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Comparison on Different Load Balancing Algorithms of Peer to Peer Networks

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***Abstract*— Load balancing is the process of improving the performance of a peer to peer networks through a redistribution of load among the processors. In this paper we present the performance analysis of various load balancing algorithms based on different parameters, considering two typical load balancing approaches static and dynamic. The analysis indicates that static and dynamic both types of algorithm can have advancements as well as weaknesses over each other. Deciding type of algorithm to be implemented will be based on type of parallel applications to solve. The main purpose of this paper is to help in design of new algorithms in future by studying the behavior of various existing algorithms.**

Keywords- Peer to Peer networks, Load Balancing Algorithms. Distributed systems

I. INTRODUCTION

Parallel and distributed systems more than one processor processing parallel programs. The amount of processing time needed to execute all processes assigned to a processor is called workload of a processor. A system of distributed computers with tens or hundreds of computers connected by high speed networks has many advantages over a system that has the same standalone computers. A distributed system provide the resource sharing as one of its major advantages, which provide the better performance and reliability than any other traditional system in the same conditions. One of the research issues in parallel and distributed systems is the development of effective techniques for distributing workload on multiple processors. The main goal is to distribute the jobs among processors to maximize throughput, maintain stability, Resource utilization and should be fault tolerant in nature. Local scheduling performed by the operating system consists of the distribution of processes to the time-slices of the processor. On the other hand Global scheduling is the process of deciding where to execute a process in a multiprocessor system.

Global scheduling is further classified into static and dynamic scheduling categories. In static scheduling processes are assigned to processors before the executions starts. On the other hand dynamic scheduling can reassign the processes to the processors during the execution. Load sharing and load balancing are the further classifications of dynamic scheduling. Load sharing struggle to avoid the unshared state in processors which remain idle while tasks compete for service at some other processor. Load balancing also do the same but it goes one step ahead of load sharing by attempting to equalize the loads at all processors. Load balancing is to ensure that every processor in the system does approximately the same amount of work at any point of time. Processes may migrate from one node to another even in the middle of execution to ensure equal workload. Algorithms for load balancing have to rely on the assumption that the on hand information at each node is accurate to prevent processes from being continuously circulated about the system without any progress. Load balancing is one of prerequisites to utilize the full resources of parallel and distributed systems. Load balancing may be centralized in a single processor or distributed among all the processing elements that participate in the load balancing Process. Several tasks are scheduled for separate processors, based on the current load on each CPU. Many researchers have been carried out on load balancing for many years with the aim is to find the load balancing schemes with overhead as low as possible.

II . PAPER ORGANIZATION

There are different load balancing algorithms and study of six load balancing algorithms; various parameters are used to check the results.

III .Gives the brief Introduction of static load balancing algorithms
IV. Gives introduction of dynamic load balancing algorithms.
V. More load balancing algorithms.
VI. Parameters
VII .Comparison
VIII. Conclusion

III. STATIC LOAD BALANCING

In this method the performance of the processors is determined at the beginning of execution. Then depending upon their performance the work load is distributed in the start Performance Analysis of Load Balancing Algorithms The slave processors calculate their allocated work and submit their result to the master. A task is always executed on the processor to which it is assigned that is static load balancing methods are non-preemptive. The goal of static load balancing method is to reduce the overall execution time of a concurrent program while minimizing the communication delays. A general disadvantage of all static schemes is that the final selection of a host for process

allocation is made when the process is created and cannot be changed during process execution to make changes in the system load.

A. Round Robin and Randomized Algorithms

In the round robin processes are divided evenly between all processors. Each new process is assigned to new processor in round robin order. The process allocation order is maintained on each processor locally independent of allocations from remote processors. With equal workload round robin algorithm is expected to work well. Round Robin and Randomized schemes work well with number of processes larger than number of processors. Advantage of Round Robin algorithm is that it does not require inter-process communication. Round Robin and Randomized algorithm both can attain the best performance among all load balancing algorithms for particular special purpose applications. In general Round Robin and Randomized are not expected to achieve good performance in general case.

B. Central Manager Algorithm

In this algorithm a central processor selects the host for new process. The minimally loaded processor depending on the overall load is selected when process is created. Load manager selects hosts for new processes so that the processor load confirms to same level as much as possible. From then on hand information on the system load state central load manager makes the load balancing judgment. This information is updated by remote processors, which send a message each time the load on them changes. This information can depend on waiting of parent's process of completion of its children's process, end of parallel execution the load manager makes load balancing decisions based on the system load information, allowing the best decision when of the process created. High degree of inter-process communication could make the bottleneck state. This algorithm is expected to perform better than the parallel applications, especially when dynamic activities are created by different hosts.

C. Threshold Algorithm

According to this algorithm, the processes are assigned immediately upon creation to hosts. Hosts for new processes are selected locally without sending remote messages. Each processor keeps a private copy of the system's load. The load of a processor can characterize by one of the three levels: underloaded, medium and overloaded. Two threshold parameters *under* and *upper* can be used to describe these levels.

Under loaded - load < under
Medium - under ≤ load ≤ upper
Overloaded - load > upper

Initially, all the processors are considered to be under loaded. When the load state of a processor exceeds a load level limit, then it sends messages regarding the new load state to all remote processors, regularly updating them as to the actual load state of the entire system. If the local state is not overloaded then the process is allocated locally. Otherwise, a remote under loaded processor is selected, and if no such host exists, the process is also allocated locally. Thresholds algorithm have low inter process communication and a large number of local process allocations. The later decreases the overhead of remote process allocations and the overhead of remote memory accesses, which leads to improvement in performance. A disadvantage of the algorithm is that all processes are allocated locally when all remote processors are overloaded. A load on one overloaded processor can be much higher than on other overloaded processors, causing significant disturbance in load balancing, and increasing the execution time of an application.

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IV. DYNAMIC LOAD BALANCING

It differs from static algorithms in that the work load is distributed among the processors at runtime. The master assigns new processes to the slaves based on the new information collected. Unlike static algorithms, dynamic algorithms allocate processes dynamically when one of the processors becomes under loaded. Instead, they are buffered in the queue on the main host and allocated dynamically upon requests from remote hosts.

I. Central Queue Algorithm

Central Queue Algorithm works on the principle of dynamic distribution. It stores new activities and unfulfilled requests as a cyclic FIFO queue on the main host. Each new activity arriving at the queue manager is inserted into the queue. Then, whenever a request for an activity is received by the queue manager, it removes the first activity from the queue and sends it to the requester. If there are no ready activities in the queue, the request is buffered, until a new activity is available. If a new activity arrives at the queue manager while there are unanswered requests in the queue, the first such request is removed from the queue and the new activity is assigned to it. When a processor load falls under the threshold, the local load manager sends a request for a new activity to the central load manager. The central load manager answers the request immediately if a ready activity is found in the *process-request queue*, or queues the request until a new activity arrives.

II. Local Queue Algorithm

Main feature of this algorithm is dynamic process migration support. The basic idea of the local queue algorithm is static allocation of all new processes with process migration initiated by a host when its load falls under threshold limit, is a user-defined parameter of the algorithm. The parameter defines the minimal number of ready processes the load manager attempts to provide on each processor.

Initially, new processes created on the *main* host are allocated on all under loaded hosts. The number of parallel activities created by the first parallel construct on the main host is usually sufficient for allocation on all remote hosts. From then on, all the processes created on the main host and all other hosts are allocated locally. When the host gets under loaded, the local load manager attempts to get several processes from remote hosts. It randomly sends requests with the number of local ready processes to remote load managers. When a load manager receives such a request, it

compares the local number of ready processes with the received number. If the former is greater than the latter, then some of the running processes are transferred to the requester and an affirmative confirmation with the number of processes transferred is returned.

V. MORE LOAD BALANCING ALGORITHMS

A. Random walk algorithm
B. Simple efficient load balancing algorithm
C. Load Balancing in Structured P2P Systems
D.Simple Load Balancing for Distributed Hash Tables

A. Random walk algorithm

We quantify the effectiveness of random walks for searching and construction of unstructured Peer-to-peer (P2P) networks. For searching, we argue that random walks achieve improvement over _ooding in the case of clustered overlay topologies and in the case of re-issuing the same request several times. For construction, we argue that an expander can be maintained dynamically with constant operations per addition. The key technical ingredient of our approach is a deep result of stochastic processes indicating that samples taken from consecutive steps of a random walk can achieve statistical properties similar to independent sampling (if the second Eigen value of the transition matrix is bounded away from 1, which translates to good expansion of the network; such connectivity is desired, and believed to hold, in every reasonable network and network model). This property has been previously used in complexity theory for construction of pseudorandom number generators. We reveal another facet of this theory and translate savings in random bits to savings in processing overhead.

In every case where uniform sampling from the set of nodes of a P2P network would have been a good algorithmic approach, the random walk method is an excellent candidate (i) to simulate uniform sampling, moreover, (ii) the number of simulation steps required can be as low as the number of samples in independent uniform sampling, which translates to constant network overhead, independent of the size of the network.

B. Simple efficient load balancing algorithm

Load balancing is a critical issue for the efficient operation of peer-to-peer networks. We give two new load- balancing protocols whose provable performance guarantees are within a constant factor of optimal. Our proto- cols refine the consistent hashing data structure that underlies the Chord (and Koorde) P2P network. Both pre- serve Chord's logarithmic query time and near-optimal data migration cost. Our first protocol balances the distribution of the key address space to nodes, which yields a load-balanced system when the DHT maps items "randomly" into the address space. To our knowledge, this yields the first P2P scheme simultaneously achieving O(logn) degree, O(logn) look-up cost, and constant-factor load balance (previous schemes settled for any two of the three). Our second protocol aims to directly balance the distribution of items among the nodes. This is useful when the distribution of items in the address space cannot be randomized—for example, if we wish to support range- searches on "ordered" keys. We give a simple protocol that balances load by moving nodes to arbitrary locations "where they are needed." As an application, we use the last protocol to give an optimal implementation of a distributed data structure for range searches on ordered data.

C. Load Balancing in Structured P2P Systems

Most P2P systems that provide a DHT abstraction distribute objects among "peer nodes" by choosing random identifiers for the objects. This could result in an O(log N) imbalance. Besides, P2P systems can be highly heterogeneous, i.e. they may consist of peers that range from old desktops behind modem lines to powerful servers connected to the Internet through high-bandwidth lines. In this paper, we address the problem of load balancing in such P2P systems. We explore the space of designing load-balancing algorithms that uses the notion of "virtual servers". We present three schemes that differ primarily in the amount of information used to decide how to re-arrange load. Our simulation results show that even the simplest scheme is able to balance the load within 80% of the optimal value, while the most complex scheme is able to balance the load within 95% of the optimal value.

D. Simple Load Balancing for Distributed Hash Tables

Distributed hash tables have recently become a useful building block for a variety of distributed applications. However, current schemes based upon consistent hashing require both considerable implementation complexity and substantial storage overhead to achieve desired load balancing goals. We argue in this paper that these goals can be achieved more simply and more cost effectively. First, we suggest the direct application of the "power of two choices" paradigm, whereby an item is stored at the less loaded of two (or more) random alternatives. We then consider how associating a small constant number of hash values with a key can naturally be extended to support other load balancing strategies, including load-stealing or load-shedding, as well as providing natural fault-tolerance mechanism

VI. PARAMETERS

The performance of various load balancing algorithms is measured by the following parameters.

A. Overload Rejection

If Load Balancing is not possible additional overload rejection measures are needed. When the overload situation ends then first the overload rejection measures are stopped. After a short guard period Load Balancing is also closed down.

B. Fault Tolerant

It enables an algorithm to continue operating properly in the event of some failure. If the performance of algorithm decreases, the decrease is proportional to the seriousness of the failure, even a small failure can cause total failure in load balancing.

C. Forecasting Accuracy

Forecasting is the degree of conformity of calculated results to its actual value that will be generated after execution. The static algorithms provide more accuracy than of dynamic algorithms as in former most assumptions are made during compile time and in later this is done during execution.

D. Stability

Stability can be characterized in terms of the delays in the transfer of information between processors and the gains in the load balancing algorithm by obtaining faster performance by a specified amount of time.

E. Centralized or Decentralized

Centralized schemes store global information at a designated node. All sender or receiver nodes access the designated node to calculate the amount of load-transfers and also to check that tasks are to be sent to or received from. In a distributed load balancing, every node executes balancing separately. The idle nodes can obtain load during runtime from a shared global queue of processes.

F. Nature of Load Balancing Algorithms

Static load balancing assigns load to nodes probabilistically or deterministically without consideration of runtime events. It is generally impossible to make predictions of arrival times of loads and processing times required for future loads. On the other hand, in a dynamic load balancing the load distribution is made during run-time based on current processing rates and network condition. A DLB policy can use either local or global information.

G. Cooperative

This parameter gives that whether processors share information between them in making the process allocation decision other are not during execution. What this parameter defines is the extent of independence that each processor has in concluding that how should it can use its own resources. In the cooperative situation all processors have the accountability to carry out its own portion of the scheduling task, but all processors work together to achieve a goal of better efficiency. In the non-cooperative individual processors act as independent entities and arrive at decisions about the use of their resources without any effect of their decision on the rest of the system.

H. Process Migration

Process migration parameter provides when does a system decide to export a process? It decides whether to create it locally or create it on a remote processing element. The algorithm is capable to decide that it should make changes of load distribution during execution of process or not.

I. Resource Utilization

Resource utilization include automatic load balancing A distributed system may have unexpected number of processes that demand more processing power. If the algorithm is capable to utilize resources, they can be moved to under loaded processors more efficiently.

VII. COMPARISION

The comparison of various load balancing algorithms on behalf of the different parameters is shown in table I

VIII. CONCLUSION

Load balancing algorithms work on the principle that in which situation workload is assigned, during compile time or at runtime. The above comparison shows that static load balancing algorithms are more stable in compare to dynamic and it is also ease to predict the behavior of static, but at a same time dynamic distributed algorithms are always considered better than static algorithms.

TABLE I
PARAMETRIC COMPARISON OF LOAD BALANCING ALGORITHMS

Parameters	Round Robin	Random	Local Queue	Central Queue	Central Manager	Threshold
Overload Rejection	No	No	Yes	Yes	No	No
Fault Tolerant	No	No	Yes	Yes	Yes	No
Forecasting Accuracy	More	More	Less	Less	More	More
Stability	Large	Large	Small	Small	Large	Large
Centralized/Decentralized	D	D	D	C	C	D
Dynamic/Static	S	S	Dy	Dy	S	S
Cooperative	No	No	Yes	Yes	Yes	Yes
Process Migration	No	No	Yes	No	No	No
Resource Utilization	Less	Less	More	Less	Less	Less

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