Cost based Resource Provisioning Policy for Grids

Rajni Aron, Inderveer Chana

***Abstract*—Grid Computing provides the facility of resource sharing of under utilized resources. The efficient management of dynamic nature resources can be done with the help of Quality of Service (QoS) based resource provisioning. So it is required to design resource provisioning policy which helps in the efficient management of resources from both user and provider aspects. In this paper, a Cost based Resource Provisioning Policy (CRPP) has been proposed. Cost is the major factor in Grid services and is considered as a QoS parameter in Grid resource provisioning. This paper provides the formal representation of cost based resource provisioning policy for Grid environments. Formal representation helps in clear goals to be achieved and prior verification before actual scheduling takes place and thus helps in anticipating the success of achievement of QoS parameters like cost for Grid resource provisioning.**

***Index Terms*—Resource Provisioning, Quality of Service, Grid Computing**

I. Introduction

In the recent years, a growing number of science projects like LHC, Seti@home, quantum monte carlo@home and milkyway @home etc. require huge amount of storage capacity and resources which has been made possible with the help of grid computing. Grid computing is coordinated resource sharing and problem solving in dynamic, multi-institutional virtual organizations [1]. The ultimate goal of grid computing is to provide the computing facility to users like power grid without knowing the detailed characteristics of the source. The deployment of Grid systems involves the efficient management of heterogeneous, geographically distributed and dynamically available resources. These requirements introduce a number of challenging issues that are to be addressed, like resource allocation, resource sharing, QoS parameter based resource provisioning, efficient scheduling etc. Resource provisioning is the key issue for grid resource management besides numerous other issues. The base of the grid is the resource. Resources provide the cell functions, such as mathematic computing, data source managing, storage managing, transaction processing, sensing and actuating, for the application. In order to access the right resource in the right time by the right way, it should be the first step to find out resources features such as accessing interface, meaning of parameters, functions realized, required conditions for accessing etc. Hence, it is very important for grid to describe resources clearly [2]. Resource provisioning allows the users and providers to access the specified resources according to availability of the resources in virtual organizations. Resource Provisioning is particularly useful for grid scheduling because most often grid scheduling is done on the best effort basis in the grid environment so the overheads of grid scheduling like inter-independent tasks can be very costly and time consuming [3]. Unless resource provisioning is considered a fundamental capability, predictable QoS cannot be delivered to Grid consumers. So it is required to design a resource provisioning policy based on QoS parameter as cost for Grid environment. By addressing these issues, management of the resources will become considerably easy and better consumer satisfaction can be attained.

This paper addresses the enforcement of the cost based resource provisioning policy for efficient provisioning of the resources. Most of the existing grid models have only security policy and there is no resource provisioning policy for efficient resource sharing. Cost based resource provisioning policy is particulary useful for grid scheduling because most often, resource providers have different resource policies for provisioning and they want to get profit. If they use the same policy then profit would be maximized and cost of resources for user will automatically be less. So, the Grid resource provisioning plays a vital role in building an effective and a well-organized grid environment [4].

The motivation of our work stems from the challenges in managing, sharing and efficient utilization of the grid resources. In real life situations, there are many constraints including (i) satisfying the quality of service (ii) minimizing the cost of the resources which are required for the application's execution which will be submitted by the user. The main aim of this work is to provision the resources along with achieving the practical constraint minimizing the cost as mentioned above.

This paper presents Cost based Resource Provisioning Policy. This policy results from common aspects of allocation of resources for execution of application and QoS requirements for resource provisioning. For verifying the policy itself, actual provisioning and scheduling of resources can be well anticipated. This paper presents related work in section 2, In section 3, a description of objectives and Cost based resource provisioning policy have been presented. Section 4 shows the verification and performance evaluation of resource provisioning policy with Z specification language, using grid sim toolkit and finally the conclusion in section 5.

II. Related work

Resource Provisioning is the core of resource management in grid computing. There has been little effort on resource provisioning for grid resource management

C. Vazquez et al addressed dynamic provisioning problem as interoperability, dynamic growth and enforcement of a budget by designing the architecture for an elastic grid infrastructure [5]. Feasibility solution by harnessing resources of the Tera Grid, EGEE and Open Science grid infrastructures through a single point of entry for the computational resources for grid infrastructures and cloud providers

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R. Aron is with the Department of Computer Science and Engineering, Thapar University, Patiala,India e-mail: (rajni3387@gmail.com).

I.Chana is with with the Department of Computer Science and Engineering, Thapar University, Patiala,India. e-mail: (inderveer@thapar.edu).

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has been given but these solutions of dynamic provisioning do not support the QoS parameter as cost for online job provisioning.

A. Filali et al [6,7] used the adaptive resource provisioning schema to achieve resource utilization in the best manner satisfying the required QoS by maximizing network utilization, minimizing request blocking probability and maximizing the providers revenues. Local Optimization Heuristic and Global Optimization Heuristic have been proposed by using optimization techniques. An optimization model that enables the simultaneous allocation of interrelated resources as CPU and Bandwidth for grid applications has been proposed. However in, Resource provisioning policy, we can not only provision the resources, but we can also investigate ways to provision the resources to user applications with QoS parameter cost.

G. Singh et al [8,9] have presented a provisioning model for resource provisioning where grid sites provide the information about resource availability in the form of time slots.The main aim of the model is to identify the subset aggregate resource availability so that cost and make span are minimized. They have used a Multi -Objective Genetic Algorithm(MOGA) to find resource plan that corresponds to the pareto-optimal set. A drawback of the previously mentioned approaches is that provisioning is performed without consideration of resource provider's profit and user's QoS requirements simultaneously.

I. Raicu et al [10] have proposed dynamic resource provisioning architecture using the existing system *falkon*. Allocation and deallocation policies have been presented. The policies are evaluated using two metrics as provisioning latency and accumulated CPU time. DRAGON [11] and GLARE [12] frameworks also provide provisioning in heterogeneous grid environments. As per DRAGON framework, network infrastructure is deployed, which allows dynamic provisioning of network resources in order to establish deterministic paths in direct response to end-user requests. It also allows advanced e-science applications to dynamically acquire dedicated and deterministic network resources to link computational clusters, storage arrays, visualization facilities,remote sensors and other instruments into globally distributed and application specific topologies. GLARE provides distributed registries for activity types, activity deployments and services which perform registration, provisioning, monitoring and automatic deployments of new activities on different Grid computers in Virtual Organization (VO).

The design of gateway that provision resources to deadline applications relying on information given by current resource management services, may be complex and prone to scheduling decisions, that are far from optimal when providers and brokers use conflicting policies, the number of migrations can be high [13]. So if we will use same techniques with resources providers and user then automatically number of migrations and complexity of policies can be less and the performance will be high. In this work, a resource provisioning policy is designed in XML schema and validation and implementation of this policy has been done using Z-language.

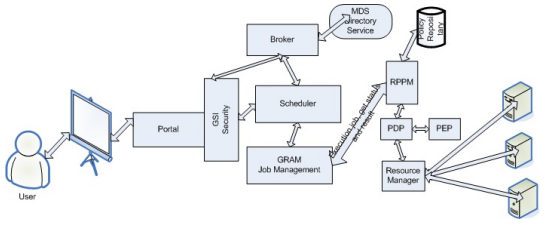

Fig. 1. Cost based Resource Provisioning framework

III. Resource Provisioning Policy

Resource Provisioning policy provisions the resources on the basis of QoS parameter Cost. This policy standard is based on ISO:9000-2000, RFC 4745 [14].

A. Mode of operation : Resource Provisioning

Resource Provisioning framework provisions the resources on the basis of cost based resource provisioning policy. First of all user will try to access the grid resources for the execution of the grid applications through a grid portal. After this a certificate will be generated, and the authentication and authorization would be performed through Grid Security Infrastructure (GSI). GSI Security will communicate with the broker. Broker will collect the information about the resources and job status. Grid computing resources are typically operated under the control of a scheduler which implements allocation and prioritization policies while optimizing the execution of all submitted jobs for efficiency and performance. GRAM is not a resource scheduler, but rather a protocol engine for communicating with a range of different local resource schedulers using a standard message format [16]. GRAM will communicate with the Resource Provisioning Policy Manager (RPPM) for resource provisioning. RPPM will take the information about policy which is stored in the policy repository. The policy repository contains the policy documents and programmatic interface for instantiating policy objects. PDP is a logical entity that makes policy decisions for itself or for other network elements that request such decisions[16]. PEP is a logical entity that enforces policy decisions according to user's requirements. Resource Manager (RM) checks for availability of the resources according to policy conditions and then provision the resource to user's application and after that the scheduler will perform scheduling. Resource Manager handle operations such as resource allocation, configuration and reservation etc. After getting the result, it is again sent back to the user.

B. Objectives and Commitment

The objective of Cost parameter(s) based resource provisioning policy is to ensure that the policy will provision resources for execution of the job.It facilitates to :

1) Clearly understand the current and potential future requirements and expectations of resource consumers.
2) Measure at an appropriate level service performance and customer satisfaction by minimizing cost.
3) Enhance customer satisfaction by meeting their requirements.

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C. Methodology

1) Resource provisioning manager will ask the user to submit SLA form to fill their requirements. So that RPPM can provide the facility according to user's requirements.
2) RPPM tries to minimize the cost of user's application execution resources.
3) Once cost is minimized, the customer will automatically be satisfied.

1) Cost based RPP: Under cost QoS parameter, a resource is used for the provisioning of job execution on consideration of cost of the resources. Cost is an important aspect to be considered at the time of resource provisioning. Cost is identified as per unit of resources that are consumed by the user for execution of their application. After the minimization of the cost of the resources, resource would be provisioned. Thus, Cost based QoS can be provided to resource consumer. An XML schema of Cost based Resource Provisioning Policy (CRPP)is as follows:

```
<?xmlversion="1.0"encoding="UTF-8"?>
<xs:schema
xmlns:xs="http://www.w3.org/2001/XMLSchema"
elementFormDefault="qualified"
attributeFormDefault="unqualified">
<xs:elementname="Cost">
<xs:annotation>
<xs:documentation>
Resource Provisioning Policy
for Cost Operation
</xs:documentation>
</xs:annotation>
<xs:complexType>
<xs:sequence>
<xs:elementname="application
execution service">
<xs:complexType>
<xs:attributename="resource"
type="xs:string"
use="required"/>
<xs:attributename="type"
type="xs:string"
use="optional"/>
</xs:complexType>
</xs:element>
<xs:elementname="compute
QoS parameter Cost" minOccurs="0">
<xs:complexType>
<xs:attributename="capacity"
type="xs:integer"
use="required"/>
</xs:complexType>
</xs:element>
</xs:sequence>
</xs:complexType>
</xs:element>
</xs:schema>
```

IV. Verfication of Cost based RPP

Formal method are used in developing critical computer systems and fault avoidance techniques and help in reduction of errors. QoS based resource provisioning policy stated above can be verified using a formal language like Z specification. In Z [17][18], schemas are used to describe both static and dynamic aspects of a system. The states it can occupy; the invariant relationships that are maintained as the system moves from state to state. In our resource provisioning policy, we need to deal with resources and consumers. In this policy, we will provision the resources to those consumers whose requirement as *cost* is fulfilled by resource provisioning manager. We introduce the set of all resources and the set of all consumers as *basic types* of the specification:

$$[RESOURCE, CONSUMER].$$

The first aspect of the system to describe is its *state space*:

$$\begin{array}{|l} \textit{ResourceProvisioningpolicy} \\ \hline list : \mathbb{P}\, RESOURCE \\ Provision : RESOURCE \nrightarrow consumer \\ \hline consumer1provision \subseteq list \\ \hline \end{array}$$

In this schema, list and provision are variables and relationship between the values of the variables has been established.

- *list* is the set of resources recorded for allocation;
- *provision* is a function which, when applied to certain resources, gives the consumer associated with them who fulfill all the conditions of the policy.

Detail of resources has been shown in Table 1. Cost based Resource Provisioning Policy give the facility of resource provisioning to user for optimum results and better services and avoid the violations of service level guarantees. The implementation of this policy will enable the user to analyze customer requirements and define processes that will contribute to the achievement of a product or service that is acceptable to their resource consumer.

TABLE I
Resource Characteristics

Name	Location	Resource types
RP1	Research lab	PC C-2-D Quad /250GB Sata
RP2	Software Engineering lab	IBM C-2-D 2.33 Ghz
RP2	HECL lab	IBM PCs P4 3.0 Ghz Dual core 2.8 C-2-D 2.33 Ghz
RP4	CC Main	Pentium IV 3.0 GHz
RP5	CC MXI	Pentium-IV (HT),3.0 GHz
RP6	CC MXII	Dell optiplex 330 PIV Dual Core 1.6 GHz

A. Performance evaluation

The performance evaluation is performed through the simulation by using gridsim [19]. In addition to designing a cost based resource provisioning policy, we have also conducted a comprehensive performance analysis. We have tested the cost based resource provisioning policy. Figure 2, shows that the cost of the execution of application decreases, with cost based resource provisioning policy but the cost of the execution of application increases without cost based resource provisioning policy. Figure 3 shows that cost of the execution of application decreases and resource utilization increases simultaneously, with cost based resource provisioning policy

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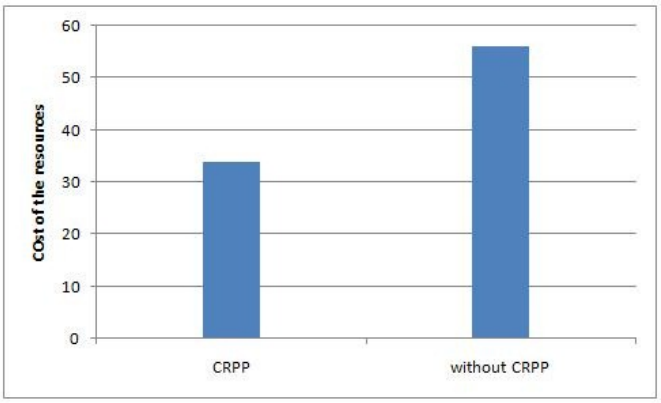

Fig. 2. cost of the resources for the execution of the application

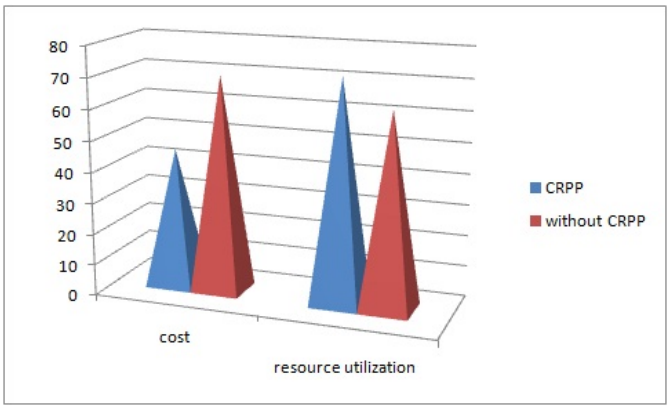

Fig. 3. cost and resource utilization of the resources for the execution of the application

but the cost of the execution of application increases and resource utilization decreases without cost based resource provisioning policy.

V. Conclusion

In this paper, we have proposed cost based resource provisioning policy for grid environment. Cost based Resource Provisioning policy can assist organizations in enhancing customer satisfaction and contribute directly to the company's growth and institution's progress. Verification and implementation of the proposed policy has been done with the help of Z specification language. Performance evaluation has been done with the help of grid sim. In future resource scheduling algorithms based on resource provisioning policy would be incorporated to achieve better resource provisioning.

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