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Analysis of Various Load Balancing Techniques in Computational Grid: An Assessment

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Abstract:
The computational grid is a new distributed computing pattern that gives resources for large scientific computing applications. It consists of heterogeneous resources such as clusters that may occupy in different administrative domains. Many researchers proposed distinct scheduling and load balancing approaches and algorithms for locally distributed multiprocessor systems. However, they go through from serious deficiencies when spread towards a grid environment. Grids environment have possibility for solving large-scale scientific computing applications. This paper contains literature study on grid computing concept and grid architecture for load balancing. It also gives a brief description about different tools, approaches and strategies of load balancing.

Index Terms: Computational Grid, Scientific Computing Application.

I. INTRODUCTION

"GRID" is the term based on the infrastructure of the distributed computing and suggests the resources based on the client requirement. A generic definition for grid computing is "The distributed system that based on the sharing selection and gathering of distributed and heterogeneous resources at runtime build upon their availability, cost and requirement of service quality [2]." In grid, there are bulks of systems connected to grid architecture for executing jobs given by the clients. Among available systems at least one system will perform as a server and that have total control to allocate the client's jobs to the suitable resource that are ready to execute. Generally, grid resources are divided into two types: First is a software resource, and second one is hardware resources. The software resources Includes origin of application pack, component services and data resources. The hardware resources include network resources, memory resources and computing resources. In grid, the word resource is described as the capability that can be allotted and applied in network grid environment.

The pros of grid computing are:
• Grid performance in processing data integration.
• Gird takes less time to solve more complex problems.
• Process the big data sets into smaller for faster execution.
• Good uses of the available heterogeneous hardware in the grid.

A task in a grid is related with the following parameters:

1. CPU queue length
2. Memory Size
3. Deadline to complete the task
4. Resource allocation
5. Priority
6. Network bandwidth
7. Software availabilities
8. Load of a site in a particular server etc.

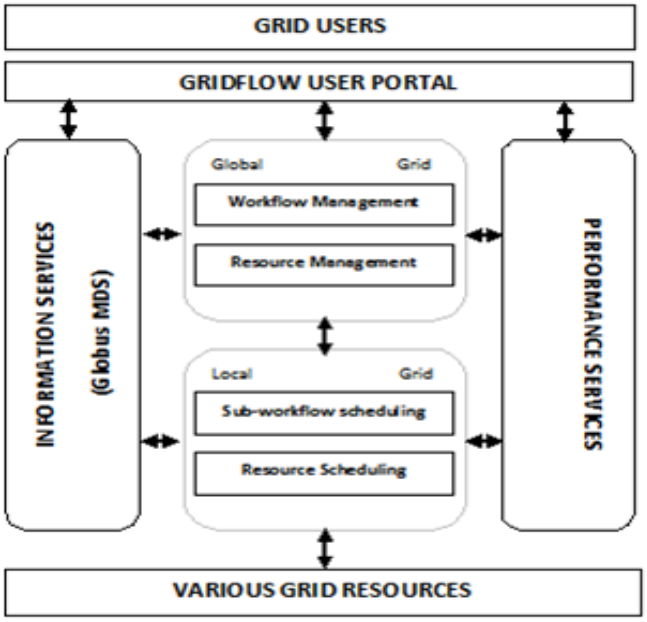

Fig.1: Architecture of Grid Computing

II. LOAD BALANCING IN GRID:

Load balancing is to expedite the execution of task on resources whose load changes at run time in unpredictable manner. Load balancing is an important term. The purpose is to balance the load of each server in order to increase the system throughput and resource utilization. Load balancing is a process of ordering tasks on computational resources and ordering control between tasks and their respective processor. Aim of load balancing is to: Optimize resource use, Maximize throughput, Minimize response time, avoid overload on a single node. The load balancer is like a software program that is listening on the port where clients connect to access services. This request is forwarded to one of the "backend" servers with the help of load balancer, which consistently replies to the load balancer. This permitted the load balancer to reply client without the client ever knowing about the internal separation of functions. It also avoids clients from contacting

back-end servers directly. Load balancing is carried out for following managing purposes.

1. CPU queue length.
2. Low cost update of the workload.
3. Less mean response time.
4. Average CPU queue length.
5. CPU utilization.
6. Process transfer.
7. Enhance the system throughput.
8. Load estimation.
9. Migration.

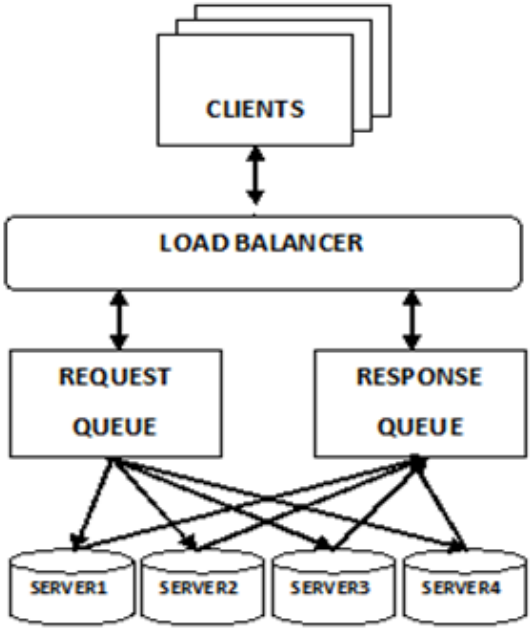

Fig.2 Flow of Load Balancing.

III. TOOLS RELATED TO LOAD BALANCING IN GRID [2].

The toolkit allows modeling and simulation of entities in parallel and distributed computing system users, application and resource brokers for design and evaluation of scheduling algorithms.

3.1 OPTORSIM

The OptorSim is the part of the European Data Grid project. OptorSim is a simulator designed to test dynamic replication strategies used in optimizing data location within grid. OptorSim has structure like EDG. It consists following elements:

- Storage resource.
- Computing resource.
- Scheduler.

Network.

- Replica management.

There are some input parameters of OptorSim:

- Auction: It uses an auctioning protocol for finding the best file among the grid.
- Scale Factor: It is used for simulation run faster by scaling down the size of files.
- Simulation Time.
- Job Submission.
- Site information.
- Grid Status.

3.2 SIMGRID [2].

SimGrid was initially release in 1998 which was written in core C. It supports various platforms like: UNIX, MAC OSX, Microsoft windows. It is toolkit which gives core services for simulation of network application and distributed application. The SimGrid toolkit uses various usage of MSG interface. There are three version of SimGrid tool:

- SimGrid v1.
- SimGrid v2.
- SimGrid v3.

3.3 GRIDSIM [3].

The GridSim toolkit is open source simulation software with behavior of grid, written in java which mostly used by researcher. This simulation tool has been designed for the study of efficiency of various algorithms for scheduling and load balancing. The architecture of GridSim toolkit is layered and modular. It consist four layered structures:

- First layer communicate with the scalability interface.
- Second layer concerned in building basic discrete event infrastructure by the help of first layer interface.
- Third layer is interested for modeling and simulation.
- And last fourth one is responsible for final creation of higher level organisms.

IV. STRATEGIES [11]:

The load balancing strategies are hierarchical. Main advantage of strategy is to prioritize local load balancing first (within a site, then cluster and finally whole grid). Hence, we illustrate three load balancing levels [11].

- **Intra-site load balancing:** This is the first level which depends on its current load. In this operation the site distributes workload on the basis of priority among its computing element.
- **Intra-cluster load balancing:** This is the second level which depends on a single cluster among clusters of grid. In this operation load balance is achieved when any site fail to balance its workload within along its respective computing element.
- **Intra-grid load balancing:** This is the final level of balancing. It starts only if any cluster fails to balance their workload among the assistant sites.

V. APPROACHES:

It minimize the response time on large and small scale heterogeneous grid environment [8].

- **Static Load Balancing [8]:** In static load balancing number of processors are fixed i.e. it assigns fixed resource for given job. It uses a simple static strategy; jobs can be assigned to resources in a round robin fashion so that each resource executes approximately the same number of task. Hence if there is any changes occur in task size, fixed numbers of processors may not sufficient and in some condition all processors never used whole time. One

of the major benefits of this static load balancing approaches is that it easier to implement.

Dynamic Load Balancing [4]: The term dynamic load balancing takes means that it uses the recently executed and current load information when making distribution decisions and it regularly monitor the load on the processors and when load is disturb or uneven then the redistribution of work is done. In short we can say that the algorithm make changes to the distribution of work among computing nodes at run time.

VI. LITERATURE REVIEW:

6.1. Resource Allocation in Grid Computing: An Economic Model [1].

In this paper, Author's propose a tender/contract-net model for Grid resource allocation, showing the interactions among the involved actors. The performance of the proposed market-based approach is experimentally compared with a round-robin allocation protocol. To this aim, some economic/market-based models have been introduced in the literature, where users, external schedulers, and local schedulers negotiate to optimize their objectives. The problem of allocating resources in Grid scheduling requires the definition of a model that allows local and external schedulers to communicate and achieve an efficient management of the resources themselves. The behavior of the proposed approach was experimentally compared with a round-robin allocation protocol, showing how the former is able to produce more effective results in terms of both system load and execution cost. New researcher's focuses on scheduling the CPU resources using a different scheduling algorithm. Grid simulation toolkit is used.

6.2. Grid Architecture for Scheduling and Load Balancing – An Assessment [2].

This paper gives the overview of the grid computing concept. This paper deals with the survey of different grid scheduling algorithms, information about types of grid, various grid application areas like: Medical applications, E-governance, E-learning etc. It define various advantages of grid, Designing feature, Standard for grid environment, Approaches related to grid, Load balancing in grid, Various tools associated with grid simulation. In this paper author proposed a model for scheduling and load balancing with help of Grid Architecture for Scheduling and load balancing (GASLB). In which two main components are used named Grid information server and Grid scheduler. The GIS predict information about resource state: CPU capacities, Memory size, Network bandwidth, Software availability etc. And the second GS works within four phases:

- Resource Listing and Filtering.
- Resource Allocation.
- Analyzing the load. (It used for load balancing concept)
- Job Execution.

6.3. Fair Scheduling Algorithms in Grids [3].

In this paper Author's proposed a new algorithm for scheduling, and then compares it to other algorithms like the Earliest Deadline First (EDF) and the First Come First Served (FCFS). Author's uses a MAX- MIN fair sharing approach for fair access to users. Here three different kinds of fair scheduling are used: Simple Fair Task Order (SFTO), Adjusted Fair Task Order (AFTO) and Max –Min Fair Share (MMFS) scheduling policies. In SFTO scheme the jobs are scheduled in the queue in ascending order with respect to their non adjusted fair completion time but in MAX-MIN scheme the jobs are obtained by the no adjusted fair computational rates. In AFTO scheme the jobs rates are not constant but they maximize when jobs completely execute and minimize when new jobs arrive. At last in MAX –MIN (MMFS) scheme the selection of processors and the jobs queuing order are scheduled simultaneously. In this paper the author's using GRIA and GRIDLAB architecture.

6.4. A Dynamic Load Balancing Algorithms in Computational Grid Using Fair Scheduling [4].

In this paper the author's proposed a new algorithm for load balancing scheme and comparing it with traditional algorithms like: Earliest Deadline First (EDF), Simple Fair Task Order (SFTO), Adjusted Fair Task Order (AFTO) and Max-Min Fair Scheduling (MMFS). In author's algorithm there are two parameters Make span and Cost and comparison chart with above mention algorithms. Author's also gives a Flow chart and an Event diagram for their proposed load balancing algorithm. In this paper author's scheme tries to reduce the execution time and price for execution of all tasks in grid system. The proposed algorithm has proved expected results in term of execution cost and Make span. By this the allocation of requesting task are equally distributed to all available processors. For future author's defines that Fair scheduling can be done by Optimization techniques and also a reliability or QoS parameter used as a performance factor.

6.5. Load balancing Grid Computing Middleware [10].

This paper deals with the load balancing problems in grid computing firstly; it gives an overview on the global image of load balancing process. It also specifies the challenges related to grid and provides comparison between traditional and current research and gives outline of various algorithms. In this paper author's provides information about the general load balancing problems, policies and mechanisms, comparison between various loads balancing scheme, various load balancing algorithms. According to author the goal of this paper is to discuses methods and issues related to load balancing system for grid environment. Here Author's claim that the load balancing for traditional system cannot be applied to the grid environments. In Future new researchers add classic load balancing algorithms, new methodology are applied. Grid simulation toolkit is used.

6.6. A Review on different Approaches for Load Balancing in Computational Grid [8].

In this paper author provide overview on various load balancing algorithms for heterogeneous network like: Grid. Different algorithms work on various metrics such as make span, time, reliability, stability, fault tolerance, communication overhead and average resource utilization rate. In this paper author provide information about strategies, approaches, policies, various issues, load balancing steps and comparison of different load balancing algorithms having various issues which are mention above.

VII. CONCLUSIONS:

This paper presents a survey of load balancing algorithms in grid environment. Main objective of load balancing algorithm is to achieve high performance in grid environment by optimal usage of geographically distributed and heterogeneous resources. For this purpose we use any application effectively on grid computing system, load balancing algorithm must be selected and design carefully. This review paper is for discusses on various issues, strategies, approaches, policies, different tools related to grid and their features. We also provide the recent survey or literature review based on the different load balancing strategy and approaches on grid environment. Hence, such algorithm which efficiently manages and balances the workload according to working capacity of processor and minimized the execution time and increases the global throughput of system is called fair load balancing algorithm.

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