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Challenges of Various Load Balancing Algorithms in Distributed Environment

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ABSTRACT

Distributed system is the collection of various components connected over a communication network. All computer system have their own memory and processor. The tasks are executed concurrently but some processors have more task some having the less load on the processor which affect the performance. Enormous load balancing algorithms are proposed but all the techniques and algorithms have some limitations. This paper discussed the basic concepts of load balancing. Load balancing algorithms and techniques are also discussed with their pros and cons along with future scope.

Keywords: *Distributed System, Load Balancing, Data Migration, Real time System*

1. INTRODUCTION

Distributed computing system is one in which the components are located at remote site and they are communicated using message passing. It consist of several computer systems but not the common clock and shared memory, each computer systems has its own memory and their own operating system shown in the fig 1.

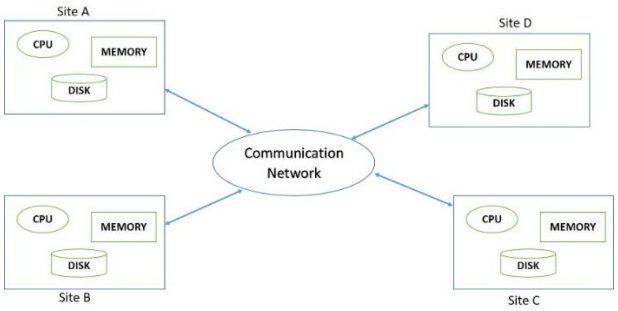

Fig 1: Architecture of Distributed System

The same resources accessed by the different computer systems on the network is known as remote resources and they are very expensive because of the communication delay and
CPU overhead. These resources are available to users with the help of following techniques [1]: Distributed scheduling, Data migration and computation migration. Data migration is the process in which the data are bought from one location to another location when it need and update the current value.
In distributed network the computer system are connected in distributed architecture and having different types of processors. Each processors have their own reliability characteristics, performance, execution time, cost etc. just because of the load.

There are various advantages of Distributed System [2]:

1. **Sharing of Resources:** A computer system request a service for other computer system which is connected through the internet over communication network via a request message. Requesting a service means system can request for printer or a database which is shared with remote computers.
2. **Better Performance:** In distributed system the task are concurrently executed so that the system response time is very less and system throughput get higher.
3. **System reliability availability improved:** Few computer system fails without affecting the other computer systems.
4. **Autonomy:** Each sites have degree of control of the data that are shared among all the sites over a communication network.
5. **Global database administrator:** Responsible for overall operation.

Apart from the advantages there are various challenges in Distributed System discussed below:

1. Due to the parallel execution of task in each node, uneven loads are distributed which increase the response time.
2. Communication cost are very high.
3. More processing [3] overhead in distributed system.

1.1 Load Balancing in Distributed System

Load balancing is one of the major factor and very popular term in distributed computing system. Different processors have different load which actually make some adverse effect on the system performance, makes very critical issues now a day.

One of the processor have less load or can say that one of the processor or lightly weighted and other are heavily loaded so in that case system performance degraded. To maintain this load balancing[4] issues there are various effective techniques/algorithms are developed for the distribution of process or load to achieve the goal such as less response time, less execution time, communication delay minimized, more resource utilization and maximum throughput.

In various load balancing algorithms the loads on each processor are equally divided to maintain the load, some algorithms analyses the capability of the processors and then they distribute the load to that node. Poisson pattern and queuing analysis are used to find out the probability of the processors load i.e. processor are ideal in condition or having a multiple jobs.

In distributed system the processors are divided into two parts according to their workload conditions first is heavily loaded and lightly loaded. Heavily loaded means in more task are in the waiting queue and lightly weighted means less task in the waiting queue.
Static and dynamic algorithms are used to balance the load. A new concept come in the picture i.e. Grid computing which also used for the load balancing.
Various algorithms are proposed for grid architecture to improve the system performance, communication cost, the reliability of the system. Different simulation and analysis results shows that the performance are improved and it was done with the help of various simulation tools.

Load unbalancing is a serious problem in parallel computation where data are not evenly distributed to every processors through which a good system efficiency and speedup not achieved. There are various issues related to load balancing in distributed architecture and according to that some literature survey [5] are presented in the below section.

1.2 Issues Related to load balancing

There are various issues related to load balancing. Some are listed below.

1. Every task is divided into subtask and each task has separate execution time.
2. Processors capacity are different, it depends on the system configurations.
3. Workload generated by the user can vary time to time on each processors which leads to the uneven distribution of loads.

2. NOTABLE ALGORITHMS FOR LOAD BALANCING

A. ECLB (Earliest Completion Load Balancing)
W. Haque et al. [6] proposed a new Load Balancing protocol named ECLB (Earliest Completion Load Balancing), for heterogeneous, distributed systems. To achieve the significant performance gain, ECLB use a load model which is very important in decision making and perform testing on three factors that affect the workload in different ways.
First is percentage of write operation, second factor is size of work and third factor is transaction's inter-arrival rate.
Now dealing with high latency situations, ECLB give a better performance output to the next algorithm [7], which is purely load-focused algorithm, named as BLB (Basic Load Balancing). In the situation of extreme latency case BLB first match the performance of latency-based protocol and then tested all pipes of the network by increasing the latency and observed. The observation provide a result that ECLB performed well as well as NNLB (Nearest Neighbor Load Balancing).
In the end, ECLB is tested against other protocols in a heterogeneous environment. As the system became more heterogeneous the testing results shows that all the other protocols lost some performance but ECLB increased the PTCT (Percentage of Transfer Completed on Time).

Advantages:
1. In heterogeneous environment ECLB increase the percentage of transfer completed on time.
2. In high latency situation ECLB perform very well.

Limitations:
1. ECLB maintain the replicated data in all nodes.
2. At any selected node the exact execution start time cannot be determined, it can be guesses by latency value.

Future work:
1. Use more sophisticated concurrency control protocol.
2. Add the transactions deadline into decisions.
3. Dynamic Assignment of varying latency values.

B. Distributed Hash Table Algorithm
Lin Xia et al. [8] propose an idea that in structured peer to peer systems, objects are randomly distributed over nodes using Distributed Hash Table algorithm which cause unbalanced load in each of the node. In peer to peer network various load balancing protocol are introduced which really works in ideal conditions but in heterogeneous environment it fails. It ignores the effect of varying objects loads as well as varying capacity of nodes.
This paper proposed an algorithm for load balancing in such heterogeneous systems. A typical virtual server based load balancing technique are used in which every node has their own id and have other information about other node. With the help of this techniques load is transferred from heavily loaded node to less heavily loaded node successfully. In this paper the simulation work shows that even in the overloaded condition algorithms are able to transfer the load from one node to another effectively.

Advantages:

1. Effective in achieving the load balancing in heterogeneous environment.
2. Overloaded nodes are reduced.
3. Transferring virtual servers.

Limitations:

1. Node must maintain the information of all other node.
2. Node information are stored statically.

Future work:

1. u=8 gives the exception condition.

C. Greedy Based Scheduling Policy

B. Sahoo et al. [9] suggests that the dynamic load balancing problem is deals with the allocation of tasks to compute nodes in heterogeneous computer system. Due to the allocation of task the computed nodes are equally loaded. Dynamic load balancing problem is modelled as minimization problem in which the tasks are assigned in heterogeneous computer system which is presented in linear programming problem.

In heterogeneous computer system, for load balancing various greedy resource allocation algorithms are present with task as Expected Time to Compute (ETC) matrix [10]. With the help of house simulator, under the different conditions, the performance of four heuristic algorithm are simulated on two different heterogeneous computer system. It is observed that the greedy based algorithm is affected by heterogeneity.

Advantages:

1. Batch mode heuristic makes better result
2. Performance on the basis of rate of heterogeneity of the task and no of computing nodes.

Limitations:

1. Centralized approach
2. Based on non-pre-emptive scheduling mechanism
3. Randomly transfer method.

Future work:

1. MINMIN algorithm is used to improve the performance.

D. CIRT (Common Information Response Technique)

Mohammad Haroon et al. [11] proposed that in heterogeneous distributed system, variety of load balancing protocols are introduced. A new algorithm are introduced for dynamic load balancing in distributed system but it is applicable for heterogeneous not for homogeneous distributed system or grid systems. After the analysis of load balancing the computing nodes are capable to exchange loads to its neighbor node or adjacent node and associate nodes.

A cognitive and heuristic based algorithm are used to solve the problem of load balancing. The algorithms has increased the computing node and the size of the architecture. After doing some analysis on this algorithm static and dynamic loaded are managed in different types of topology, and load with heterogeneous calculating nodes and networks [12]. Finally the results conclude that there is no adverse effect on efficiency, performance and speedup of load balancing. In order to give a better speedup [13] the algorithm does not apply every open source in the case of slow network.

Advantages:

1. No adverse effect on efficiency.
2. Improve the system performance.

Limitations:

1. Not suitable for homogeneous system or grid system.
2. Information are exchanged among neighbor nodes and adjacent node only.

Future work:

1. Improve the interest attentive dynamic load balancing algorithm for homogeneous distributed system.

E. SLB vs. DLB Algorithm

Amit Chhabra et al. [14] suggests that in multiprocessor system the probability of one processor to become ideal and other processor have excessive loads which are in queue, is very high in distributed computing. Due to this performance had degrade. To improve the system performance the loads are transfers from heavily loaded processor to lightly loaded processor.

Various load balancing algorithms are introduced to achieve the above goal. These load balancing algorithms are classified into two categories first static and second is dynamic.

The static load balancing (SLB) algorithm [15] [16] is responsible for the assignment of loads to the processor. These assignment is based on the process execution time and communication delays average estimated values at the compile time.

The dynamic load balancing algorithms (DLB) are responsible to take decisions at run time. In this the computer system are modelled as the queuing with job arrival and resource utilization through which performance can be measured [17] [18] [19] [20] [21]. The overall conclusion of this paper is to find out the parameters for comparison of static and dynamic load balancing algorithm and then make the comparisons on the basis of qualitative parameters

Advantages:

1. Improve the performance by transfer of load from heavily loaded processor to light loaded processor.

Limitations:

1. Not suitable for real time distributed system.
2. Prior information of processing time and communication time.

Future work:

1. Based on the identified comparative parameters quantitatively, develop a virtual environment for the study of load balancing algorithms.
2. Supporting data generated with the help of target data.

3. CONCLUSION

This paper discusses the advantages and challenges of distributed system. This paper begins with the issues/ challenge which are present in distributed system. The overview of all the load balancing techniques/ algorithms are discussed. Further the challenges faced in load balancing techniques are also discussed. Various proposed algorithms and techniques for load balancing are discussed with their advantages, disadvantages along with their future scope. The overall conclusion of this paper is for real time load balancing dynamic approach is better as compared to static and grid structure play an important role in future.

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