Towards Scalable Grid Replica Optimization Framework

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Abstract

Data Grids are becoming a popular infrastructure for distributed, data intensive scientific application. Data access optimization is one of the key features of such systems, as the transfer and access to the huge amounts of data are often the bottleneck of the data intensive tasks. Concept of replication, creation of multiple copies of a data source across multiple grid nodes, was adopted by grid community to increase data availability. In this paper, we present the ongoing work on the grid replica optimization framework that addresses both short-term and long-term replica optimization problems. We describe high level architecture of the optimization framework and discuss the promising results achieved by prototype implementation of several system components.

1 Introduction

Many scientific communities face the problem of sharing data sets between geographically distributed organizations and their storage resources. Data Grid technology address this challenge, data grids connect computation and data resources spread in a large geographical area and allows users to share them. The concept of replication - creation of multiple copies of a data source across multiple grid nodes - was adopted to increase data availability in the Grids.

High energy physics domain is a classic example of advantageous use of the data grids. Physical experiments produce large amount of data which needs to be distributed to hundreds of scientist around the world.

Earth observation is another domain that can profit from the data grid technology. We illustrate this on the example of the Medigrid project. The project aims at creating a distributed framework for multi-risk assessment of natural disasters. It will integrate models of forest fire behavior and effects, flash floods, erosion and landslides. These models will be upgraded to web applications in order to be able to be run remotely as web services and to eliminate a single point of failure. Data for the simulation models needs to be shared between geographically distributed computational facilities. All the models use the spatial data for computation of the simulations; those spatial data are often reused by different simulation jobs. The data grid technology and the replication concept will be used to satisfy the requirements of the project. As the access to the data is often the bottleneck of such distributed systems, we propose a replica optimization framework to provide efficient, reliable and transparent access to the distributed data. The problem of replica optimization can be divided into two subproblems:

- Short-term optimization - aims at minimizing data transfer time, given a requesting grid node and logical file name.
- Long-term optimization - concerns global reduction of network traffic in the grid by deciding which files should be replicated (or deleted) and where to place those replicas.

In this paper, we present the ongoing work on the replica optimization framework that addresses both short-term and long-term optimization. We present the framework's architecture, which was designed to be highly scalable to support the needs and requirements of diverse user communities. We describe the primary modules of the system, the short-term and long-term optimizers. Moreover, we present, in the scope of the grid technology, an alternative approach to the short-term replica optimization and a novel function for predicting the replica usability for long-term optimization. Finally, we discuss the performance results achieved by prototype implementation of those components.

2 Related work

As the optimization of access to the data in the highly distributed environment is an important issue, it was ad-