A Detailed Study of Resource Scheduling and Fault Tolerance in Grid

Mrs. Radha1, Dr.V.Sumathy2

1 Asst.Professor , Dept. of Computer Applications,
Sri Ramakrishna College of Engineering ,
Coimbatore-641 022, India

2Prof. Dept. of ECEs,
Government College of Technology,
Coimbatore-641 022, India

Abstract

The grid computing enables the users to share the heterogeneous resources which are distributed geographically. The main advantage of grid is to utilize the unused resources in other words an effective utilization of resources. When considering about the resource utilization the focus is on the different strategies and methods which are implemented for effective scheduling .This paper presents an extensive survey about the different techniques available in scheduling the resources.

Keywords- Distributed systems, Grid Computing, Error Detection, Fault Tolerance

1. Introduction

Grid computing has emerged as a distributed methodology that coordinates the resources that are spread in the heterogeneous distributed environment. The resources can be categorized as computational resources and storage resources .The example for computational resource is CPU and an example for storage resources is all storage devices like hard disc and drives .Based on the need the resources can be scheduled .The management and scheduling of those resources is very difficult since it is owned by a different network or by an individual owner as well the policies also will differ. There are four basic building blocks in a grid model[1] ,the user, resource broker, the grid information system(GIS)and lastly the resources. When the user submits the job to the broker, the broker splits the job into various sub tasks and allocates to the appropriate resources based on the user specification .The Broker gets the resource information from the GIS which updates the information regarding the available resources. The rest of the paper structured as follows. Section II presents scheduling in grid. Section III addressed on the Error detection framework, Fault tolerance is discussed in section IV, the existing algorithm in Section V and section VI presents the proposed work and concludes the paper.

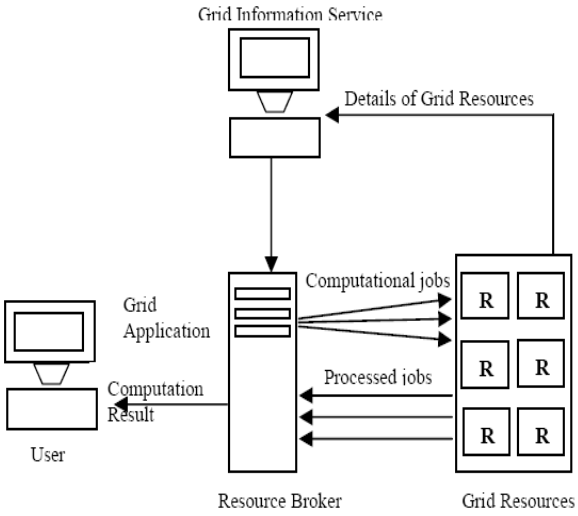

Fig1: Basic Grid Model

2 Scheduling in Grid

The scheduling may be either a job or a resource. The job scheduling is just splitting the job into different sub tasks and allocating it to the resources. The resource scheduling is just matching the query for a resource to a group of available resources. There are many classifications on resource scheduling they are static vs dynamic, in static all the information regarding the available resources will be available in hand, but in case of dynamic the information will be fetched up during the execution.

There are many algorithms available in order to schedule the resources like genetic algorithm, Particle swarm

optimization algorithm, Ant colony algorithm etc.. Many research papers focus on these type algorithms. In [2] the comparison proves that the PSO works very efficiently in comparative to the ant colony optimization algorithm.

Grid resources are highly heterogeneous and dynamic; more faults are likely to occur in Grid environment.

3. Error Detection

The grid can schedule the jobs to the resources as well the vice versa. In that cases there are many possibilities for errors, the errors may be the destination may not be reachable ,network failure while during the data transmission ,messages may got lost due to system failure ,the listed failures may occur during the data transfer in the distributed environment .There are some failures that occurs during the allocation of resources to the jobs like the resources may not be available .The GIS which gets updated about the resource information may be unaware of the unavailability of the resource. These errors should be overcome in order to gain more efficiency. A lot of Error detection techniques are available to overcome such problems .[8]A new methodology named early error detection and classification was proposed to reduce the errors that occur during data transfer.

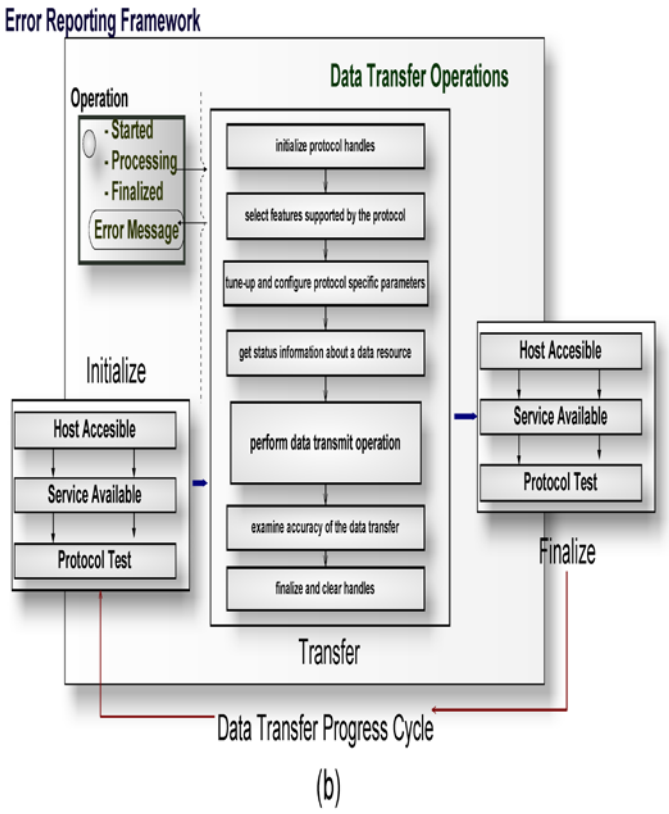

Fig2: Early Error Detection and Error Classification

4. Fault Tolerance

Fault tolerance [9] is the ability to preserve the delivery of expected services despite the presence of fault-caused errors within the system itself. It aims at the avoidance of failures in the presence of faults. A fault tolerant service detects errors and recovers from them without participation of any external agents, such as humans.

Faults may be classified based on several factors

- Network faults: Faults those results due to network partition, Packet Loss, Packet corruption.
- Physical faults: Faults that occur in CPU ,in memory, and in storage devices
- Life-cycle faults: Versioning faults.
- Media faults: Disk head crashes.
- Processor faults: Machine or operating system crashes.
- Process faults: Resource shortage, software bug.
- User “aborts”: Control “C”.
- Service expiry fault: The service time of a resource may expire while application is using it.
- Interaction faults: Protocol incompatibilities, Security incompatibilities, Policy problems, Timing overhead.

With respect to time, three types of failures can occur in computer systems [10]:

• Permanent

• Intermittent

• Transient.

Permanent: These failures occur by accidentally removing the wire, power breakdowns and so on. It is easy to reproduce these failures. These failures can cause major problems which results in affecting the system functionality.

Intermittent: These are non-deterministic failures that are not common. Most of the times, these sought of failures are not given much importance it appear when the system goes into operation. Therefore, it is hard to predict the extent of damage these failures can bring to the system.

Transient: These failures are caused by some inherent fault in the system.. These failures are very common in computer systems.

As mentioned in [11], different types of failures are given in Tabel1

Table 1. Types of failures.

Class of failure	Subclass	Description
Omission failure		A server omits to respond to a request
Response failure		A server responds incorrectly to a request
	Value failure	The server returns the wrong value
	State transmission failure	The server makes incorrect state transition
Timing failure		A server does not respond in the specified real-time interval
	Late Performance	The server responds too late
	Early	The server responds too early
Crash failure		A server repeatedly fails to respond to requests until being restarted
	Amnesia crash	The server restarts in initial state
	Partial amnesia crash	Some part of the state is as before the crash while the remainder is reset to initial state
	Pause crash	The server restarts in the state before the crash
	Halting crash	The server never restarts

5. Existing Resource scheduling algorithms

The different algorithms listed below are taken as survey

A. Research on Novel Dynamic Resource Management and job scheduling in grid computing (RNDRM).

Description: This scheduling model is based on Heap Sort Tree (HST) [12] for computing the available computational power of the nodes (resource) as well as whole grid system. Here the resource with largest available computational ability among the whole grid system is selected to be the root node of the HST and it is ready for the scheduler to submit a job. The algorithm design for job scheduling is well suitable for the complex grids environment and it is based on agents.

Advantages:

1) This algorithm makes the system more scalable, robust, fault-tolerant and high performance.

2) This strategy provides dynamic status information of the resources in an unpredictable fast changing grid environment.

Disadvantages:

1) This algorithm is silent at the condition of job submission failure.

2) The job scheduling strategy may not utilize resource sufficiently.

3) Job waiting time is high.

4) It does not provide real time dynamic grid environment.

B. Agent Based Resource Management with Alternate Solution (ABRMAS).

Description: Agent based Resource Management with Alternate Solution [13] gives an alternate solution at the situation when resource discovery fails. Algorithm identifies an equivalent resource without affecting the performance and it also avoids unnecessary resource discovery. Sometimes resource discovery is done for time bound task and required resource is unavailable at that situation. Alternate solution reduces delay overhead in waiting for the unavailable resource and enhances the system's efficiency. Implementation result shows the system success rate Is 30% higher with alternate solution.

Advantages:

1) It limits and steer the search towards the anticipated result and provide efficient resource discovery.

2) Useful in both cases when discovery fails and more than one solution proposal offered.

Disadvantages:

1) For large agent hierarchy proposal's invitations may be restricted to sub hierarchy.

2) It is not explicit.

C. New Resource Mechanism with Negotiate Solution based on agent in grid environments (NRMNS).

Description: Agent Based Resource Management with Negotiate Solution gives an alternate solution [14] at the situation of resource discovery failure. Algorithm adds the middleware Grid Architecture for Computational economy (GRACE) with Resource Pricing Fluctuation Manager (RPFM) into ABRMAS in order to improve the efficiency of the resource management scheduling allocation in Grid Computing. The feedback model plays a very important role in the agent-based system when resource discovery failed for cost bound.

Advantages:

1) The resource provider can get the maximum investment profit.

2) Feedback capability of RPFM is used to adapt the highly dynamic grid environment.

3) Simulation result shows successful rate of resource discovery increases by about 10%.

Disadvantage:

1) The resource discovery is aborted when the RPA (resource provider agent) refuses to decrease the cost of the resource; this one is the major drawback.

D. Improved Resource discovery approach using P2P model for condor (IRP2P).

Description: IRP2P is a grid middleware. It is a decentralized technique [15] which opposes traditional client - server model. Goal of the model is to improve performance of condor middleware. Proposed hybrid model uses four axis frameworks in P2P approach. Each framework overcome some limitations of condor middleware and makes it more reliable, robust and scalable. By implementing membership protocol, network communication is easy and using overlay construction algorithm inter process communication is also allowed which is restricted in condor.

Advantages:

1) Independence from central global control.

2) Fast discovery of resources using DHTs and indexing concept.

3) Scalability.

4) Support for intermittent resource participation.

Disadvantages:

1) Need to have strong self organization capabilities in order

to be able to maintain their rigid structure.

2) High maintenance cost in the presence of high churn.

E. Virtual Computing Grid using Resource Pooling (VCGRP).

Description: The System is based on loosely coupled concept. Virtual Computing Grid means the system can choose a resource and allocate tasks to it. Here, it is a single point web based access known as Virtual Computing Grid Portal and the Virtual Computing Grid Monitor is a central resource manager for the System. [16].

Advantage:

1) Cost Effective model.

Disadvantages:

1) Not much Reliable because of only one central manager and single point web access.

2) Since it is cost effective solution quality of service has been play down in the prototype model.

6. Proposed Work

In this section we present the outline of our proposed technique .We implement in our data aware scheduling ,the we schedule the resources by overcoming the errors that occur during the system by implementing the early error detection technique which gets updated the resource information as well the task/job information and during the failure of the resource it submits the job by choosing the alternate resource dynamically. The fault tolerance is also implemented with check pointing and Replication. As per stated in[17] “Check-pointing” is the process of saving the state of a running application to “stable storage”. In case of any fault, this saved state can be used to “resume” execution of the application from the point in the computation where the check-point was last taken instead of restarting the application from its very beginning .The check pointing is categorized under two criteria they are

- Check pointing with migration
- Check pointing without migration

In our sytem we introduce the checkpoint with migration.
Replication is also introduced where by the same job is submitted to multiple resources and based on the execution time and completion of execution of the job the other remaining resources gets stopped to reduce the computational power .
Finally a new algorithm is proposed and compared with the existing resource scheduling algotirhtm which are dicussed under section 5. to save the computational power and utilize the underutilized resources to achieve the goal of grid computing .

References

[1] Rakesh sharma ,Vishnu kant Soni,Manoj Kumar Mishra,Prachet bhuyan, “A survey of job scheduling and resource management in grid computing ", *world academy of Science Engineering and Technology64 2010*,

[2] Radha.B and Sumathy.V Comparison of ACO and PSO in Grid Job Scheduling .CIIT International journal of networking and communication Engineering print: ISSN 0974 – 9713 & Online: ISSN 0974 – 9616 DOI: NCE102009003

[3] Fufang Li, Deyu Qi, Limin Zhang, Xianguang Zhang, and Zhili Zhang,“Research on Novel Dynamic Resource Management and Job Scheduling in Grid Computing”, IEEE Proceedings of the First International Multi-Symposiums on Computer and Computational Sciences , IMSCCS 2006

[4] Ms.P.Muthuchelvi, Dr.V.Ramachandran, “ABRMAS: Agent Based Resource Management with Alternate Solution,” IEEE, The Sixth International Conference on Grid and Cooperative Computing, GCC 2007.

[5] Junyan Wang, Yuebin Xu, Guanfeng Liu, Zhenkuan Pan, and Yongsheng Hao, “New Resource Discovery Mechanism with Negotiate Solution Based on Agent in Grid Environments”, IEEE The 3rd International Conference on Grid and Pervasive Computing – Workshops, 2008.

[6] Anju Sharma, and Seema Bawa, “An Improved Resource Discovery Approach Using P2P Model for Condor: A Grid

Middleware", World Academy of Science, Engineering and Technology, 2006.
[7] Alpana Rajan, Anil Rawat, Rajesh Kumar Verma, " Virtual Computing Grid using Resource Pooling", IEEE, International Conference on Information Technology , 2008.
[8]Mehmet Balman ,Tevfik Kosar "Early Error Detection and Classification in Data Transfer Scheduling ",IEEE, International Conference on Complex ,Intelligent and Software Intensive systems ,2009
[9] Paul Townend, Jie Xu, Fault tolerance within a grid environment, As part of the e-Demand project at the University of Durham, DH1 3LE, United Kingdom, 2003
[10] Naveed Arshad, A planning-based approach to failure recovery in distributed systems, A thesis submitted to the University of Colorado in partial fulfillment of the requirements for the degree of Ph.D., 2006
[11] René Meier, A framework providing fault tolerance using the CORBA trading service, A thesis submitted to the University of Dublin, in partial fulfillment of the requirements for the degree of Masters of Science, 1998
[12] Fufang Li, Deyu Qi, Limin Zhang, Xianguang Zhang, and Zhili Zhang,"Research on Novel Dynamic Resource Management and Job Scheduling in Grid Computing", IEEE Proceedings of the First International Multi-Symposiums on Computer and Computational Sciences , IMSCCS 2006
[13] Ms.P.Muthuchelvi, Dr.V.Ramachandran, "ABRMAS: Agent Based Resource Management with Alternate Solution," IEEE, The Sixth International Conference on Grid and Cooperative Computing, GCC 2007.
[14] Junyan Wang, Yuebin Xu, Guanfeng Liu, Zhenkuan Pan, and Yongsheng Hao, "New Resource Discovery Mechanism with Negotiate Solution Based on Agent in Grid Environments", IEEE The 3rd International Conference on Grid and Pervasive Computing – Workshops, 2008.
[15] Anju Sharma, and Seema Bawa, "An Improved Resource Discovery Approach Using P2P Model for Condor: A Grid Middleware", World Academy of Science, Engineering and Technology, 2006.
[16] Alpana Rajan, Anil Rawat, Rajesh Kumar Verma, " Virtual Computing Grid using Resource Pooling", IEEE, International Conference on Information Technology , 2008.
[17] Greg Bronevetsky, Rohit Fernandes, Daniel Marques, Keshav Pingali, Paul Stodghill, Recent advances in checkpoint/recovery systems, in: Workshop on NSF Next Generation Software held in conjunction with the 2006 IEEE International Parallel & Distributed Processing Symposium, April, 2006.

Author's Biography

Ms. B.Radha received B.Sc Degree in Chemistry in 2001, MCA Degree in Computer Applications in 2004. She is currently working as a Assistant Professor in the Department of Computer Applications, Sri Ramakrishna Engineering College, Coimbatore She is currently perusing Ph.D her research interest includes Resource allocation in Grid Computing and Simulation. She has published two technical papers in National conferences. one paper in the International journal and International Conferences she is a life time member of ISTE.

Dr.**V.Sumathy acquired** B.E degree in Electronics and Communication Engineering from Government College of Technology (GCT),coimbatore, in the year1988. She obtained her Master's degree in Computer Science and engineering from Government College of Technology, Coimbatore, in the year 2000.She has completed her Ph.D in the area of Ad-Hoc Networks .At present she is an Associate Professor in the Department of ECE, GCT, Coimbatore. She has published nine papers in both National/International Conferences and two papers in journals in the area of Ad-Hoc Networks.