An Evaluation of Availability Comparison and Prediction for Optimized Resource Selection in the Grid

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ABSTRACT

Resources in the Grid exhibit different availability properties and patterns over time, mainly due to their administrators' policies for the Grid, and the different domains to which they belong e.g. non-dedicated desktop Grids, on-demand systems, P2P systems etc. This diversification in availability properties makes availability-aware resource selection, for applications with different fault tolerance capabilities, a challenging problem. To address this problem, we begin by characterizing resource availability properties to explore different patterns over time. We further model availability behavior of resources belonging to different classes of availability policies. Predictions for resource *instance* and *duration* availability are made through *pattern recognition and classification* using different availability properties. We are able to achieve an average accuracy of more than 80% in our predictions.

1. INTRODUCTION

With the growing maturity of the Grid technology, the composition, functionality, utilization and scale of computational Grids continue to evolve. The large scale computational Grid environments and testbeds under centralized administrative controls, such as, Cern LCG [1], Tera Grid [4], Grid'5000 [2], Austrian Grid [3] etc. amass hundreds/thousands of resources, which vary considerably in terms of number of sites, resources at each site and their availability patterns. These include high performance dedicated clusters, resources available for short periods such as public resource computing PRC systems [6], labs from the universities, and resources on-demand [3]. At such a diversified scale, a large number of these resources may be unavailable at any time, mainly due to wide range of policies for contributing these resources to the Grid, scheduled maintenance, and unpredictable resource failures. The same resources may exhibit different usage patterns over time and thus resource owners/administrators implement different policies for *when* and *how* to make their resources available to the Grid. Some of the Grid-sites might even be temporarily removed partially or completely from the Grid to accommodate other tasks or projects.

The resource components, Grid middleware maturity, varying resource maintenance and manageability make resource availability characterization and prediction a hard problem. In addition, necessity of inclusion of information from a wide range of policies for resource availability in the Grid makes the problem even more challenging. To address this problem, we present in this paper our Grid resource characterization, modeling and prediction system. Availability trace of resources in Austrian Grid is undertaken for our present study. To understand resource (un)availability behavior, we begin by considering resource availability policies, exposing availability characteristics and finding different patterns over time from a long-term trace, in Section 4.2. Several other studies characterize or model availability in different environments like cluster of computers [7], multi-computers [21], meta-computers (also called desktop Grids) [17], Grid [19], [5], super-computers [21], and peer-to-peer systems [16], we are the first to identify the different resource classes based on their high level policies for availability in the Grid and characterize their availability behavior to find availability patterns at class level. We further compare resources based on their MTBF(Mean Time Between Failures), MTR(Mean Time to Reboot), time distribution in different availability durations, and are the first to compare resources based on their stability for jobs of different durations (see Section 4.3). Next, we model resource lifetimes and unavailability durations at class level to quantify their availability behavior as mathematical models and make their survival analysis, as described in Section 5. Section 6 describes mathematical reasoning for our present study. In Section 7, we make resource *instance* and *lifetime* availability predictions using methods from *pattern recognition and classifications* incorporating their availability patterns. Please note that in this paper we use the terms *machine* and *resource* interchangeable.

We design and build different predictors that take advantage of different availability properties, and compare their effectiveness. We investigate effectiveness of our prediction methodology on Austrian Grid resource availability trace. Results from the prototype implementation of our system in ASKALON [22] show that more specific information is critical for better predictions. On average, we are able to get more than 95% accuracy in our *instance* availability predictions and more than 75% accuracy in *lifetime* predictions.

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Research Abstract	The functional heterogeneity of computational Grids has highly increased due to inclusion of resources other than dedicated to Grid, like from non-dedicated desktop Grids,on-demand systems and even from P2P systems and mobile Grids. At such a diversified scale, resources exhibit different availability properties mainly due to administrators' policies for resource availability in the Grid, and their failure/unavailability properties. These make resources' availability predictions for optimized resource selection, a challenging problem. Addressing this problem, we characterize resource availability properties against their availability policies to understand their availability behavior and quantify it through availability models. We further exploit the availability/failure properties to make predictions about their availability through pattern recognition and classification. We have achieved, on average, accuracy of more than 90% and 75% in our predictions for resource instance availability and lifetime respectively.