.

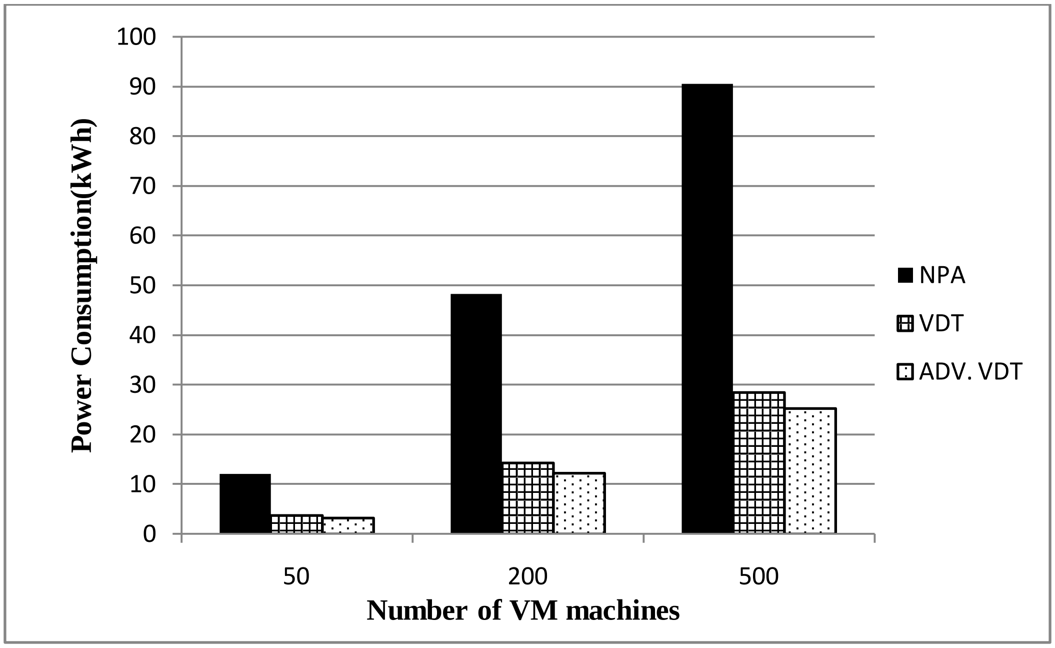
Number of Virtual Machines = 500

Power consumed by NPA (Non-power aware), VDT (VM based dynamic threshold) and Advance VDT is compared by taking 500 virtual machines for 2 hours.



Graph 3: Comparing average power consumed by 500 VMs.

Summarized graph for average power consumption and number of VMs



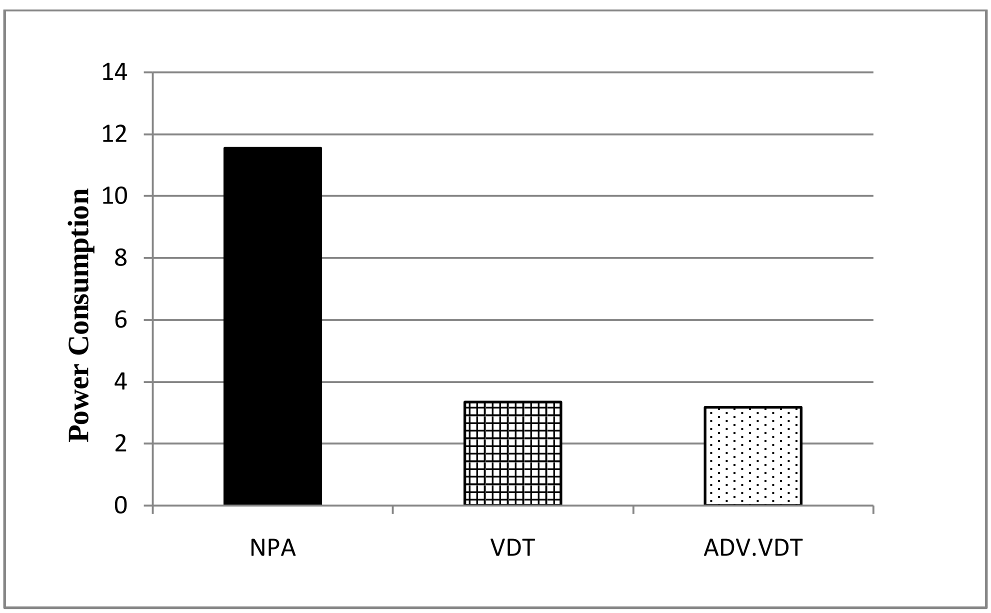
Graph 4: Summarized graph for Power consumption and number of VMs

Analysis

In above graph average power consumption is compared with three techniques varying number of nodes. The power consumed by the virtual machines in Advance VDT is less as compared to non-power aware and VDT techniques. The power consumption of Advance VDT is less than the VDT because of dynamic voltage and frequency scaling used in it.

Comparison of Power consumption at different time intervals

Time interval = 1 hour

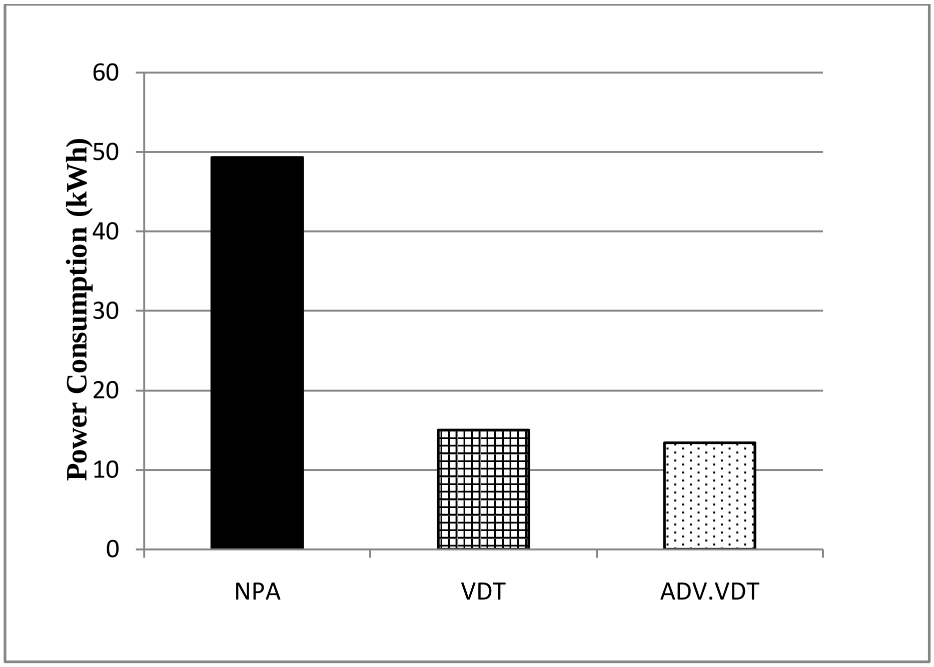


Graph 5: Comparing average power consumed by 100 VMs in 1 hour

Power consumed by NPA (Non-power aware), VDT (VM based dynamic threshold) and Advance VDT is compared by taking 100 VMs for 1 hour. In above graph, power consumed by NPA is highest and power consumed by Advance VDT is lowest.

Time interval = 4 hours

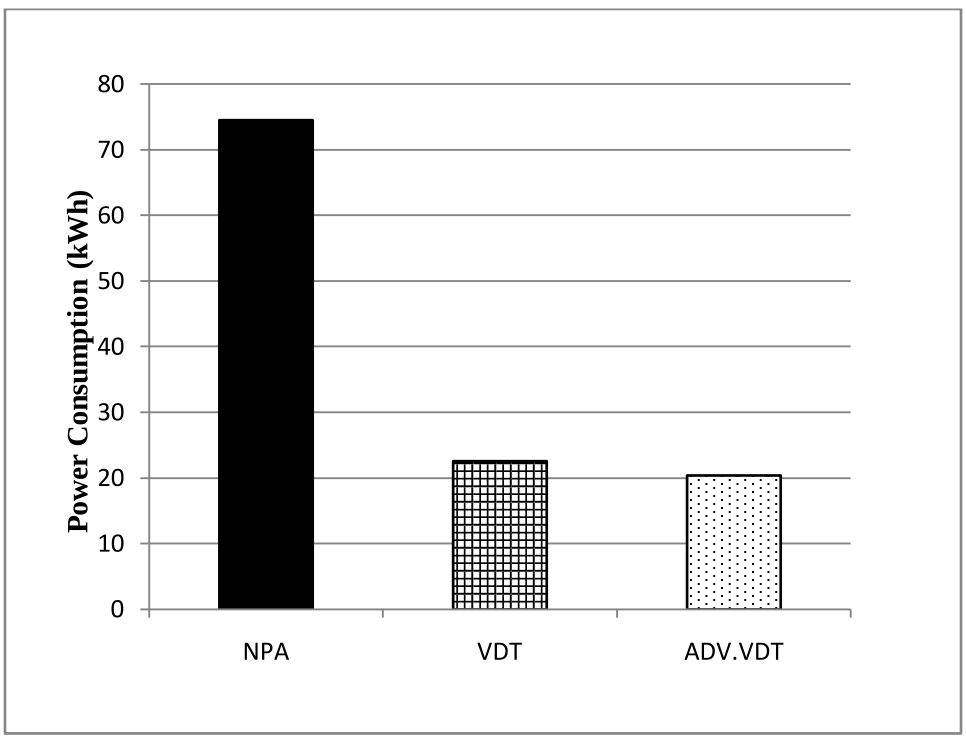
Power consumed by NPA (Non-power aware), VDT (VM based dynamic threshold) and Advance VDT is compared by taking 100 virtual machines for 4 hours.



Graph 6: Comparing average power consumed by 100 VMs in 4 hour

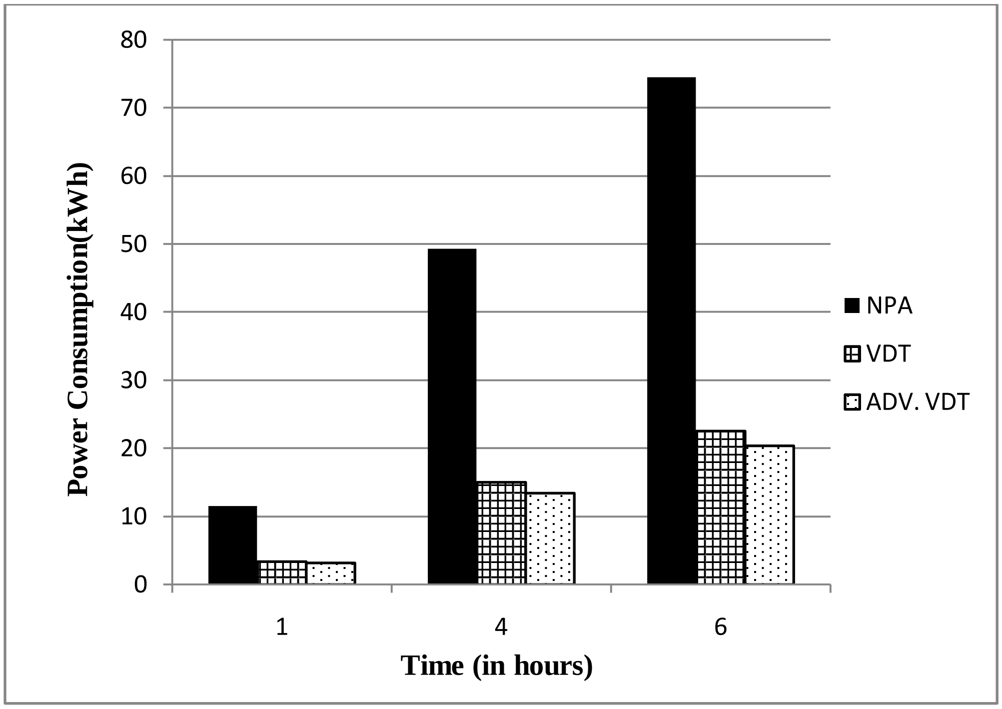
Time interval = 6 hours

Power consumed by NPA (Non-power aware), VDT (VM based dynamic threshold) and Advance VDT is compared by taking 100 virtual machines for 6 hours.



Graph 7: Comparing average power consumed by 100 VMs in 6 hour

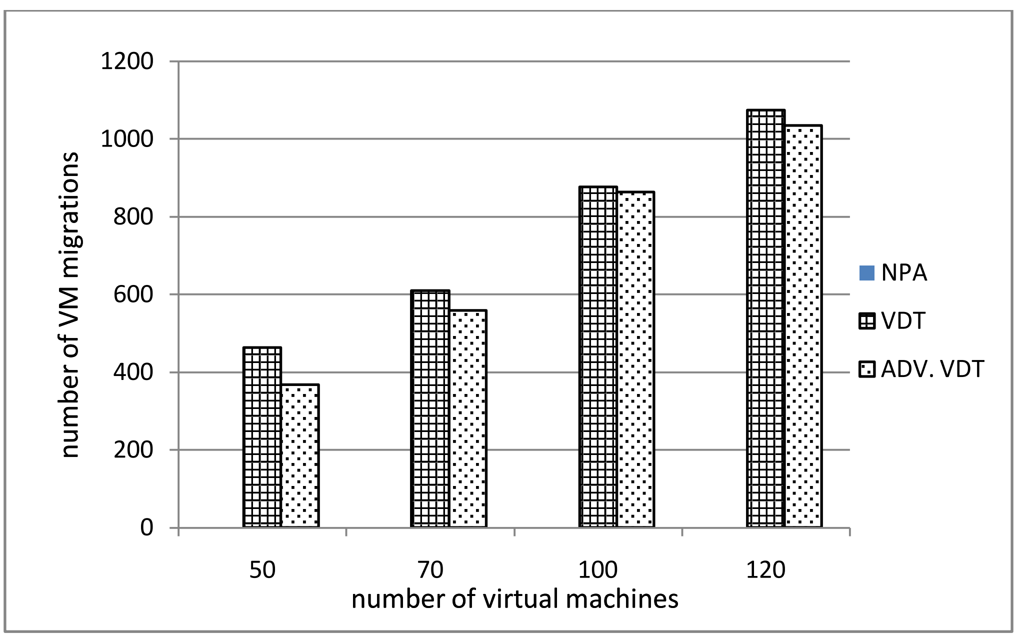
Summarized graph for average power consumption and time interval



Graph 8: Comparing average power consumed by 100 VMs in different time intervals

Analysis
In above graph average power consumption is compared with three techniques varying time intervals. It is shown that at different time intervals also the power consumed by the Advance VDT is lowest as compared to non-power aware and VDT by 100 virtual machines.

Comparison of average number of VM migrations

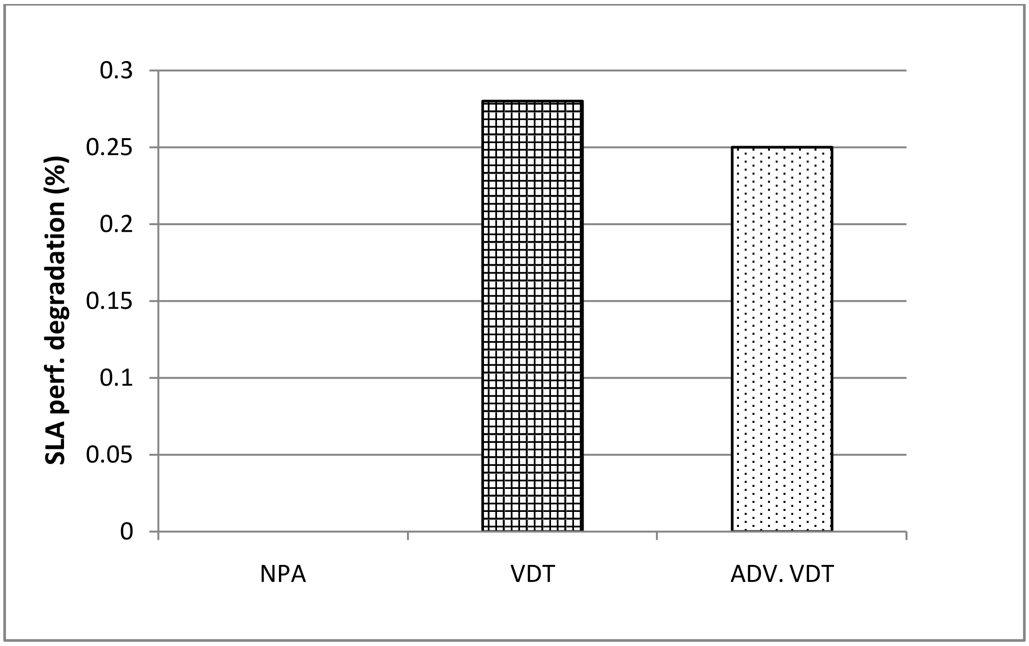


Graph 9: Comparison of number of VM migrations in 2 hours by varying number of machines

Analysis

In above graph average number of virtual machines migrated is compared in NPA (Non-power aware), VDT (VM based dynamic threshold) and Advance VDT by taking different number of VMs for duration 2 hours. It is shown that number of VM migration is less in Advance VDT as compared to VDT.

Comparison of SLA performance



Graph 10: Compares the SLA performance degradation in NPA, VDT and Advance VDT.

Analysis

In above graph average SLA (Service Level Agreement) performance degradation is compared of three techniques. It is shown that SLA performance degradation is lowest in Advance VDT is as compared to non-power aware and VDT using 200 virtual machines for 2 hours.

CONCLUSION AND FUTURE SCOPE

This paper work presents a new algorithm called Advance VDT (VM based dynamic threshold). Advance VDT is basically an improvement over VDT. The new algorithm is hybridization of VDT and DVFS (Dynamic voltage and frequency). The implementation of new algorithm shows a tremendous improvement over the VDT. The new algorithm has reduce the power consumption in cloud computing, migration time, number of virtual machines migrations. Tradeoff between power consumption and Service License Agreement violation (SLAV) has to be made by the cloud providers. Usage of energy efficient resource management policies will eventually escort to the increment of revenues. This all can be achieved by the consolidation of virtual machines and keeping the idle server on the sleep mode. Though if, consolidation is done improperly, it will lead to SLAV.

The proposed algorithm is efficient to reduce power consumption and SLAV and at the same time a technique called dynamic voltage and frequency scaling would be applied on the servers when the load is light. Eventually it will reduce the power consumption to few percent. As the servers with DVFS can save at least 50% power cost as compared to the servers without DVFS.

As cloud computing is increasing day by day. The rapid increase computing is responsible for a global increase in energy consumption, and energy cost additionally as a proportion of IT costs. Although Advance VDT shows good results, still the algorithm can be further improved to lower the power consumption. In future work, the research direction is the consideration of proposing an algorithm which reduces the power, enhances the performers while reducing the number of migration so that it may not violet service level agreement and provides the flexible service delivery.

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