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# RULE BASED GRID SCHEDULING IN STATIC JOB SUBMISSION ENVIRONMENT

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***Abstract*—The grid scheduling algorithms are used for resource utilization and minimization of job completion time and waiting time. In this paper a rule based approach is presented to minimize average turnaround time in heterogeneous resource environment and static job submission environment. In static job submission environment, all the jobs are submitted at same time. Taken all jobs independent and applying the rules, the turnaround time of each job is minimized to minimize the average turnaround time of all submitted jobs.**

***Keywords-grid; high performance computing; rule based; scheduling.***

## I. INTRODUCTION

With the improved communication capabilities, the remote resources are frequently used to solve the applications involving large volume of data is known as grid computing. There exists many tools to submit jobs on the resources which have different computational power and are connected via Local Area Network (LAN) or Virtual Private Network (VPN). The users submit their jobs using these tools on scheduler. The challenges in grid computing are efficient resource utilization and minimization of turnaround time.

In grid computing environment, the resources include computing power, communication power and storage. An user application consists of number of jobs; users want to execute these jobs in an efficient manner [1]. There are many possibilities of submission of jobs/data on resources; in one of them, users choose the resource on basis of their status information and then submit jobs on scheduler and data on resource and in the other, on the basis of specific criteria, resource is selected on which both job and input data are transferred. This paper uses second approach, wherein the job is submitted on a scheduler and data on a resource identified by the scheduler. In this paper a rule based approach is presented to choose a resource.

The next section describes details about rule based system. Section 3 describes the proposed rule based approach in static job submission environment. In section 4 the experimental details and the results of experiments are presented with comparison of non rule based approach. In section 5 conclusions and suggestions for future improvements are proposed.

## II. RULE BASED SYSTEM

A simple form of artificial intelligence, which is now frequently used by the researchers is known as rule based system [2]. The rule based system is used to present the human knowledge. A rule based system is the set of if-then rules; it used to convert users high level query to low level query. The rules are stored and the decisions are taken according to the rules. e.g.

If number is divisible by 2 then number is even.

The Figure 1 shows the rule based system, in this system n rules are presented and each rule having statement and corresponding action.

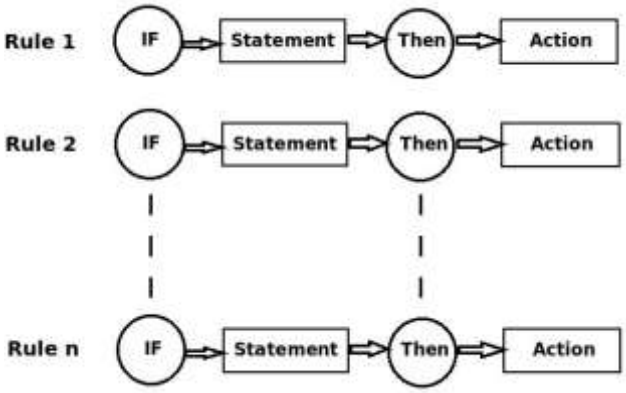


Figure 1: Rule Based System.

## III. PROPOSED RULE BASED APPROACH

The existing grid scheduling approaches are based on the speed of resources [3], [4]. Each resource has different processing power and all the resources are connected via homogeneous communication environment in which the communication delay between scheduler and resources is assumed constant, also the jobs are assumed to submitted on terminals having different job requirement.

The rule based approach use in this paper is suitable for static job submission in heterogeneous resource environment connected to the scheduler through homogeneous communication environment. The rule based approach takes every job as independent of each other and each of them is scheduled on a resource on the basis of these rules. The overall turnaround time of all the jobs is thus minimized. The parameters used in this approach are as follows:

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*The resources $R_1$, $R_2$, $R_3$,....., $R_n$.*
***$J_i$*** *= The submitted $i^{th}$ job.*
***$Proc\_power_j$*** *= Processing power of resource $R_j$.*
***$Expt\_avail_j$*** *= Estimated time at which resource $R_j$ is available to execute.*
***$Job\_req_i$*** *= Length of job $J_i$.*
***$Expt\_comp_{ij}$*** *= Expected turnaround time of $i^{th}$ job at $j^{th}$ resource.*

The rule based approach to schedule a job $J_i$ is given below, here a resource $R_j$ is selected on the basis of these rules.

**Rule 1:**
{
**IF** ($R_j$ is idle and $Proc\_pow_j > Proc\_pow_k$, $\forall k$)
**THEN** Choose $R_j$.
}
**Rule 2:**
{
$Expt\_avail_k = Status_k$ $\forall k$.
**IF** ( $Expt\_avail_j < Expt\_avail_k$ and
$Proc\_pow_j > Proc\_pow_k$, $\forall k$)
**THEN** Choose $R_j$
}
**Rule 3:**
**{**
$Expt\_comp_{ij} = Status_j + Job\_req_i/Proc\_pow_j$
**IF** ($Expt\_comp_{ij} < Expt\_comp_{ik}$, $\forall k$)
**THEN** Choose $R_j$
}
**Rule 4:**
{
**IF** ($Expt\_comp_{ij} = Expt\_comp_{ik}$ and
$Proc\_pow_j < Proc\_pow_k$, $\forall k$)
**THEN** Choose $R_j$
}

After assigning the job $J_i$ at resource $R_j$ the status of this resource has been modified and the new status is the $Expt\_comp_{ij}$. According to the resource information and these rules the jobs are submitted on resources.

## IV. EXPERIMENTAL RESULTS

The experiment use the GridSim simulator [2] to simulate the approach. The GridSim toolkit is used to simulate heterogeneous resource environment and the communication environment. The experiments are performed with rule based approach and non rule based approach. The input data is taken to be the same for both the approaches. The simulation is conducted with three resources which are shown in Table 1 and the input data is shown in Figure 2.

Table 1: Resources with their architecture and processing power.

| **Resource** | R0 | R1 | R2 |
|---|---|---|---|
| **Architecture** | Sun Ultra | Sun Ultra | Sun Ultra |
| **OS** | Unix | Unix | Unix |
| **Proc_power( in MIPS)** | 48000 | 43000 | 54000 |

The scheduler submits these jobs on resources according to the approaches. The approaches are presented one by one with their experimental results.

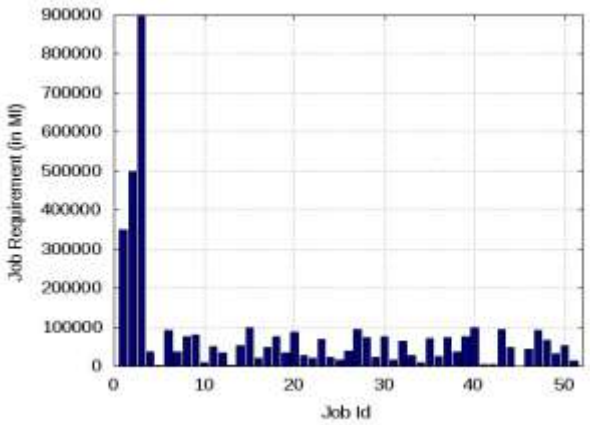


Figure 2: Jobs and requirement (in Million Instructions).

### A. Non Rule Based Approach

In non rule based approach as the jobs are submitted to the scheduler, the resources are allocated in order in which the request is made. In our experiment there are three resources (i.e. $R_0$, $R_1$, $R_2$). The $J_0$ is submitted to $R_0$, $J_1$ is to $R_1$, and so on. In this approach the resources have equal distribution of jobs. The turnaround time of each job is shown in bar chart in Figure 3. Through this approach the average turnaround time of these jobs is 160.58 seconds and all the jobs are completed at 317.45$^{th}$ second.

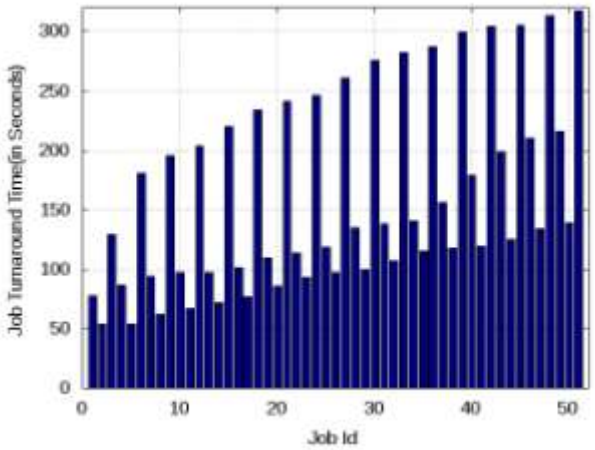


Figure 3: Jobs and turnaround time (in seconds) using Non Rule Based Approach.

### B. Rule Based Approach

In rule based approach, the scheduler finds the resource information and apply the rules on the job and all the resources. According to these rules scheduler chooses a resource and submits that job on this resource. The

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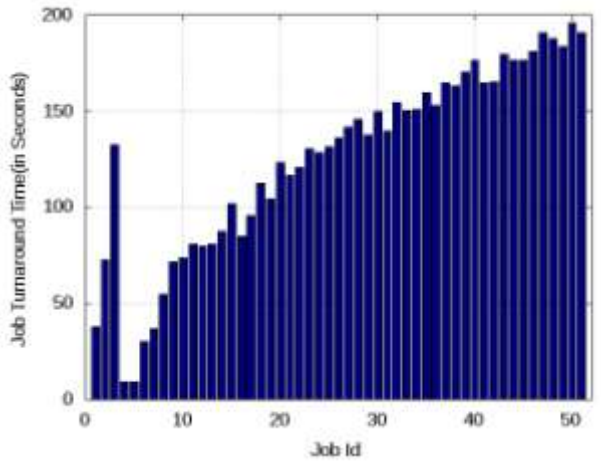
turnaround time of each job is shown in bar chart in Figure 4. Through this approach the average turnaround time of these jobs is 125.37 seconds and all the jobs are completed at 196.1$^{th}$ second. The rule based approach reduces the average turnaround time by **21.92%** as compared with non rule based approach. The completion time of all jobs takes more less




time than non rule based approach.

Figure 4: Jobs and turnaround time (in seconds) using Rule Based Approach.

## V. CONCLUSIONS AND FUTURE WORKS

The proposed rule based approach reduces the average turnaround time of all submitted jobs. The considered environment executed the jobs on different resources which are geographically distributed. It is observed that the rule based approach reduces the average turnaround by 21.92% with non rule based approach (as shown in Table 2). The comparison of turnaround time between these two approaches is shown in Figure 5.

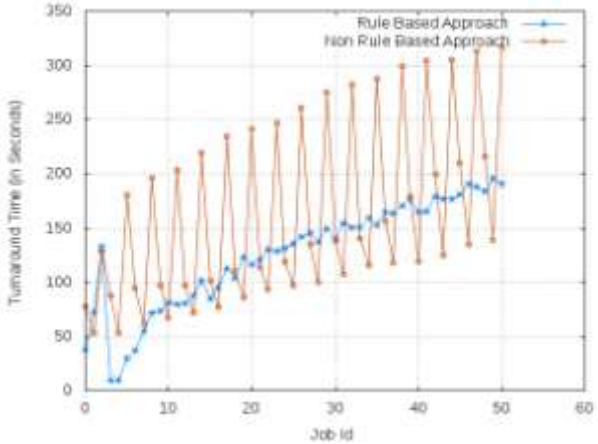



Figure 5: Comparison of turnaround times (in seconds)

Table 2: Average turnaround time and completion time

| **Approaches** | **Average Turnaround Time (In Seconds)** | **Completion Time (In Seconds)** |
|---|---|---|
| Non Rule Baesd Approach | 160.58 | 317.45 |
| Rule Based Approach | 125.37 | 196.1 |

## VI. REFERENCES

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