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Certificate

I hereby certify that the work which is being presented in this thesis entitled “QoS based Resource Provisioning and Scheduling in Grids”, for the award of degree of “Doctor of Philosophy” submitted in Computer Science and Engineering Department of Thapar University, Patiala, is an authentic record of my own work carried out under the supervision of Dr. Inderveer Chana and refers other researchers works which are duly listed in the reference section.

The matter presented in this thesis has not been submitted for the award of any other degree of this or any other university.

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This is to certify that the above statement made by the candidate is correct and true to the best of my knowledge.

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Abstract

Grid computing has emerged as a computing paradigm to solve large-scale scientific applications which require massive amount of high computation power that can be achieved by efficient utilization of heterogenous and dynamic resources. As the Grid has become a viable high-performance alternative to the traditional super-computing environment, various aspects of effective Grid resource utilization are gaining significance as resources being the base of the Grid. In order to access the appropriate resource at the right time, in the right manner, the first step should be to find out resources' features such as accessing interface, meaning of parameters, functions realized, required accessing conditions etc. Therefore resource management in Grid computing has become a key research area and due to multitude of heterogeneous resources, resource provisioning and proper scheduling in the Grid resource management is required for improving the performance of the system.

Resource provisioning and scheduling are key issues to handle the resource management efficiently besides other numerous issues. Unless resource provisioning is considered a fundamental capability, predictable QoS can't be delivered to Grid consumers. Therefore, it is an inherent need to design a resource provisioning policy based on QoS parameters for Grid environment. Resource provisioning and scheduling solutions strengthen the management of Grid resources in an efficient and effective way. To achieve the set objectives of addressing QoS based resource provisioning and scheduling challenges laid for this thesis, a comprehensive literature review on Grid resource provisioning and scheduling has been done. A thorough study of resource provisioning with QoS and without QoS has been carried out. A comparative study of Grid middleware and Grid schedulers has been done. The existing Grid scheduling heuristic approaches have also been studied and analyzed. Based on the literature survey, it is apparent that issues of provisioning and scheduling are the main challenges besides numerous other issues that need to be addressed. To address diverse Grid resource provisioning and scheduling challenges, a Resource Provisioning and Scheduling Framework has been proposed in this work.

The proposed Resource Provisioning and Scheduling Framework offers resource provisioning policies and resource scheduling algorithm that caters to provisioned

resource allocation and resource scheduling. The policy rules have been specified in XML schema. QoS parameter(s) based Resource Provisioning Policies provide provisioning of the resources according to user's requirements. The policies have been validated by Z Formal specification language. Further, the QoS based resource provisioned approach has been implemented in GridSim toolkit. The results demonstrate that QoS based provisioned approach is effective in minimizing cost and submission burst time of applications in comparison to non-QoS based resource provisioned approaches. The implementation of this policy enables the users to analyze customer requirements and define processes that contribute to the achievement of a product or service that is acceptable to their consumers.

A hyper-heuristic approach for resource provisioning based scheduling can be used to effectively schedule the jobs on available resources in a Grid environment as it applies a low-level heuristic that associates the best mapping of the resources to the corresponding jobs. Bacterial Foraging Optimization (BFO) is a technique which is able to attain optimal scheduling decision by satisfying QoS services and can thus be applied to a Grid environment. Therefore, a novel Bacterial Foraging Optimization (BFO) based hyper-heuristic resource scheduling algorithm has been designed, proposed and implemented for scheduling of jobs in Grid environment so as to minimize the cost and time by minimizing the makespan and maximizing the security and reliability. The comparison of the proposed algorithm with existing scheduling heuristic based algorithms has also been done. The proposed algorithm not only minimizes the time and cost but also maximizes security and reliability. The performance of the proposed algorithm is evaluated through the GridSim toolkit using Ali's simulation model. The experimental results show that hyper-heuristic based Grid resource scheduling algorithm outperforms in comparison to hybrid-heuristic in all cases.

Finally, the framework has been compared with existing Resource Provisioning and Scheduling frameworks to validate the outcomes. The results show that Resource Provisioning and Scheduling Framework successfully and collectively addresses the issues of resource provisioning and scheduling to establish an efficient Grid.