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Load balancing in cloud computing: an analytical review and proposal

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ABSTRACT

Task scheduling or mapping of requests to machines with specified requirements becomes a very important problem to get optimized results. With the requests of many users, the machine can go under different conditions such as heavy load and minimum load. These various aspects can lead to system failure and loss of data. Hence the load must be balanced to beat the losses of the system. A load balancing concept described how different types of loads could be balanced with each machine. The load can be of memory, computation, and network. The paper mainly focuses on all kinds of load to provide a big view for load balancing in cloud computing. Along with a review of all load balancing techniques, the paper is also presenting a proposal to balance the load with decision theory. The proposed paper introduces the basic techniques and types for load balancing and their implications for innovation.

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1. INTRODUCTION

Communication within a network is the most important stage of information exchange. It is also showing the exponential growth of networking. The Internet is a primary aspect of building networks within multiple nodes for effective communication. The Internet is the basic prerequisite for the cloud computing process. This process provides an accurate data transmission across channels without any delay and quality communication with a check log. Cloud computing influenced the user by providing multiple services like platform, software, and infrastructure at a time. By combining these services, a complete project module can be implemented to perform tasks based on the needs of the users.

The services deal with on-demand requirements, as software can be selected by requesting software scheduled on-demand. For the platform, the prescribed application has to be selected as an on-demand platform to run. Finally, the infrastructure service can be availed with the pre-requested demand of fixed infrastructure [1]. Apart from these services, many more customized services are introduced in cloud computing such as security as a service, trust as a service, quality as a service. Figure 1 is showing these services that are specified for the pre-described application only. The pre-detail of the required information is maintained by the broker in the form of a service level agreement for the user. This agreement enshrines a commitment with the user for their requested services.

Cloud computing becomes an essential bridge for some major IT sectors such as international business machines (IBM), Amazon, Microsoft, to perform confidential tasks. By pooling these three deployment models, multinational companies (MNCs) are able to enhance their facilities for embedded and

advanced execution. In addition, cloud computing is providing a resource pool through which people can get the necessary resources for their implementation. Cloud computing is providing essential services in terms of basics and customization. The customization of the services is systematically designed by respected researchers to keep up with the growth. These services are designed on the basis of specifications such that the trust as a service satisfies the trust factor between the service provider and the user. It can accept any measurement factor like reliability, accuracy.

The process of providing service is completed by a broker named cloud service provider (CSP). It works between the user and the system. The broker takes the request from the user and processes it to reach the higher level i.e., application level. After the request reaches the upper layer, the server is now active to meet the execution of the incoming requirement. The behavior of the broker should always be good as there are many requests with different requirements that come every second as the technology progresses. Hence it is a very difficult task for the broker to maintain the entire request landscape from the bottom to the top level. From the point of view of precise performance, the load should be uniformly optimized for the machine. According to the proper definition of load balancing, it is a method of evenly distributing workloads in a shared system such that no computing system should be overtired or ideal in a cloud computing process. Load balancing tries to speed up the working of the system with various constraints like execution time, makespan, system durability. The most relevant term used in cloud systems, known as cloudlets. This is a basic requirement for starting a computing process that has the relevant characteristics for the concept of the task scheduling. Virtual machines and physical devices are typically used to initiate the cloudlet processing. Load balancing works with virtual network addresses, when the address is found, the data packets move from the sender to the destination address within a limited time period. The process moves from the origin to the last node, filtering out the necessary resources. This interruption delay is avoided if the system finds the network address in the pre-requisites.

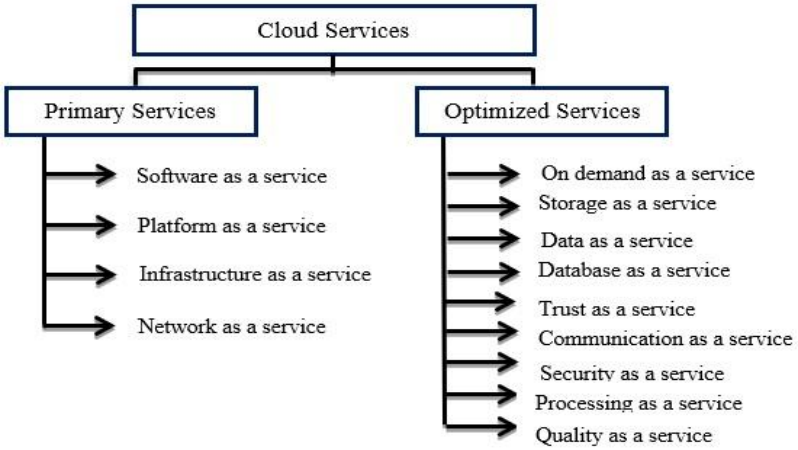

Figure 1. Cloud services

2. RELATED WORK

Existing load balancing techniques are defined by this section with a detailed classification of balancers and the measurement factors to calculate system performance for useful evaluation in the context of load. Through multinational organizations, load balancers are classified into four terms which are represented by Figure 2. Active end user level application balancer, which handles the problem related to the type of software applications supported with the help of hypertext transfer protocol (HTTP)/hypertext transfer protocol secure (HTTPS). It operates with the help of dynamic node port mapping of data packets in a collaborative network [2]. With the help of transport control protocol (TCP) network load balancer is able to process millions of requirements per second with uniform load distributed within the respective network. It also works on dynamic load balancing theory. The classic load balancer runs on the traditional mapping concept of the load on the machine. It follows the static load balancer rules that satisfy the pre-requisites for the actual mapping between the container instance port and the load balancer node. Gateway provides so many facilities to accommodate various achievements towards load balancing of a system. It accumulates surveillance towards prevention and detection of systems from unauthorized attacks [3]. It monitors compatibility for deploying software, manages virtual implementations and finally checks the transferred data packets. The variety of latest load balancing work is detailed through Table 1 mentioned here. The table

will explore the findings of existing load balancing techniques that will be viable for future papers as a valuable investigation to achieve their research objective.

Generally, in load balancing the system has two categories to perform well i.e., static and dynamic. Static load balancing works with two phases: the start of a task and the availability of resources for a particular task. Dynamic load balancing is another category of load balancing. It works with the running environment of a dynamic process. This ensures the number of resources, which will also be available in the dynamic method for the next task.

According to the findings of the latest analysis for load balancing research, most papers have been prepared for survey and review. These papers show a comprehensive analysis for researchers to come up with some new analytical techniques. Instead, some papers also showed a proposal for better load balancing techniques. This paper also tries to meet the market motivation by introducing an innovation decision technique to balance the request for good customization.

Figure 3 is trying to show the latest scenario on load balancing with different publishers. It concludes that most of the publications expressing the detailed analysis and review only. But market needs some innovation and new algorithm to run the end users' request within the factor of quality measures. In this figure, publishers classified as: i) Elsevier; ii) Springer; iii) IEEE; and iv) others.

The next section is coming up with some new ideas i.e., decision theory concept. The principle proved to be the right decision to make the request go smoothly. For inspiration, a mix tool will work for performing cloud computing tasks. For this, different types of workloads will also have to be submitted. Load equity includes several factors such as: strong spec caliber must be present to calibrate heavy loads. Communication network efficiency must be accomplished by executing multiple types of loads along different channels. Customizable tasks will proceed smoothly as the complexity of similar types of tasks continues to grow. Since IoT comes with some development of technology, it has to bear all kinds of load. Embedded cloud hosting is running for multi-specialty programs. Security is a major concern for dynamic real-world execution environments. The financial support will look for multi-tenant applications to handle heavy loads with various extensions. Elastic feature for scaled to run nice with latest technology.

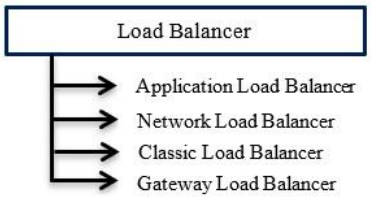

Figure 2. Classification for load balancer

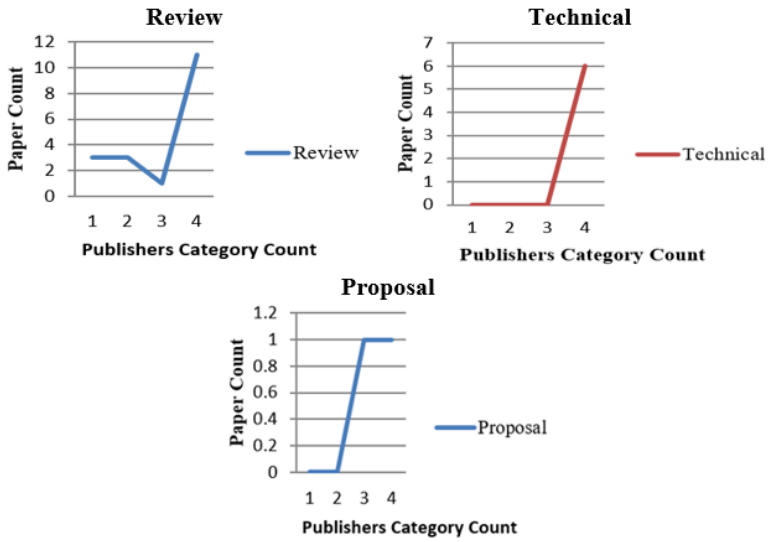

Figure 3. Findings from the survey

Table 1. Latest research publication on load balancing in cloud computing

Ref	Type of the paper	Proposal/technique	Year	Publisher	Outcome
[4]	Review paper	-	2019	Springer	Detailed encyclopedic review for load balancing techniques
[5]	Technical original paper	VM allocation based on their processing power	2020	Other	Reduction in user request response time and data centre processing time
[6]	Review paper	-	2019	Other	Study of various hybrid load balancing algorithms in cloud computing environment
[7]	Technical original paper	Energetic neighbor selection for scheduling and transmission	2019	Other	Improved network performance and energy efficiency in terms of throughput, packet delivery, delay, packet loss, and remaining energy
[8]	Technical original article	Adding more nodes without the need to increase the power of each node	2019	Other	Reduction in throughput and response time
[9]	Technical original article	Randomization and greedy load balancing algorithm	2019	Other	Reduction in cost, response time, and data processing time
[10]	Technical original article	Throttled modified algorithm	2018	Other	Reduction in response times and processing time
[11]	Review paper	Developed an effective load reconciliation algorithmic rule mistreatment divisible load programming theorem	2017	Other	Shown improved performance in terms of throughput and latency
[12]	Review paper	-	2018	Other	Shown optimized load on cloud servers along with a proposed work based on clustering algorithm
[13]	Review paper	Particle swarm optimization	2019	Other	Compare a particle swarm optimization technique with round robin, ant colony, and honeybee foraging load balancing algorithm
[14]	Technical original article	Genetic algorithm is improved for VM migration	2017	Other	Reduced the execution time-space and bandwidth utilization
[15]	Review and proposal	Problems and need for a novel balancing algorithm that employs fault tolerance metrics	2020	IEEE Access	Critical study of existing techniques of LB with various parameters such as throughput, performance, migration time, response time, overhead, resource usage, scalability, fault tolerance and power savings
[16]	Review paper	Various standard load balancing techniques and challenges	2019	Other	better utilization and better understand for users' needs
[17]	Review paper	Various load balancing techniques in a static, dynamic, and nature-inspired	2021	Elsevier	Addressed the data center response time and overall performance
[18]	Review paper	Taxonomy for the load balancing algorithms	2018	Elsevier	Analyzed the performance of heuristic-based algorithms through cloudSim
[19]	Review paper	-	2020	Other	Shown the matrices that affect the load balancing algorithm
[20]	Review paper	-	2020	Other	detailed study on the different load balancing algorithms
[21]	Review paper	-	2019	IEEE	Surveyed the comparison and contrast of various loads balancing policy
[22]	Review paper	-	2019	Springer	Shown the concept for reducing energy consumption and response time
[23]	Review paper	-	2019	Other	Shown conceptual model for efficient resource management and reliability for cloud services
[24]	Review and proposal	Concentrate on scheduling at the local and global level for optimal use of computing elements	2018	Other	Proposed method (decider, threshold based), with various parameters such as RAM, CPU consumption, network traffic statistics
[25]	Review paper	Load balancing techniques categorized	2021	Elsevier	Hidden Markov Model helps in better CPU utilization as well as faster execution environment
[26]	Review paper	-	2018	Springer	Enhanced the efficiency and reliability
[27]	Review paper	Stack modifying estimation	2021	Other	Resource utilization

3. METHOD

A tree mechanism for balancing the load is shown in most of the papers. Because a tree tries to balance the load on either side of the center of the root. Agreeing with the tree concept, some other theories are also capable of doing the distribution of work with equitable division such as decision theory. Continuing with the proposed concept, it operates with two variables, either 1 or 0. With large amounts of data, applications are picked up from a pool of applications. The nature or basics of each application are already determined at the time of incoming requests or registration of applications. The predefined system automatically rejects applications if it is found to be inappropriate for the configured system. And then a new machine is quickly setup to take that into account, as the application requires. The objective of the innovation system is to meet all incoming and registered requests as soon as possible so as to achieve useful results for the development of new technology or methods.

Figure 4 serves as a landscape view. Many applications are to be processed. A load balancer will allocate applications to different servers according to its configuration and capacity. A greater number of applications would be needed to accommodate the highly capable servers. The execution process will process the shorter length task with the lower configured system. Sometimes requests have to wait for execution or the machine is not found, this usually happens when there is no space in the machine to execute more applications. Then a threshold value is to be set which will indicate that it is either 0 or 1. If the server is close to reaching the ideal state, it will be 1 and show that the machine is still working and there is no room for more application. But if the value reaches 0 in a very short time, this means, now the machine is able to run the next application. The length of application (MI) will be the only factor to calculate the size of the application machine usage count (MUC). But the system configuration will be measured with the help of various parameters like bandwidth Mbps, memory (usually GB), size instruction count (IC) and speed million instructions per second (MIPS). In order to obtain the best mapping of applications to the appropriate machine, the fitness measured must be in the calculation.

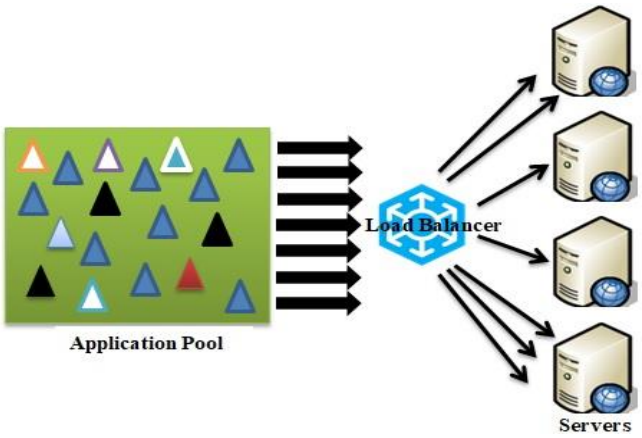

Figure 4. Load balancer

An attempt is made to propose a decision-based load-balancer (DLB) model in the paper. And it also tries to address the gaps, which are generally covered in current research papers. Such references are already described above in existing concepts.

A stable system is recognized by its functionality. It should achieve 100% accuracy in the results. Still, no system is capable of performing 100% accurate. With regard to this issue a process is being initiated through DLB to get the best results with as little as possible. The proposed system will show answer in only two states i.e., 1 or 0. A range value will only be set between 0 and 1. When the system is in the ON state, the value will be initially set to 1 and the variation will be noted until the 0 value is reached.

For better performance a fitness value must be calculated at every moment (mainly: new application come and in waiting state) to check the load state of a system. Mapping of n number of applications should be allotted to the appropriate and ideal machine. A counter has to be set to monitoring the queue for coming applications. If counter found application in a queue, then fitness count will be measured of the system and if the value found 0 then the coming application will get executed. Top layer in Figure 5 shows that this time system is fully occupied with the load. In same figure, lower stages showing that system is now available to take more applications into account as it reached to 0.

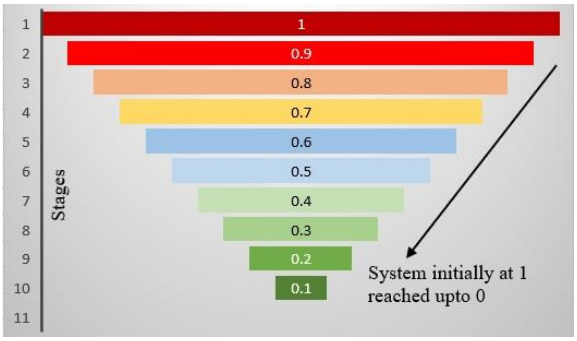

Figure 5. System load

Initially fitness value variable introduced as (FV) and initially counter C is set to be at 0 value. An application came into queue, counter C will get update its value as 1. Now FV will measure the machine state value from 1 to 0. Table 2 summarizes every possible system stage with its outcome. To calculate the fitness value for ith application and jth machine, an expected executed time (EET) has to be measured for a single application/process. Then it will collaborate with the decision value (DV), and finally the proposed system will be into execution.

$$DVij == System\ stage\ is\ 11\ (Specified) \quad (1)$$

$$\text{FV} = \sum_{i=0}^{n} DV_{ij} \times EET_{ij} \quad (2)$$

Let's say FV will get the value near any stage then the result will be found in the table. Using (1) and (2), the value will definitely go from 1 to 0 because the pre-requisites of EET are to be measured by measuring the length of the task before the start of execution. In recent studies, several load-balancers have been taken into account. However, they all have some benefits and some limitations as well. Some are only capable of balancing the network load and some are only for hardware load balancing. So, the balancer introduced in the past was specified only with certain specified conditions. The concept of decision-based load-balancer enables balancing of loads with multiple requirements with the help of decision and fitness theory.

Table 2. System-load-output with different fitness values

System stages	Counter	Fitness value	Outcome
1	1	1	no allocation
2	1	0.9	no allocation
3	1	0.8	no allocation
4	1	0.7	no allocation
5	1	0.6	no allocation
6	1	0.5	no allocation
7	1	0.4	no allocation
8	1	0.3	no allocation
9	1	0.2	no allocation
10	1	0.1	no allocation
11	1	0	allocation
-	0	-	-

4. RESULT AND DISCUSSION

A useful method allows the task to satisfy the need in order to satisfy the customer. What factors affected taking into account load balancing are listed here. User request response time, data processing time, network performance, energy efficiency in terms of throughput; packet delivery, delay, packet loss and remaining energy; cost, latency, execution time-space, bandwidth usage, migration time, overhead, resource utilization, scalability, fault tolerance and power saving, energy consumption, reliability. In cloud computing, load balancing is considered the most difficult challenge. Dependent on this factor alone, the organization and service provider think before taking any request or contract from any user. The proposed decision principle also helps in decision making of the request. The percentage value of the factors affected by load balancing is applied here. Table 3 is showing actual uses of load balancing techniques.

Looking at analytical data, more attention is being paid to response time and resource utilization factors. The rest are achieving normal ranking by implementing other load balancing. Since user response time should always be the first in evaluation all functioning and value of a demanding market is really dependent on this factor alone. Effective fault tolerance load balancing adaptability, availability and meets all the mentioned factors.

Table 3. Factors affected by load balancing

No.	Factor name	Ref.
1	User request response time	[5], [9], [10], [15], [17], [22]
2	Data processing time	[5], [9], [10]
3	Network performance	[7], [15], [17]
4	Energy efficiency (throughput, packet delivery, delay, packet loss, and remaining energy)	[7], [11], [15], [26]
5	Cost	[9]
6	Latency	[11]
7	Execution time-space	[14]
8	Bandwidth usage	[14]
9	Migration time	[15]
10	Overhead	[15]
11	Resource utilization	[15], [16], [23], [25], [27]
12	Scalability	[15]
13	Fault tolerance	[15]
14	Power saving	[15]
15	Energy consumption	[22], [24]
16	Reliability	[23], [26]

5. CONCLUSION AND FUTURE WORK

The study described a clear approach to a holistic balancing technique. It tolerates all types of inputs and processes it with a uniform balancer concept with effective decision principle for absolute satisfaction rate either it is 100% or 0%. Furthermore, the paper reflects the current perspective of load balancing towards research and innovation. Load balancing affects many measurement factors of the machine such as makespan, throughput, accuracy, predictability, observation, overhead, and reliability. In order to accomplish a true performance appraisal, the required factors must be processed with some more effective techniques for load-balancing. This line is also welcome for future work by respected researchers that along with more analysis, some new results and actual implementations should also appear in upcoming publications.

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