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Energy Aware Load Balancing Fault Tolerant Mechanism for Enhancing Reliability of Cloud

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***Abstract* -** In the current years, the broad utilization of cloud computing in IT industry has prompted excessive utilization of energy in the host and subsequently data centers, which obviously, has turned into a matter of thought. To spare energy in cloud, dynamic virtual machine consolidation and power aware mechanisms can be thought of one of the best strategies. In this approach, a portion of the under-stacked physical machines (PMs)are place either into low-control mode or are turned off with the assistance of live relocation of Virtual Machines(VMs). Fault tolerance mechanism with dynamic relocation is proposed through this literature. Proposed work presents a novel approach of conserving energy considering parameters such as fan speed, temperature, power consumption and energy. Fan speed is allocate to each Virtual Machine(VM) along with temperature. Deterioration of virtual machines are detected at distinct level of examination. 1) Fan speed is compared against temperature, In case Fan speed is lower as compared to temperature then VM with temperature rise upon load is detected. 2)Energy consumption is another criteria used to detect deterioration. Deterioration can be detected at any level and if detected, dynamic relocation through Live VM migration is done and progress monitoring mechanism is used to conserve energy. Using the approach energy efficiency is achieved along with reliability. Simulation is conducted in Netbeans with CLoudsim 3.0.3. Proposed approach conserve energy up to 25% .

Keywords— Fault Tolerance; Energy efficiency; Reliability; Migration

I. INTRODUCTION

Cloud Computing is the emerging technology satisfying the large scale computational requirements of the clients. Cloud computing offers a package of hardware and software resources that can be leveraged by clients on pay per use basis [1]. The clients no longer need to worry about the initial investments on the resources as cloud computing exploits virtualization technology to share multiple resources such as storage, hardware, software and network resources among different clients in accordance with their requirements on demand basis [2]. As the technological advancement continues the rising demands for high computation facility has resulted in the expansion of IT infrastructure which is a major source of energy consumption and carbon dioxide emission posing greater threat to environment and cloud service providers who would have to spend additional amounts to keep energy consumption within limits. According to SPEC (Standard Performance Evaluation Corporation) by 2020, the energy consumed by datacenters will rise to 38000 billion Wh/year [3]. The huge servers hosted in the datacenters dissipate a large amount of heat and need cooling systems to regulate the optimal temperature which in turn also adds to the carbon footprints and results in energy crises due to high power consumption. Thus there is a need of eenergy management strategies which utilize energy efficiently so that energy saving can be considerably increased controlling the rising energy crisis. It also increases profit margins of service providers by promoting the optimal use of cooling equipments and underutilized resources.[6]

Moreover, the failure rate grows with the growth in system components. According to this paper system represents cloud computing infrastructure including hardware (network, servers) and software (cloud management system, appliances) components [4].The number of computing, storage and communication components that can fail is relatively large as a result failure the probability of failure increases [5]. Continuous availability and reliability of services is key concern in an organization and any interruption due to failure may result in severe consequences and the loss may not be recovered. Thus there is a need of fault tolerant strategies which can handle failures gracefully while ensuring continuous availability, scalability and reliability of services [7].

Fault tolerance and energy efficiency are the two key challenges in cloud computing that need to focused in order to provide the desired QoS(quality of services) to the clients.

There is very limited research which considers both these parameters simultaneously. A review is done to explore the present fault tolerance and energy management strategies. In this paper a fully coordinated approach to provide energy efficient fault tolerance was proposed. In Section 2 related work is discussed. Section 3 Section 4 algorithms are proposed that solve the gaps. Finally Section 5 concludes this paper.

II. RELEATED WORK

Fault tolerance and energy efficiency are the key parameters that must be considered by cloud service providers to provide reliable QoS to clients while gaining profit at the same time. Various fault tolerance strategies where used to improve reliability and availability of cloud services which can be broadly classified as reactive and proactive approaches. In reactive fault tolerance strategies, recovery mechanism where implemented in the event of occurrence of failure. Redundancy is the most traditional approach to provide fault tolerance. Check pointing approach proposed by[12] record the progress so that in case of fault or failure vms does not have to perform entire task again rather progress can began from same position where fault occurs. The framework in [6] proposed a model for versatile adaptation to non-critical failure in cloud computing. In the proposed demonstrate, the framework endures the deficiencies and settles on the choice on the premise of dependability of the preparing hubs that is the virtual machines. The unwavering quality of the virtual machines is versatile, which changes after every single processing cycle. In the event that the virtual machines figure out how to create the right outcome inside as far as possible, its dependability will increment. Furthermore, in the event that it doesn't create the outcome inside time, its unwavering quality will diminish. The proposed method is a decent choice to be utilized as an adaptation to internal failure component for constant registering on cloud foundation. It has favorable position of forward recuperation system, a dynamic conduct of unwavering quality setup and it is very blame tolerant.

Reference [15] proposed a convenient virtual machine relocation for proactive adaptation to non-critical failure. The work means to keep up an upper bound on administration auspiciousness by relocating disappointment inclined virtual machines to other physical host.

Preemptive movement depends on a multi-level online disappointment forecast. So as to accomplish the fundamental worldwide forecast exactness, metalearning calculations are utilized on four layers that constitute the framework in particular:

- Physical Hardware
- Hypervisor/Virtual Machine Monitor (VMM)
- (Guest) Operating System
- Application and Middleware stack

After having investigated multi-layer disappointment expectation, the Last stride is to pick the relocation focus of the virtual machine. For cost reasons virtual machine is moved to another physical host running no virtual machines. Reference [16] assessed the execution of proactive adaptation to internal failure conspire over the cloud utilizing cloudsim test system. Cloudsim is a toolbox for displaying and reproduction of distributed computing situations and assessment of asset provisioning calculations [17] and in this work they proposed a dynamic calculation for cloud condition in which RAM/Broker (asset mindfulness module) proactively chooses whether the procedure can be connected (a current virtual machine or another). In this way, it can handle the event of the blame. Creators additionally proposed a procedure which proactively chooses the heap on virtual machines by making new virtual machine if necessary. Reference [18] taken a shot at assignment relocation based fault tolerant plan for distributed computing explaining the potential reasons of flaws happening inside the cloud.

Flaws of existing approach in terms of downtime or migration time can be further reduced. The fault tolerant strategy which can be optimized for future endevours is proactive approach. The objective drawn from the literature is as under

1. Building Energy efficient fault tolerant strategy
2. Saving progress of vms to reduced workload in a situation where fault occurs.
3. Reducing downtime and migration time in case of vms relocation.

III. PROBLEM FORMULATION

A. Definition

Fault tolerance and energy efficiency are the primal challenges these days. Different architectures, frameworks, algorithms and policies have been proposed to make the cloud computing environment fault tolerant and energy efficient. However, there is limited research which considers both parameters simultaneously. This proposed work focus on proactive fault tolerance strategy which predicts system's thermal behavior to reduce the overall temperature so that failures which may occur due to rising temperature can be avoided by using live migration strategy. Moreover the energy required to operate the data center cooling systems can be saved. The power-aware reallocation approach is used such that virtual machine on deteriorating physical machine can be reallocated to optimal physical machine, which further saves energy.

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B. Objective

1. Deteriorating virtual machine detection on the basis of variation in temperature.
2. Minimizing downtime and migration time by using live virtual machine migration

IV. METHODOLOGY

The methodology of proposed work includes load balancing and energy conservation mechanism using load balancing and temperature reduction procedure. The broker is used for this purpose. The broker monitors the energy consumption by checking fan speed against the temperature. In case temperature rises beyond threshold limit faulty virtual machine is detected. Then power aware relocation procedure by looking for optimized VM on the basis of highest power is selected. The overall procedure for the proposed system is given as under

Algorithm EAFT (Energy Aware Fault tolerance)

Input: load
/*Variable initialization*/
host list: all the active hosts, VM list: all vms currently available in the pool, Finalized_VM: sorted list of vms consuming minimum energy, Threshold(temp): 60, Threshold(energy): 250

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1. Initialize Fan speed and temperature to each VM.
2. Evaluate power consumption of each VM using equation

   $\text{Power}_i = \text{P1} + \text{P2} * \text{CPU}_{\text{Utilization}_i}$ -------Equation 1
3. Evaluate energy consumption of each VM using equation

   $\text{Energy}_i = \frac{\text{CPU}_{\text{Utilization}_i}(\text{P1}+\text{P2})}{\text{Power}_i}$-------------Equation 2
4. Sort VMs on the basis of energy consumption

   $\text{Finalized\_VM}_i = \text{VM}_{\text{Min}}$
5. Assign Load to Finalized_vm
6. Check for deteriorating vm

   If (Temperature>Threshold and Fan_Speed_i<Temperature)

   Else (Energy>Threshold)

   Migrate VM to optimal destination selected from Finalized_VM list
7. Use Equation 1 and 2 to check for power and energy consumption
8. **Output:** Downtime, Migration time, Average Energy Consumption and Latency

The flow of proposed system is given in figure 1.

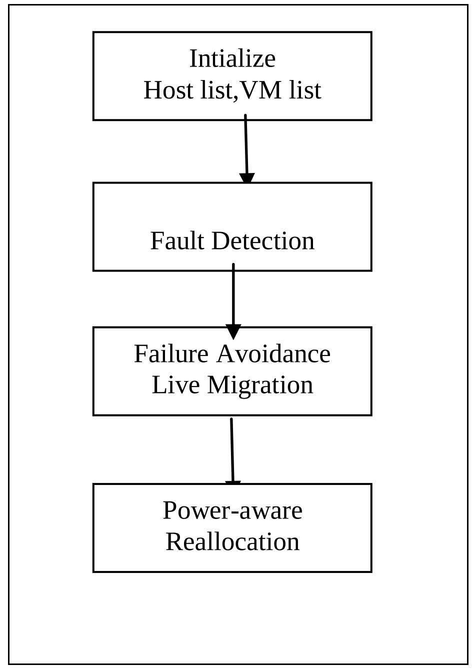


Figure 1: Flow of proposed system

The proposed work can be separated in various phases.
Firstly, the host list and vm list in accordance with the active hosts and vm's required to fulfill the service request of users. Jobs are initially allocated to virtual machines for execution on first come first serve basis.
The detailed description of each step is provided below:

C. Fault Detection

Fault tolerance and detection is the property that empowers a framework to keep working appropriately in case of the failure of (or at least one faults inside) some of its parts. On the off chance that its working quality declines by any stretch of the imagination, the lessening is corresponding to the seriousness of the failure, when contrasted with an innocently composed framework in which even a little failure can bring about aggregate breakdown. Fault tolerance is especially looked for after in high-accessibility or life-basic frameworks. The capacity of keeping up usefulness when segments of a framework separate is alluded to as agile degradation.

A fault-tolerant plan empowers a framework to proceed with its planned operation, potentially at a diminished level, instead of flopping totally, when some piece of the framework fails. The term is most usually used to depict PC frameworks intended to proceed with pretty much completely operational with, maybe, a decrease in throughput or an expansion accordingly time in case of some incomplete failure. That is, the framework in general is not ceased because of issues either in the equipment or the product. A case in another field is an engine vehicle planned so it will keep on being drivable in the event that one of the tires is punctured, or a structure that can hold its respectability within the sight of harm because of causes, for example, weariness, consumption, fabricating imperfections, or effect.

The proposed technique uses fanspeed,temperature,cpu utiliztion and energy consumption. The fanspeed is associated with every vm. In case fanspped is less and temperature is more the en chances of fault increases.The detection process uses threshold values.As the fanspeed is less than the the temperature , temperature increase. As the temperature exceeds threshold value,fault Detected. Power consumption , cpu utilization and energy cpnsumption is next in the sequence to detect faults. The assumed values corrsponding to power is as under:

P1=175, P2=75

Power=P1+P2*cpu utilization;

Equation 1: Power Consumption Equation

Energy=Cpu utilization(P1+P2)/Power

Equation 2: Energy Consumption Equation

Threshold value of energy consumption is 250. In case , energy consumption is higher than threshold, fault is detected.

D. Fault Avoidance(live vm migration)

As the fault appears within the vm on the basis of parameters, energy consumption , temperature, fanspeed etc . then new vms within distinct host must be located for future progress. For this process, live vm migration is required. In a proposed approach, the vms are arranged according to fan speed and energy consumption. As the load is executed on a vm both energy consumption and temperature increases. As these parameters exceed threshold value, deterioration is detected.

Next efficient vm or optimal vm is to be selected. After selecting the optimal vm load is shifted and progress begins from the same point where fault has been occurred in the previous vm.

E. Power-aware reallocation

In a proposed approach power aware mechanism is used.To perform reallocation. sorting operation is applied on vm list according to power consumption. When load is distributed on vm then allocation corresponding to that vm is set to one. As the load increases on that vm energy consumption also increases. Eneregy consumption is dynamic in nature indicating that energy varies as the load increases as suggested by equation 2. Threshold valueof energy consumption is maintained at 250. In case, energy consumption exceeded , new vm is selected for allocation. Record of allocation is made so that same vm is not selected multiple times.

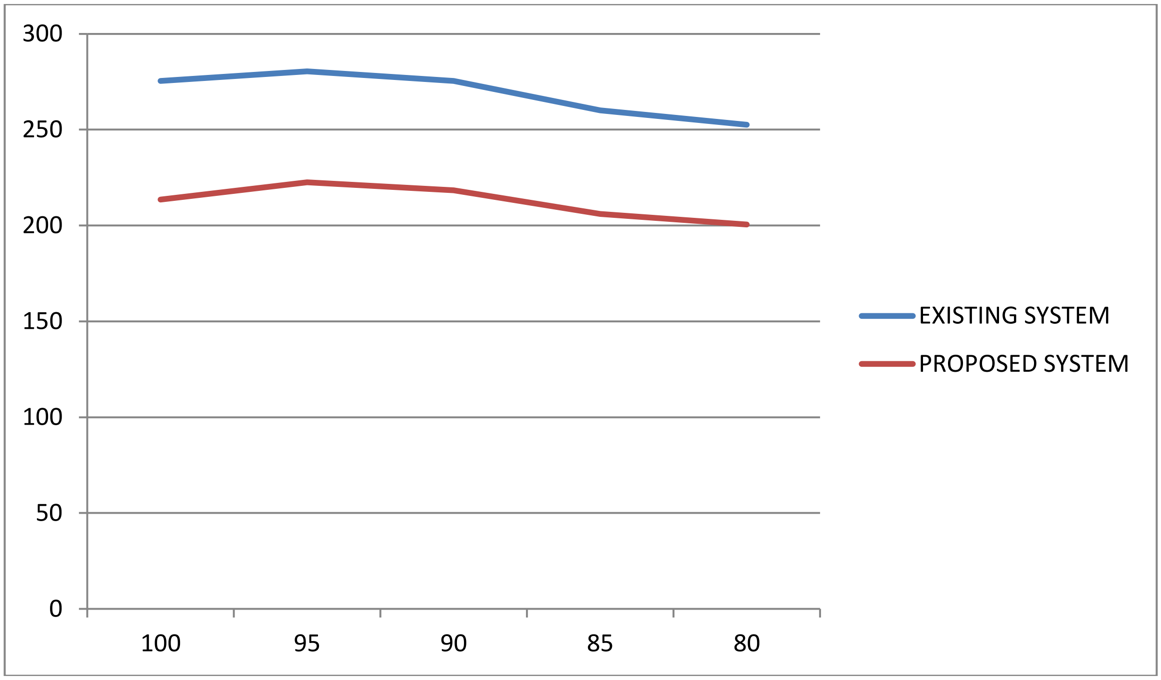
As the VM is selecred, progess is copied from previous deteriorating machine and copied to next optimal vm selected from vm sorted list.

V.RESULT AND PERFORMANCE ANALYSIS

We have considered three parameters within the result and performance analysis i.e energy consumption, downtime and migration time . The result in terms of therse parameters is as under:

Table 1 showing energy consumption corresponding to existing and proposed approach.

SIMMULATION	Cloudlet	EXISTING SYSTEM	PROPOSED SYSTEM
Simulation 1	100	275.48314	213.48314
Simulation 2	95	280.45565	222.45565
Simulation 3	90	275.42105	218.42105
Simulation 4	85	260.09743	206.09743
Simulation 5	80	252.55665	200.55665



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