Trust and Reputation Based Association Among Grid Entities

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Abstract: - Grid creates a service oriented marketplace where dynamic service level associations are setup among grid entities i.e. service providers (resources) and service consumers (application programs). Service level associations among grid entities depends upon many parameters such as performance, completion deadlines, reliability, trust and reputation of grid entities etc. In this paper a novel service level association between service provider and service consumer is proposed which depends upon trust and reputation component. Grid service is executed in a cooperative environment where a set of \( n \) resources is associated to the requesting application for execution. Resources in the set are included on the basis of their individual reputation and trust component. An overall reputation and trust component of the unit is computed from the reputation and trust of individual resources in the unit and which can be used for the allocation of application to the unit.

Key-Words: - Grid computing; Grid service; Grid entities; Trust and grid; Cooperative computing, Reputation

1 Introduction

Grid [1] can be seen as a geographically scattered marketplace [2,3] of large scale computing resources. Different autonomous domains own and manage the resources in the marketplace. Resources from multiple domains are integrated together to form virtual organizations (VO) [4] for providing service to the demanding applications. Large scale resource intensive applications which were difficult to execute due to the scarcity of resources in a single place are able to harness the computing services from this marketplace. Resource users are no more required to invest hugely in acquiring the needed resources at one place instead they can hire the needed resources from grid by paying only on resource usage basis. Tools and protocols are proposed in literature [5-7] to coordinate grid entities (resource providers and resource users) for setting up service oriented architecture (SOA) [8] for the fulfilment of requested grid services.

Grid entities operate under the aegis of their owning domains and have individual goals. Hence to ensure quality and reliability of service over grid is difficult process. Grid characteristics such as resource heterogeneity, resource dynamism, network dependency, decentralized control, volatility etc. results in incomplete or delayed application in grid. Hence to ensure quality of service and performance in grid efficient scheduling strategies are needed which can take into consideration the grid characteristics while finalising resource selection.

This paper presents a parameter of association among grid entities. A cooperative set of grid resources is formed on the basis of their trust and reputation component. Trust and reputation of the cooperative set is computed from the trust and reputation of the individual set members. Selection of cooperative set for application execution may be done on the basis of overall trust and reputation component of the set. Rest of the paper is organised as. Next section introduces the scheduling strategies devised on the basis of different parameters. A brief introduction of the related work is also included in
this section. Section 3 presents the behaviour analysis of the grid resources on usage experience basis. Evaluation of the trust and reputation of the resource set is also included in this section. Sections 4 conclude the work.

2. Existing Scheduling Parameters and Related Work

2.1 Performance Prediction and Future Forecasting Based Scheduling
Performance predictions and forecasting future resource behaviour has been used to take effective scheduling decisions in grid. In this direction PACE toolkit is proposed in [9] for performance prediction of parallel and distributed systems. It provides quantitative data regarding the performance of executing applications on parallel & distributed systems. Conservative scheduling mechanisms in dynamic environments are proposed in [10]. Mechanism uses information about future CPU load and expected variance in CPU load over some future time interval to take efficient scheduling decisions. Network Weather Service (NWS) has been proposed by R. Wolski et al [11] to forecast dynamically changing performance characteristics in the distributed computing environment. These forecasts are used to devise dynamically adaptive scheduling techniques to achieve a reliable service in distributed environment.

2.2 Adaptive and Redundant Application Execution
AppLeS [12] is a template-based grid software development and execution systems in which a scheduling agent is attached with each application to monitors resource performance and generates dynamically a schedule for the application. In Gridway framework [13] each application has a personal submission agent that provides the runtime mechanisms to adapt the execution to the changing conditions of grid. The Cactus Worm [14], an experimental framework incorporates adaptive application structures and adaptive resource selection in the dynamic grid. Following the performance degradation, alternative resource is selected and application is migrated to the alternative resource. S.S. Vadhiar et al. in [15] discussed a software system that dynamically adjusts the parallelism of the applications as per the changing load characteristics of the underlying resources in the grid. In [16] service task is partitioned into execution blocks and individual blocks are assigned to different resources for parallel execution. Service reliability is achieved by allocating same block to several independent resources for parallel execution.

2.4 Resource Availability Modelling and Scheduling
Scheduling strategies are proposed which takes into account the probable availability of the resources during application execution. Grid resources which are expected to remain available during application execution will have a stable performance. Papers [17-19] have contributed towards resource availability to make right resource selection in grid. In [17] Different availability states are identified as Available, CPU Threshold Exceeded, User Present, Job Eviction, and Unavailable. The future resource state (unavailable/available) is predicted by analyzing its availability history. In [18] resource availability in desktop grid is characterized by obtaining application level traces for four real enterprise grids (http://desktopgrid.lri.fr/traces). A measurement task is executed on desktop grids which record the attributes like computing power it has exploited from the desktop grid, various causes of task failures, and the availability pattern. Measurement task is executed as a real task on the grid and exploits the grid resource in the same way. Markov job scheduling based on availability (MJSA) is proposed in [19]. Availability of the desktop is modeled using Markov chain.

2.3 Related Study
A reputation based scheduling model for unreliable distributed infrastructure has been proposed by J. Sonnek et al. in [20]. Reputation of the worker nodes is ascertained through the statistical study of reliability of the nodes from the past performance and behaviour. P. Varalakshmi et al [21] proposed a reputation based trust management architecture where grid entities are associated with more than one broker in grid. Trust values for the grid entities are computed dynamically at the completion of each transaction in grid and are distributed among multiple brokers, hence results in redundancy of information. Information redundancy at broker level improves service reliability and eases network traffic during handling the service request. N Griffins et al [22] used experience based trust for resource selection in grid. In this model grid is organized as a multi-agent system (user agent and
 resource agent) where trust in an agent is represented by a numerical value between 0 and 1. Effectiveness of trust based resource selection is shown through comparison of different algorithms that take into account cost, strict trust, stratified trust, stratified trust with cost, windowed trust and windowed trust with cost are used for selecting resources. A trust model is proposed in [23] to manage behavioural trust between grid entities. Different mechanisms for computing behavioural trust and trust decay function are specified in the work. A resource management algorithm that includes trust is exemplified. S. ThamaraiSelvi et al [24] has proposed a trust model in grid where trust is evaluated based on affordability, success rate and bandwidth. The proposed trust model is incorporated in Gridway metascheduler [25] where resources are selected based on trust values and high success rate of job completion is achieved. Y. Yu et al [26] proposed a trust model for open grid market. Both direct trust and indirect trust (reputation) are taken into account and a method based on multiple attribute decision making is used determine the weigh for both direct trust and indirect trust in grid. A trust calculation method in grid is proposed by J. Luo et al in [27] (inter- domain as well as intro-domain). Using the computed trust a resource access framework is also given. A prototype system based on the proposed method of trust calculation is specified. Performance analysis of the prototype system verifies its suitability for grid. In the existing trust and reputation based scheduling schemes, trust and reputation of the individual resources is considered for application scheduling. Grid is a highly dynamic platform where parameters such as network failures, overloading etc may cause performance degradation. In the presented paper application is scheduled on a set which is formed on the basis of trust and reputation component of individual resources, hence even the unexpected failures due uncontrolled parameters such as network failures will not result in application disruption. The application will be executed cooperatively by the set members. The load of the failed resources will be taken up by an alternative resource in the set.

3 Experience Based Behaviour Analysis of Resources
The local (organization level) as well global (environmental) factors force the grid to exhibit highly dynamic and unpredictable behaviour. These factors include local usage policies, job and resource priorities, volunteer participation of resources, economic constraints, self inclinations, malicious behaviour of resources, network anomalies etc. Although the local factors can be managed at organization level but the environmental conditions are difficult to control due to the lack of global control over grid. In such situations, a careful selection of resources, which are committed to grant the reliability and quality of service can prove grid as a dependable and reliable service infrastructure.

We have devised an experience based behavioural analysis of the grid resources which can be used in carrying out scheduling decisions in grid. Given behaviour analysis is motivated from the actual service market where some service providers may have more dedication toward rendering a good service. They may not compromise on their reputation and goodwill. Similarly some other service providers may be having more inclinations towards profit making and are ready to compromise their reputation and goodwill in the market. Consumers can decide and choose the better options through self experience or experience based recommendations by their peers.

For making easy and effective experience based decisions for the selection of service providers in grid, their behaviour analysis is expressed tangibly. Simple mathematics is used to compute the user satisfaction factor for the service providers they have experienced with. It is the ratio of number of times the service provider has provided successful and satisfied service divided by total number of times service provider was engaged for service (number of times it has provided successful and satisfied service plus number of times it has provided unsuccessful and unsatisfied service). For the computed ratio approaching to ‘1’ the user satisfaction with the service provider is high and it will be preferred to obtain the service while for the computed ration approaching to ‘0’ the user satisfaction factor is low and the user will dislike obtaining the service from the service provider. To mark the cutoff points in user satisfaction level with the resources, the user satisfaction level is segmented for making easy decisions for the selection of service provider in grid.

\[ 0 \leq \text{user satisfaction level} < 0.5 \]

Dissatisfied, application dislike the service provider

\[ 0.5 \leq \text{user satisfaction level} < 0.75 \]

Average satisfaction level
0.75 ≤ user satisfaction level ≤ 1.0

Satisfied, resource will be preferred

These factors of user satisfaction level may be modified depending upon the situation of application execution. For the large availability of resources the satisfied segment of user satisfaction factor may further raised to high or for the lesser availability of resources the satisfied segment may be lowered to have more resource options for application execution. Similarly the segments may be decided based on the exigency of application execution.

Trust and reputation component of the cooperative set \( (\text{CS}_{\text{T&R}}) \) is computed as an average of the trust and reputation of the individual resources \( (\text{RT&R}_i) \)

\[
\text{CS}_{\text{T&R}} = \frac{\text{RT&R}_1 + \text{RT&R}_2 + \ldots + \text{RT&R}_n}{n}
\]

\( \text{CS}_{\text{T&R}} \) component can be used for scheduling application in grid

4 Conclusion

Service level association based on the trust and reputation of the cooperative group is recommended in this paper. Since the cooperative set is formed on the basis of trust and reputation of the individual resources in the set, the overall performance in the cooperative environment will be enhanced. In the future studies usefulness of the presented association among grid entities on the basis of trust and reputation of the cooperative set will be tested through simulation.

References:


