A Java-centric Network Computing Service

JICOS is a Java-centric distributed service for high-performance parallel computing which has been designed for performing highly scalable, adaptively parallel computations with basic fault-tolerant schemes and enhancements to improve the performance of the applications.

The API has been designed using the divide-and-conquer paradigm and includes a globally accessible immutable input object and an asynchronously shared mutable object. The computation is modeled as a directed acyclic graph (DAG) whose nodes represent the tasks to be performed. All the tasks have access to an environment consisting of the input object and the shared object which the tasks can modify during the course of the computation. This Cilk-like model supports explicit continuation passing that helps improve host utilization and enables efficient recovery from host failure. Each of the task objects encapsulate computation which is idempotent so as to support failure recovery.

JICOS comprises of three service component classes - 1. Hosting Service Provider (HSP) with which the clients interact (logs in , submits computational tasks, requests results and logs out) and also manages a network of task servers, 2. Task Server, that defines mechanisms to stores the Task objects created by the client applications and to distribute the tasks to a number of hosts assigned to it. 3. Hosts, that repeatedly ask for and execute the tasks and returns the results to the Task servers.

The API includes a simple set of application-controlled directives such as Task caching, Task prefetching and execution of tasks on the Task Server instead of executing them on the Hosts (Compute Server) for improving performance. These features help reduce the communication latency associated with the Host-TaskServer communication and facilitates overlapping of computation with communication.

In order to accommodate faulty hosts and to support self-healing, leasing mechanisms are used. The Task Server has a lease manager that maintains the leasing information. When the lease expires for a particular Host, the host proxy (the remote proxy to the Host) returns the host's tasks for reassignment to other host(s) and is removed from the Task Server.

The authors should that JICOS provides excellent speedup through various experimental setups. Measured times were recorded using its invoice system, which reports elapsed time between the submission of the application's source task and the receipt of the application's sink task's output. They show that it performed a 200-city TSPLIB traveling salesman problem via branch-and-bound using 1 host (2 CPUs) in 9 hours and 33 minutes, while doing the same problem using 120 CPUs in under 12 minutes, attaining 96.66% of ideal speedup in a heterogeneous environment.