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Survey on Resource Allocation Mechanisms for MapReduce Clusters

S. Janani[1], G.R. Anantha Raman[2]

PG Scholar, Department of CSE, ACE, Hosur, India[1]

Assistant Professor, Department of CSE, ACE, Hosur, India[2]

Abstract: MapReduce is one of the programming model for processing large amount of data in cloud where resource allocation is one of the research areas since it is responsible for improving the performance of Hadoop.Many resource allocation strategies are discussed that aims to improve resource utilization in Hadoop by focusing on the speculative execution and maximizing the data locality by meeting the deadlines of the job. The implementation is done in Hadoop slot based MapReduce system ex: Hadoop MVR1

Keywords: MapReduce, Data locality, Speculative execution, Hadoop.

I. INTRODUCTION

Cloud computing provides users and enterprises with various capabilities to store and process their data.However cloud applications often have to handle very large amount of data. Hadoop a open source framework supports processing of large datasets in a distributed computing environmentmain components of Hadoop are Hadoop Distributed File System and MapReduce.eg:Facebook,google stores and process their large data using Hadoop.MapReduce is one of the popular computing paradigm of Hadoop that contains map() function which performs filtering and sorting and reduce() function that performs summary operation. Eg: we can calculate everyone's common friends once a day and store those resultsby using MapReduce program. Resource utilization is one of the major problems in MapReduce thereby decreasing the performance of Hadoop.The resources are allocated to the map and reduce tasks to complete their operations. The resources are abstracted into map and reduce slots that are configured by the administrator. Various resource allocation strategies are used that includes dynamic, cost, deadline, locality aware resource allocation to MapReduce which improves the Hadoop performance.

The purpose of this survey is to review the different resource allocation strategies for mapreduce and also identifying the advantages of all the approaches along with the performance metrics, datasets used.

Furthermore the remainder of this paper is arranged as follows. Related work is described in Section 2. We make a comparative study in section 3. How the research is analysed is described in Section 4 and 5. Observation for the research questions are carried out in Section 6. Finally, the discussion and conclusion is analysed in Section 7.

II. RELATED WORK

In literature there was research work on the performance optimization of MapReduce jobs related to resource utilization are discussed as follows. Abhishek Verma in 2011 proposed a scheduler known as SLO scheduler that estimates the no of slots required and schedules the slots dynamically until the deadlines of the job are met [1]. Jorda Polo in 2011 proposed a utility based by allocating slots or resources dynamically to the map and reduces tasks until the deadlines of the job are met [2]. Joel Wolf in 2011 allocates the slots based on priority of the jobs.where first the scheme allocates the minimum no of slots to each job and there may be some idle slots that can be allocated to other jobs based on priority[3].Xiaowei Wang proposed a method in which the resources are allocated according to the cluster load based on the weighting technique where the resource requirement is changing based on the completion rates on the map and reduce tasks[5].Balaji Palanisamy in 2011 proposed a locality scheduling technique to increase the performance of map and reduce phases and how the network traffic is reduced in order to maximize data locality. However this technique is different from conventional MapReduce that uses the separate cloud that deals with data and vm placement [4].B.ThirumalaRao in 2013used a resource configurator that adjusts the CPU resources without Violating the completion time by dynamically increasing or decreasing the VM to maximize the data locality and resource configuration is used that allocates the required no of map and reduce slots to complete the task [6]. Mohammad Hammoud in 2013 proposed a LARTS (Locality Aware Reduce Task Scheduler) where the slots are allocated dynamically rather than statically and at the same time it handles the speculative tasks and maximizes data locality [7]. JianTan in 2013 discussed about the joint optimization of MapReduce that causes resource starvation and unfavourable data locality due to delay scheduling and then he proposed a coupling scheduler that couples the map and reduce jobs to mitigate the starvation moreover random peek scheduling and wait scheduling to optimize the data locality by making reduce tasks run close to the intermediate slave nodes. Xian ping Bu, in 2013 discussed about the inference that causes the performance degradation of map and reduce tasks and proposed a inference scheduling algorithm that predicts when the tasks slows down and further adaptive delay

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scheduling algorithm is proposed that improves the delay scheduling algorithm by adjusting delay intervals that are ready to run jobs and mainly focuses on server locality [8]. Xuanjia Qiu in 2014 an efficient scheduling mechanism that enables efficient utilization resources and to reduce the task outsourcing cost, by usinga time-slotted system where each time slot, makes the users to complete their task with in time. Zhenhua Guo in 2014 discussed about the unutilized idle slots of the tasks and proposed a stealing method to allocate the idle slots to the pending tasks by using fair scheduler and capability scheduler for resource allocation.speculative execution problem is also overcome by using BASE (Benefit Aware Speculative Execution) where the speculative tasks are launched only when they are expected to complete earlier than the original tasks [12]. R. Manopriya in 2014 proposed a Johnson algorithm where the job tracker schedules the jobs into different tasks and allocate the tasks to slots when the pool contains excess of the slots are allocated to other pools that are dependent hence this approach minimizes the execution time[11]. Abishek verma in 2014 proposed a deadline based Hadoop scheduler that allocates the number of map and reduce slots to each tasks within completion time and it allocates and deallocates the resources which are unused to some other jobs to complete their tasks moreover the jobs are ordered based on the "Earliest Deadline Policy"[10].

III. EVALUATION METHODOLOGY

The survey was focused on the resource allocation ie dynamic slot allocation to map and reduce tasks and to speculative tasks by maximizing the datalocality. Data locality is making the maptasks run locally on the local task tracker that contains the data by reducing the network traffic rather than by executing in some other node. Speculative tasks which are slow running tasks which occurs due to the slot failure in clusters. A comparative study has been made on the various resource allocation strategies that satisfy the constraints of data locality and speculative tasks are shown in the table 1.

AUTHOR &YEAR	TITLE	METHODLOGY	PERFORMANCE METRICS	DATA SETS
Abhishek Verma,2011	ARIA –Automatic Resource Inference Allocation	1.**SLO scheduler** Slots are allocated dynamically to meet the deadlines	Computation cost and time	Wordcount
Jorda Polo,2012	Resource aware adaptive scheduling for MapReduce	1.**Utility based approach** Adapts to changes in resource demand by dynamically allocating resources to jobs.by meeting the deadlines and making resource-aware scheduling decisions.	Computation time, CPU utilization	Wordcount
Joel Wolf,2013	CIRCUMFLEX scheduling optimizer for MapReduce	1.**Priority based approach** Slots are allocated to tasks based on priority by allocating only minimum no of slots to each tasks	Computation time, CPU utilization	Wordcount, GREP
Jian Tan,2013	Coupling tasks progress for MapReduce resource aware scheduling	1.**coupling scheduler** –couples the progress of map & reduce tasks to mitigate the starvation 2.Wait scheduling for reduce tasks, peek scheduling for map tasks to optimize data locality	Computation time, CPU utilization	Wordcount, sort
Xiaowei Wang,2013	Dynamic spilt model of resource utilization in MapReduce	**Resource Usage Pipeline (RUP) –**resources are allocated based on the cluster loadby weighing the map and reduce phase	Computation time, CPU utilization	Wordcount
B.Thirumala Rao,2013	Scheduling Data Intensive Workloads through Virtualization on MapReduce based Clouds	**Resource configurator-** dynamically determines the required no of map and reduce slots **Resource configuraror-** it adjusts the CPU time by increasing and decreasing the VMs to maximize the data locality	Computation time, CPU utilization	Wordcount,
Mohammad Hammoud,2013	Locality-Aware Reduce Task Scheduling for MapReduce	**LARTS scheduler**-slots are allocated to the speculative tasks dynamically	Computation time, CPU utilization	Wordcount, sequence count
Xiang ping Bu,2013	Interference and Locality-Aware Task Scheduling for MapReduce	**Inference scheduling algorithm-** detects the inference that causes performance degradation **Adaptive scheduling algorithm-**	Computation time, CPU utilization	Wordcount

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	Applications in Virtual Clusters	adjusts the delay scheduling by adjusting the delay intervals		
Balaji Palanisamy, 2013	Cost-effective Resource Provisioning for MapReduce in a Cloud	**Intelligent VM-aware scheduling**-that reschedules the VMs if the deadlines of the job are met	Computation time, CPU utilization	Wordcount, sort
Abhishek Verma,2013	Deadline-based Workload Management for MapReduce Environments: Pieces of the Performance Puzzle	**Novel Hadoop deadline scheduler**-that allocates and deallocates the VMs to the map and reduce tasks and the jobs are	Computation time, CPU utilization and computation cost	Wordcount
R.Manopriya,2014	Optimal Resource Allocation and Job Scheduling to Minimise the Computation Time under Hadoop Environment	**Johnson algorithm**- job tracker schedules excess of the slots in a pool to be allocated to other pools that are independent to minimize the computation time	Computation time, CPU utilization	Wordcount
Zhenhua, 2014	Improving resource utilization in MapReduce	1.**Resource stealing**-The idle slots that are not utilized are allocated to pending tasks 2.**Benefit aware speculative execution**-speculative tasks are launched earlier than the original tasks	Computation time, CPU utilization	Wordcount
Balaji Palanisamy, 2014	Purlieus: Locality-aware Resource Allocation for MapReduce in a Cloud	Data locality is favoured by making map phase executing the map task should be close to the node that contains input data and reduced phase VM's execute close to the map task	Computation time, CPU utilization	Wordcount, GREP
Shanjiang Tang,2014	Dynamic MR: A Dynamic Slot Allocation Optimization Framework for MapReduce Clusters	**Dynamic Hadoop Slot Allocation**-allocates the slots dynamically to the map and reduce tasks **Speculative Execution Performance Balancing**-handles the speculative tasks by running as back up tasks **Slot Pre Scheduling**- pre schedules the idle slots to map and reduce tasks to maximize datalocality	Computation time, CPU utilization	Wordcount, sort, sequence count

Table 1 Comparative study

IV. SEARCH PROCESS

The search process is done manually by reviewing the journal and conference of resource allocation strategies for MapReduce clusters from 2011.The manual search is done randomly and sequentially. Random search is based on the search engines such as Google, Bing etc and sequential search is based on the transaction papers from 2011.

V. RESEARCH METHOD

This study is considered to be a review over the resource allocation strategies for MapReduce clusters. A research questions plays major role in survey and it also gives a clarity .The questions related to the survey are

A. The resources or slots allocated are dynamic or static? why the map tasks get more slots when compared to the reduce tasks?

B. whether the network traffic is reduced while running the map tasks?

C. whether the slots are allocated only with the pools?

D. whether the Hadoop performance is improved?

E. whether the speculative tasks decrease the performance of Hadoop? how it is handled?

VI. OBSERVATION

A**.** The resources or slots allocated are dynamic or static? why the map tasks gets more slots when compared to the reduce tasks**?**

The resources that are statically preconfigured by the administrator and for performing MapReduce operations based on the demand the slots are allocated dynamically to complete their tasks. In the most of reviewed papers ,slots are allocated dynamically .Since map tasks performs

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major mapping operations when compared to reduce tasks hence the map slots gets more slots when compared to the reduce tasks.

B. whether the network traffic is reduced while running the map tasks?
In the most of the reviewed data locality is achieved by running map tasks locally in the node that contains the data rather running in remote nodes that increases the network traffic there by decreasing the performance of Hadoop

C. whether the slots are allocated only with the pools?
Slots can be borrowed from other pools to complete their MapReduce operation. here pool refers a group of map and reduce tasks of a specific job**.**

D. whether the Hadoop performance is improved?
The performance of the Hadoop is increased by focusing on resource allocation based on the metrices like cost and time

E. whether the speculative tasks decrease the performance of Hadoop? how it is handled?
The speculative tasks which are slow running tasks which happens due to slot failure ant it decreases the performance by increasing the time and cost .It handled by running the speculative tasks as backup tasks from the reviewed papers Speculative Execution Performance Balancing(SEPB) and Benefit Aware Speculative Execution(BASE) handles the speculative tasks

VII. CONCLUSION

Resource allocation is one of the important factor while performing the MapReduce operations since the resources are allocated statically sometimes the resources goes unused which makes most of the resources to become idle and inturn increases the cost and time. From the reviewed papers it is preferred and concluded to use a resource allocation strategy that includes the speculative execution and maximizing the data locality.

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