AN INTELLIGENT GRID RESOURCE BROKERS ELICITING NON-FUNCTIONAL REQUIREMENTS PREFERENCES OF GRID USERS.

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Abstract

The main objective of grid computing is resource sharing through an efficient resource management system. It has emerged to facilitate resource sharing and efficient utilization of grid resources. However the grid resources are still underutilized and not widely used by all. Existing resource brokers focused on to select the resources based on user requirements and availability of resources. However, there is no work focused on to provide an intelligent assistance for resource brokers. Besides, Non-Functional Requirements presents a systematic and pragmatic approach for building quality into grid software systems. Such kind of systems must exhibit quality attributes, such as accuracy, performance, security, modifiability etc. However, such non-functional requirements are not addressed so far in grid environment. Towards this end, a system "An intelligent grid resource brokers eliciting non-functional requirements (NFR) preferences of grid users." is proposed to provide an intelligent assisted service and to elicit NFR preferences of users in the grid environments.

Keywords: Grid computing, resource brokers, NFR preferences, intelligent assistance.

I. INTRODUCTION

The term "the Grid" was coined in the mid 1990s to denote a proposed distributed computing infrastructure for advanced science and engineering. [1]. Grid computing is a hot research direction and drawing a lot of attentions from both academia and industry. It provides solution to the complex scientific problems. [2]. It has emerged to facilitate better utilization of under utilized heterogeneous resources. The main motivating factor in grid computing is resource sharing. [4].. It is provided by resource management system, which is the central component of grid computing. It mainly focuses on management and scheduling of computations over dynamic resources scattered geographically across the internet. Resource management acts not only as an interface between grid resource and grid application but also to provide reliable service to the user.

For a Grid with a small or limited number of participating sites, existing Meta brokers service is feasible. But for a grid with large number of participating sites, intelligent assistance for Meta brokers' is required to provide feasible service. In a dynamic grid environment any new mechanism needs to be adaptive to handle constant dynamic changes in the availability of resources and user requirements. In such an environment, in the absence of intelligent assistance, grid users experience difficulty in finding answers recurring questions such as the following

- Is it possible to complete the job with given cost?
- What to do when the required resource is not available in intense pressure?
- Is there any intelligent assistance based on grid market dynamics?.
- How to find best providers, requesters and resources?
- Any other assistance to the resource request?.

However, at present resource brokers lack of intelligent assistance in resource request and discovery. It will therefore necessary to have a intelligent assistance for providing intelligent solution for quickening the resource discovery process.

The quality of the service being provided in the grid environment depends on both functional as well as the non-functional requirements [NFR]. But conflicts between NFRs are not yet resolved effectively in grid. There are many issues and challenges in the Grid environment. Amongst the challenges for Grid computing, to date, there is little work that addresses the issues of requirement engineering. To the best of the author's knowledge, at present, there are only a few (preliminary) efforts on considering NFRs to provide quality software.

In addition to the functional requirements of the system, if non-functional requirements are also added, then the quality of the system will get refined. This is the need behind to elicit NFR. Therefore the approach proposed in this paper focuses on providing high level service like providing intelligent assistance and to elicit the NFR to the Mata brokers or Meta schedulers.

II. RELATED WORKS

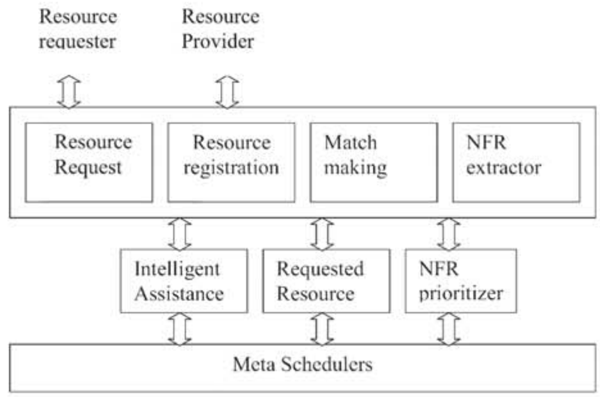
There are only few mata brokers or meta schedulers used in the grid environment. First scheduler is

Community Scheduler Framework(CSF) [7] - CSF enables communication between heterogeneous schedulers on local level, allows reservations on resources, offers simple scheduling mechanisms and extensible via scheduling plug-ins. However , Gridway[8,3] is the very popular meta scheduler has standard API for job submission and management and it follows very simple scheduling mechanisms. It also allows job dependencies and supports job migration/adaptive execution. The first economic based broker is GSB [9] – Grid Service Broker (GridBus) mainly focuses on trading and accounting services. It interacts with workflow management service, leverages economic scheduling model. GRMS[10] -Grid Lab Resource Management System is another meta scheduler supports Job dependencies, defines a Job Definition Language (GJL), simple scheduling mechanisms, extensible, allows job migration, and provides a GSI enabled Web Service interface. Moab/Maui[11] commercial Meta scheduler with advanced scheduling has monitoring capabilities. It is deployed on top of most major scheduling systems. Nimrod/G[13] is a Grid aware solution of Nimrod for compute intensive tasks works with Globus Tool kit - GT, Legion, Condor. Condor-G[14] follows simple queue submission system treats a Grid as local resource.

Considering the inadequacies of the efforts previously made and referred to above, the motivation behind the work is to sets out the system for providing intelligent assistance for resource discovery and to elicit the NFR preferences of grid users. The main objective of this work is (i)to provide an intelligent assistance for resource discovery (ii) to increase the number of request serviced and (iil) to increase the utilization of resources. In addition to that , Extract the NFRs from the user preferences, analyze the conflicts among different NFRs and resolve the conflicts using trade analysis and increases the quality of service.

III. COMPONENTS OF PROPOSED SYSTEM

An overview of the proposed system in the form of block diagram is shown in Figure 1. The components of this system include (i) Resource Provider - RP.(ii) Resource Requester – RR (iii) intelligent Assistance (iv) NFR extractor (v) NFR prioritizer



g.1. Block diagram of the proposed system

A.1. Resource providers

There are two categories of users in the grid computing environment viz 1.Resource requester and 2.Resource providers. Second type of user is resource providers who register the resources, with specifications and constraints. Resource providers try to maximize his return-on investment. Both type of users have recourse for meeting their requirement. Resource providers are able to contribute resources to the grid community. When resource providers tries to register the resource with specifications, resources are included in the relevant group after due verification of service that can be provided. User may contact Grid Resource Information Service - GRIS of the Globus through information providers.

A.2. Resource Requester

The resource requester may seek the resource for application and try to obtain the exact match of the resource with inherent constraints. Such users always strive to get the exact match of the resource quickly at minimal cost. Resource request specification is read from user who desiring to utilize the services from the Grid. Request will be routed to the corresponding group. Thus the risk of referring the request to irrelevant group can be avoided.

A.3. Intelligent Assistance

It is a customized component, collecting information on all the process taking place in the system and replying to the queries by applying its intelligence. The developments of the grid in recent times have significantly speeded-up its performance and yet the position has remained inadequate. One possible reason for this could be that existing resource brokers are not having any intelligent assistance. In the proposed system, intelligent assistance helps the brokers and is equipped to play the crucial role. Acting as a back-end assistant for providing information when required, it acquires its knowledge from the processes happening in the system and updates itself while fulfilling its role. Proposed system is responsible for the following services provided by ARDNAS[5]

- High/low demand resource
- Instantly available resource
- Transaction History
- Suitable resource identification
- Performance Evaluation
    1. Best provider
    2. Best consumer
    3. Best resource

A.4 NFR Extractor

NFR preferences for the grid user requirements are extracted with the help of goal based questionnaires and grid user preferences. The goal based questionnaire includes all possible questions for the activities of both resource requester provider user. Users have to give their preferences by appropriately answering for the questions provided by the user friendly portal designed for this purpose. From this portal information 'NFR extractor' extracts the non-functional requirements preferences for the user and redirects them to the 'NFR prioritizer'.

A.5 NFR Prioritizer

'NFR Prioritizer' consists of two components namely 1.Conflicts identifier 2.Trade-off analyzer. 'Conflicts identifier' analyzes the conflicts among the extracted NFRs with the help of NFR taxonomy. In 'NFR Taxonomy' all the NFRs are associated with other conflicting and dependable NFRs. The entries in NFR taxonomy looks like,

Performance#Response+#Throughput+#Timeliness+#Availability-#Reliability-

It states that 'Performance' is directly proportional to 'Response', 'Throughput', 'Timeliness', and 'Availability' but indirectly proportional with 'Reliability'.

After identifying the conflicting NFRs, the NFRs are prioritized based on the trade-off analysis. Trade-off analysis explores the cost of relaxing one NFR in order to achieve an increase in another NFR. This is implemented using fuzzy rule sets. These rules are formulated for each NFR according to the conflicting and dependable NFR.

IV. GRID ARCHITECTURE WITH THE PROPOSED SYSTEM

Grid architecture is used to identify fundamental system components, purpose and their functions in grid environment. The architecture also shows how these components interact with each other to achieve the goal. To facilitate effective resource sharing, it has many protocols, services, application programming interfaces and software development kits. Generally grid architecture incorporates five layers namely fabric layer, connectivity layer, resource layer, collective layer and application layer.

A.1. Fabric Layer

This layer provides the resources which is available in grid. Resources may be of type hardware resource, software resources and Quality Of Service - QOS requirements etc However hardware resources are computational resources, storage resources, cluster etc. software resources are distributed files, licensed software, and special purpose application software. QOS requirements are network bandwidth, constraints etc. Shared accesses to these resources are supported by the grid protocols.

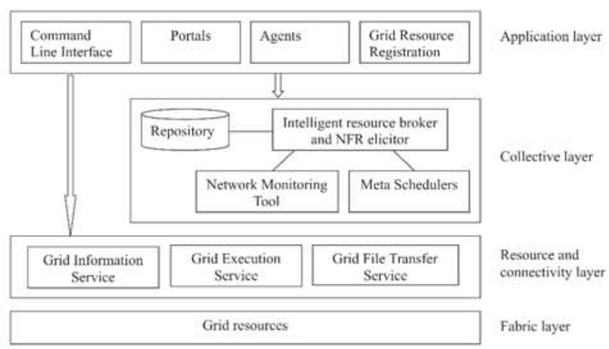


Fig. 2. Layered grid architecture with the proposed system

A.2. Resource and connectivity layer

This layer in the system shows the combination of resource and connectivity layer. These two layers play vital role in grid like monitoring and discovery of grid resources, execution of job in grid resources and file transfer between grid resources. In order to perform these tasks, Grid middleware incorporate the necessary components like grid information services (MDS), grid execution services (GRAM) and grid file transfer services(Gridftp, RFT). These services are utilized by the meta schedulers or brokers through Middleware Access Drivers (MAD).

A.2.1 Grid information service

The Monitoring and Discovery System - MDS is a component to provide grid information service in Globus Toolkit and used for monitoring and discovering Grid resources and services. MDS collects the resource details from different nodes of the grid in the distributed environment with aggregator services and stores in the xml format. It allows users to query and access the collected information with help of interface and tools. MDS4 provides services like MDS-Index, MDS trigger and MDS archiver. MDS index supports Xpath queries on the latest resource details. MDS-Trigger service is a new component of GT and collects data from resources on the grid and MDS-Archiver, stores information source values in database. GT2 has two components namely 1.Grid Resource Information Service(GRIS) 2. Grid Index Information Service (GIIS). However GT4 has webMDS for monitoring and discovery services.

A.2.1.1 Grid Resource Information Service (GRIS)

GRIS maintains local resources provided by the resource providers and register the resources with GIIS which maintains global resources. Resource providers may submit the resource information directly to the GRIS through information providers or they can submit to the agents with constraints to provide negotiated high level service. Information in the GRIS is updated to the GIIS on request periodically. If the request is not received within a period of time by GRIS, information in the GRIS will be discarded. But this information is maintained by the information providers. However, if GRIS required that information in future , it can get from the information providers.

A.2.1.2 Grid Index Information Service (GIIS)

GIIS gets the resource information from one or more GRIS and may be from other GIIS in the hierarchy. It maintains indexes of grid resource registered by the GRIS and other GIISs. Resource requesters can contact GRIS to know the status of the local resources or directly contact the GIIS to know about the status of the global resources.

A.2.2 Grid execution service

GRAM – Grid Resource Allocation Manager is a component provides grid execution service. It enable users to locate, submit, monitor and cancel remote jobs on Grid-based compute resources. It enables remote execution management in contexts for which reliable operation, stateful monitoring, credential management, and file staging are important. It also provides a single protocol for communicating with different batch/cluster job schedulers.

A.2.3. Grid file transfer service

GridFTP is a protocol which supports high-performance, secure, reliable data transfer in grid environments. It is based upon the Internet FTP protocol, and it implements extensions for high-performance operation. GridFTP uses basic grid security on both control and data channels. It also support other features like multiple data channels for parallel transfers, partial file transfers, server-to-server transfers, reusable data channels, and command pipelining.

A.3 Collective layer

This layer is responsible for resource brokering and scheduling. Resource brokers perform matchmaking, schedulers allocate the job to the best resource and alternate resource provider provides alternate resource when discovery fails for time bound and cost bound process. Meta schedulers are assisted for the intelligent and efficient resource management based on the grid market dynamics.. When the user specifies the exact resource name for specific application, the functions of schedulers can be bypassed for selection of best resource. GIIS holds the collected resources in GT2 and in the case of GT4 , web MDS has the collected resources. Network management tools are responsible for monitor the Availability, Latency and Bandwidth of the network.

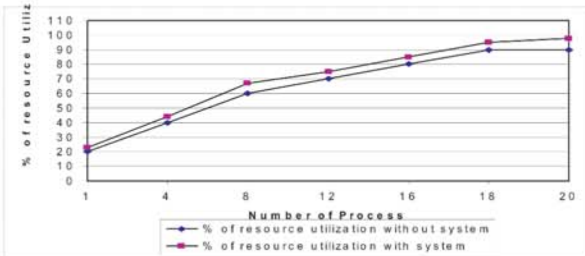
A.4. Application layer

The application layer enables the use of resources in a grid environment through several portals. It includes portals for providing resource request information with constraints. In addition to that, this layer may include portals that display availability of resources, results of job execution and necessary user interface components for job submission and resource request. Resource registration parameter with inherent constraint can be obtained directly from resource provider and the resource requester respectively.

V. IMPLEMENTATION AND RESULTS

Grid has very large infrastructure. In order to make use of the existing infrastructure efficiently, there must be an intelligent support to assist the grid components. The proposed system is implemented with GTAI 1.0.1 (Globus Tool kit Auto Install)grid middleware and Matlab tool kit. There are few Metabrokers or Metaschedulers available viz CSF (Community Scheduler Framework),GridWay,Grid Service Broker (in GridBus),GRMS (GridLab Resource Management System), Moab/Maui, Nimrod/G, Condor-G. Gridway Mata sheduler is compatible with Globus tool kit and deployment does not require any new services apart from those provided by the Globus Toolkit (MDS, GRAM, GridFTP and RFT). It is also supports for additional plug-in , the system is integrated with it.

The result produced by the system is shown in fig 3. It was observed that percentage of resource utilization is increased by using underutilized resources. Trade–off analysis among extracted security NFRs are shown in fig 4.



ig 3. Number of processvs percentageof utilization

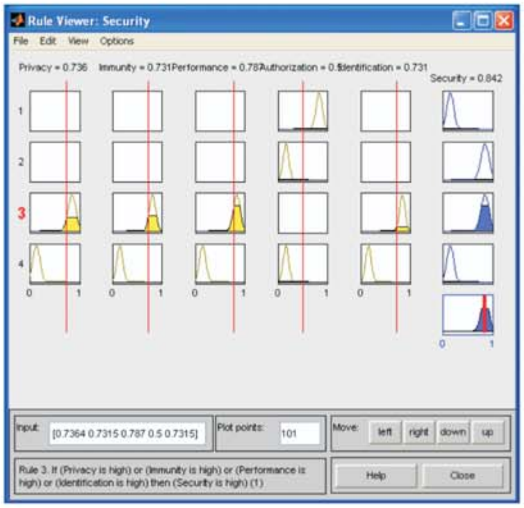


Fig. 4. Ruler view for security NFR

VI. CONCLUSIONS

On numerous occasions, grid users face non availability of high-end resources for completing the task on hand. But a resource management system needs to provide feasible, reliable and judicious resources in an efficient manner. However, current resource management system is not utilizing the resources in an efficient way. It is in this context, the system outlined in this thesis will be most appropriate and convenient.

The proposed system shows the integration of requirement engineering and grid environment. The system is proposed to enhance the known methods of grid resource discovery with an innovative mechanism. It plays a vital role in bridging the seemingly wide gap between grid environment and requirement engineering.. Quality of the service being provided also improved by considering the NFR preferences of grid users.

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