# STUDING DYNAMIC GRID OPTIMISATION ALGORITHMS FOR FILE REPLICATION

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**Key words to describe the work:** File replication algorithms, grid simulator.

**Key Objectives:** Explore the stability and transient behaviour of selected optimisation techniques.

**Motivation for the work (problems addressed):** File replication if correctly dynamically handled provides a powerful method of optimising a computational grid. This work is focused on the study of replication algorithms, to find a high performance replication strategy.

This study was made using a computing grid simulator called OptorSim [1], written to model program execution times and their dependence on file replication strategies. The simulation program was based on the architecture of the European Data Grid [2] illustrated in Figure 1. Contained within OptorSim, multiple Computing Elements and a single Resource Broker were modelled as concurrent services by implementing Java threading technology.

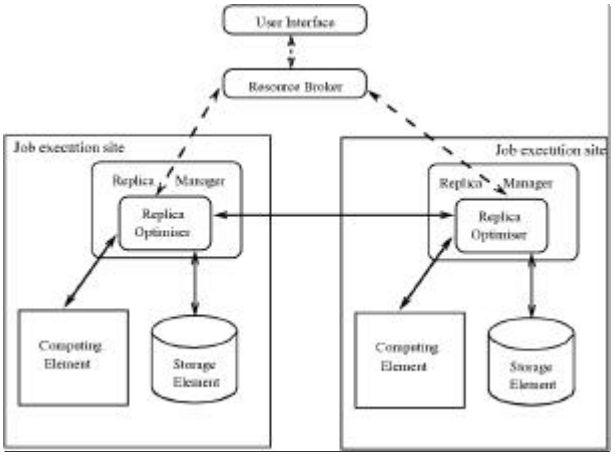


**Figure 1: Simulated European Data Grid Architecture**

Using the approximate network geometry of the testbed 1 sites, given in Figure 2, together with their respective storage allocations, applicability of the results was ensured. As the simulation program was initialised the simulated storage was filled with file sets corresponding to the CDF run II data [3], representing a typical HEP data set. These files were randomly distributed across the Grid and initially being unique i.e. no initial file replication. Then $10^4$ jobs were submitted to the Resource Broker. Since the purpose of the study was to investigate the behaviour of file replication algorithms each Computing Element was allocated to one job and had no associated queue. The

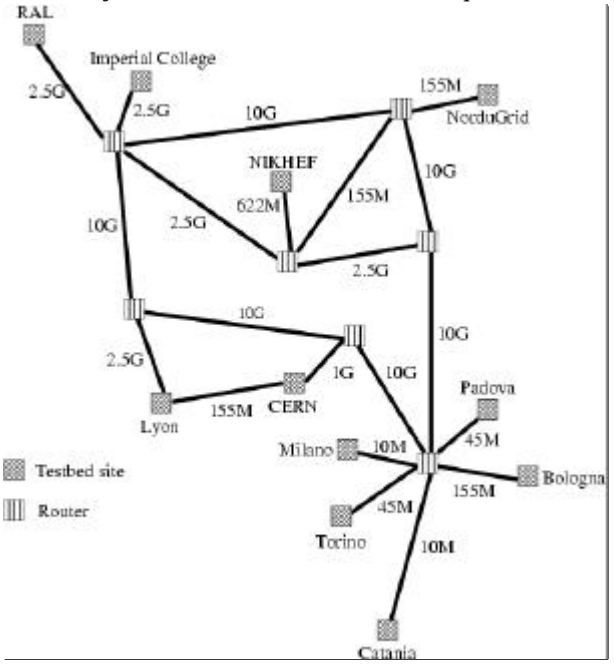


**Figure 2: The European Data Grid testbed 1 sites and the approximate network geometry. The numbers indicate the bandwidth between two sites.**

Resource Broker therefore simply operated by polling each Computing Element in turn in an attempt to start a job. Each time the simulation was run one of the four different replication strategies was employed: no replication, delete oldest file, delete least accessed or the Economic Model [4]. Using any one of the four replication strategies the Computing Element caused a file request to be made to the replica optimiser. The replica optimiser then selected the best replica based on the network bottleneck between the local site and a remote site or in the presence of a replica on the local site selected

the local one. If the replica was not found to be stored within the local site, an attempt was made to create a local replica of the remote file at the requesting site. The individual replication strategy determined if a replica was made or not. The results of the four running conditions together with four different access patterns are given in Figure 3. These results show that without

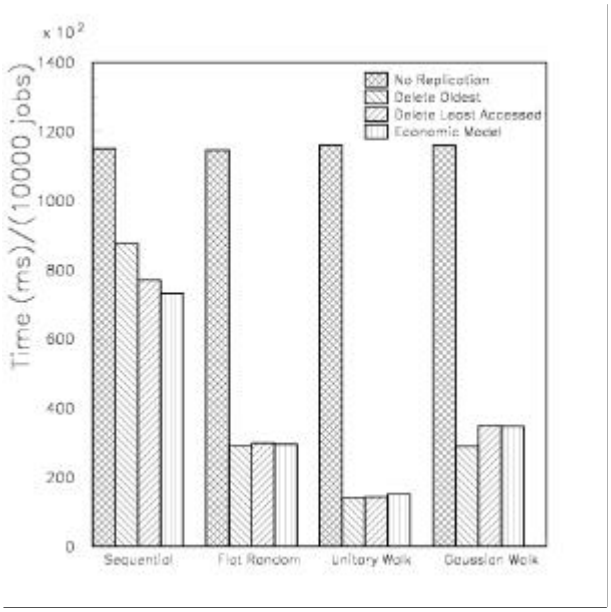


**Figure 3: Integrated running times for 10000 jobs using each access pattern and replica optimisation algorithm.**

significant tuning the Economic Model is at least as good as the best simple file replication strategies and in most cases provides a performance improvement.

The behaviour of the economic model is demonstrated by: time evolution within the simulated computing grid environment illustrated within Figure 4 and the job time distribution histogrammed in Figure 5.

All the work carried out by the authors was undertaken as part of the European Data Grid project. Authors from the University of Glasgow are also part of the GridPP collaboration.

[1] "OptorSim, A Replica Optimiser Simulation", http://grid-data-management.web.cern.ch/grid-data-management/optimisation/optor/
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[4] M. Carman et al., "Towards an Economy-Based Optimisation of File Access and Replication on a Data Grid", International Workshop on Agent based Cluster and Grid Computing at International Symposium on Cluster Computing and the Grid (CCGrid 2002), IEEE Computer Society Press.

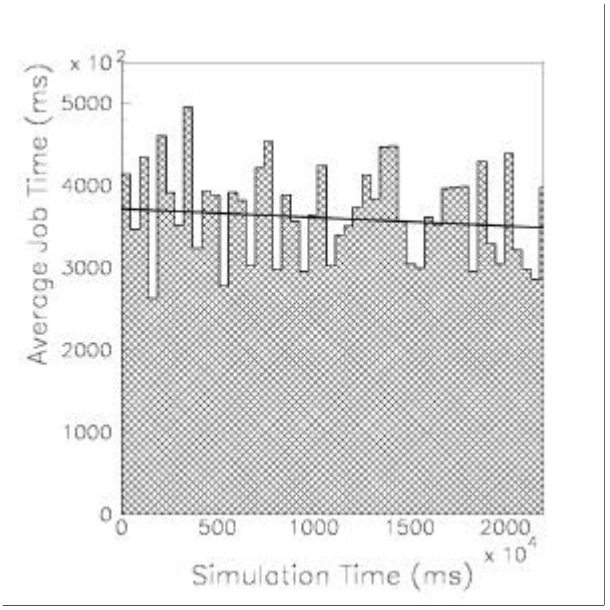


**Figure 4: The progression of integrated job time as a function of time.**

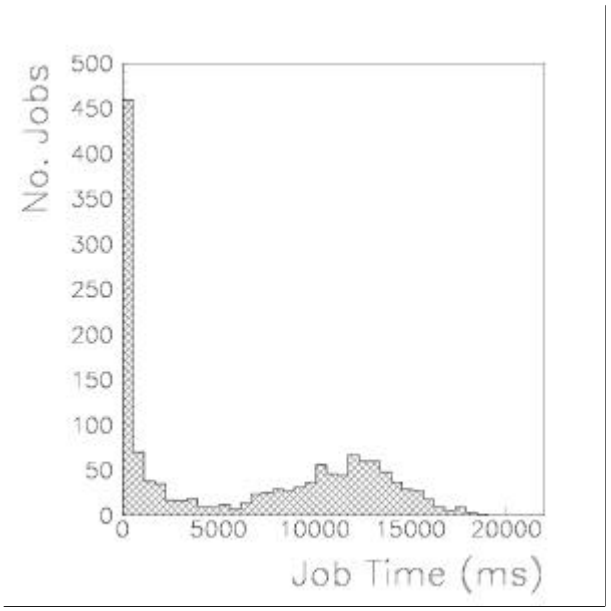


**Figure 5: A histogram of integrated job time over the total running of the simulation**